LEATHER PROCESSING INDUSTRY JIGAWA

MINIMIZING THE RISK OF FIRE **IN LEATHER** INDUSTRIES

BY

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B.SC. (HONS) ARCHITECTURE

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DECLARATION

I solemnly declare that the material presented to make this thesis is the product of my research work for the thesis topic: Minimising the Risk of Fire in Leather Industries: A Design Proposal for Leather Processing Industry Jigawa State.

All information source are acknowledged and listed in the referenes at the end of this thesis write-up.

Sign: _____ Date: 03-11-98.

Yoosuff Garba Saddeeq.

DEDICATION

This thesis write-up is dedicted to 'ALLAH' the most gracious, the most merciful for the endless love, guidance and protection during my stay in school up to the last time of struggle.

CERTIFICATION

This thesis entitled "minimizing the Risk of Fire in Leather Industries by Yoosuff Garba Saddeeq meets the regulations governing the award of Master of Science (M.Sc) in Architecture of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literacy presentation.

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EPIGRAPHS

One of the main criteria in factory design should be the needs of the workers. However, successful building is in terms of easy and cheaper erection or however attractive its facade, if the workers are not happy in their environment, then the design is a failure, therefore tension can be reduced and work output increased through careful planning.

S.S. Utkigar

(Former Senior Lecturer in Architecture, A.B.U., Zaria)

Both the quality and quantity of the products depends not only on the sequence, precision and efficiency of the factory tools and machines, but largely on the proficiency, pride and fitness both metal and physical of the personel.

(Francis W. Gencorelli)

When Architects and entrepreneurs get together to design a factory, too often, the comfortability of the workforce is neglected. S.S. Utkigar Former Senior Lecturer in Architect at Ahmadu Bello University Zaria, suggest a way in which machines and workers in a factory can be organised without much compromise.

THESIS ABSTRACT

The theme of this thesis is on Hides and skins tannery (leather processing industry) to be sited in Shiwarin, of Jigawa State. Though it is mainly in pursuance of academic goals, it is also practically feasible and therefore, accommodation has been made of this practical aim.

A remarkable feature of our post-independence national development plans is the conscious and sustainable effort to diversity Nigeria's economy. Though about 75% of Nigeria's population is agrarian, Nigeria realises that in order to attain an accelerated growth in her economy, the country must embark on a bold programme of industrialization. For this industrialization to be achieved Nigeria or its States must start with industries that can source their raw materials locally. Thus leather industry is one of such industries. The potentials for a fast Leather Industrial Development are present in Jigawa State because of availability of raw materials in every nook and corner of the State. Yet efficient exploitation and utilization of such potentials are never backed up with adequate investment; since the creation of the State; even with the presence of establishment such as Nigerian Industrial Development Bank (NIDB), the Nigerian Bank of Commerce and Industry (NBCI), the Nigerian Indigenisation decree (1972), whose primary aims are to create more business opportunities for indigenous business men and women, to maximize local retention of profits and to raise the level of intermediate and capital goods production; yet in the field of

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leather industry, despite proliferation of such industries in other States, Jigawa can not boast of any, in that direction.

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CHAPTER ONE

1.0 INTRODUCTION

Leather is by far the primary product manufactured from hides and skins. In addition to leather, other uses include food, cosmetic ingredients, an medical prosthetics, such as skin graft and sutures.

While other minor uses may be cited, the economically most important use of animal hides and skins is for leather manufacturing.

The main reasons of processing hides and skins is to render them resistant to decomposition or bacterial decay, to improve physical properties, such as tensile strength, flexibility, resilience, abrasion, resistance, and permeability to water.

1.1 MOTIVATION

The industry is looked as dirty, ugly ,dangerous and only a necessary evil. These opinions have been expressed since the industrial revolution in Britain. I honestly and sincerely believed that architects can contribute their quota in making the public to feel that industries are part of their environment and not a necessary evil.

In this thesis, I shall attempt to change this believe.

1.2 AIMS AND OBJECTIVES

To propose a leather processing industry bearing in mind the following.

1. Safety from disaster and pollution.
2. Easy flow of raw materials and finished products.
3. To provide employment to the people of the area.
4. To design the social amenities on the site to allow for maximum interaction between workers, both in the production are with machines and during as short break.
5. Plan the industry in such a way as to minimize the risk and spread of fire.

1.3 SCOPE

The scope of this proposal will includes, the provision of administrative core, production hall, anxilliary facilities, storage facilities, maintenance area, effective vehicular circulation; and future expansion.

1.4 RESEARCH METHODOLOGY

Ways on how to minimize the risk of fire in industrial buildings (leather industries) are investigated through the examination of various construction materials and application of fire safety regulations.

The following methods shall be used in obtaining information/data, necessary for the research work:

(a) Field work- This involves site visits to existing leather industries in Kano. There will be visits to the proposed site to identify the features on site.

(b) Printed Datsz - This shall involve gathering literature on Leather processing technology with particular reference to how to minimize the risk of fire such literature could be obtained from seminar paper, published and unpublished text.

(c) Interviews- This ia an interview with appropriate people concern on processing of leather, ways of minimizing industrial fire safety, so as to be acquainted with the technological problems involved.

1.5 HISTORICAL TREND IN DEVELOPMENT OF INDUSTRIAL ARCHITECTURE

Origin in industries could be traced to the beginning of industries could be traced to the beginning of industrial revolution. This means that, industries may be said to have evolved when mechanical labour was substituted for manual labour at the inception of industrial revolution.

In the change from machine tools to machines, machinery was used to produced great quantity of products quickly and cheaply. There are generally agreed three periods of industrial revolution.

First period from 1750 - 1830

Second period from 1830 - 1871

Third period from 1871 - date

The first period saw the beginning and development of machines. In the second period of industrial revolution mechanization was consolidated in many parts of Europe. From 1871 to date, industrialization has undergone many changes from simple steam powered engines to atomic energy powered plants.

Preceding the industrialization was the mechanilist period. In this period, commerce and trade were the most essential. This period was however, characterized by growth of foreign markets, individuals becoming richer and this led to the establishment of large industrial concern which meant an end to the guild restriction textiles, coal iron, and steel and steam engines were developed.

Factory designs were geared toward mass production. It should be noted that before this time, "industries" were parts of home, but with the advent of machine, the name became too small to accommodate the machines. This called for specialized buildings to accommodate machines. This marked the beginning of formal industrial architecture.

Peter Behrens (1868 - 1940) was one of the architects that developed a form of architectural thoughts that answered the demands of industrialized society. he designed and built turbine factor between 1980 and 1909 in Berlin, Germany. This became what some historian called the "industrial temple".

It served as an expression of manumentality to European architect.

Walter Gropius and Adolf Meyer designed and built the Lagos factory in 1911. This building was a stepping stone in the steel and glass construction.

Simple task performance in industrial building emerged. But the consequences of industrialization were many: the following were the most important ones:

1. Emergence of the industrial class or the capitalist class.
2. Over production of goods.
3. Improvement in transportation and communication
4. Rural - urban migration.
5. Population explosion
6. Emergency of class society.

The early industrial architecture was more oriented. because of brutal working conditions, child labour, no proper ventilation, hearing, sanitary facilities, health and comfort of the workers where not considered.

1.6 LOCATION OF INDUSTRIES

Before citing any industry, feasibility study has to be carried out. There are many factors which influence the location of an industry.

1. Availability of raw materials.
2. Labour skilled or unskilled.

3. Availability of ready market for the finished goods.
4. Site location in relation to the city in terms of transport service, prevailing winds, level of air pollution and water pollution.
5. Physical features - quality of soil terrain, (flat sloppy, steep), sewage and industrial waste disposal.
6. Technology, machinery, type and quality of production energy supply.

1.6.1 Planning the industry

It is necessary when planning an industry to zone the complex for minimization of construction costs, maximization of profit and production output. The architect, therefore has an important obligation to meet the above requirements through good planning. Proper zoning and utilization of site should be done to be above to achieve all this.

In this regards there are three main objects located in common areas:

(a) Production, storage building and plants.
(b) Energetic transportation and installation of all sorts.
(c) Social, administrative, and cultural building, labs and service objects.

Generally there are six different zones in the master plan of an industry:

1. Entrance - which depends on the volume of traffic, there are usually separate access for both pedestrians and vehicles.

2. Transportation zone - for both vehicular off-leaned and loading ares, parking areas, turning spaces are located in a place convenient enough to avoid congestion of traffic.

3. Production Area - Concerned with the production and distribution of energy are closed to biggest energy devices and units and long transportation zone.

4. Auxiliary building - It is usually designed along with the main production hall because of their close relationship.

5. Storage - There should be divisional stores (where necessary) located closed to the respective production halls and the main store near the transportation zone.

6. Administrative zone - Which caters for the day to day running of the industry concerned.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 LEATHER

Leather is animal hides or skins that has been processed or converted into a stable and non-putrescible state, whereby the skin or hide becomes more durable and capable of being used for a wide range of products. Large animals, are said to have "hides" (Cow hide, buffalo hide) while smaller animals have "skins" (goat skin, sheep skin). The principal hides and skins used in the manufacturing of leather are sheep, goat cattle, house, camel etc. These represent more than 90% of the world production. Other hides and skins used economically includes those of reptiles , donkey etc. depending on the area. In either case, the hides or skins are composed of water, proteins, and unless preserved, decay rapidly.

As regards their histological structure, the skins of mammals are al, more or less the same. The skin consists of three layers:

(a) Outre layer or epidemics (that beans the hair)

(b) Coriuim or dermis (the middle layer)

(c) Subcutaneous connective tissue or hypodermis (the belly part containing fats and proteins).

The hides and skin the most important raw material for the leather processing industry. They are removed from the animal carcass by an operation known as flaying when the

animal is either slaughtered or as a game, killed. The corium or dermis (middle layer is used for any leather production. The outer layer and the hair are removed by chemical or enzymatic treatment before processing, while the subcutaneous connective tissue (hypodermics) is removed. The connective tissue of the odium or dermis (middle layer) which consist mainly of protein collagen, is a network of fibres, ramified and interwoven in al directions without beginning or end. This corium in turn also consists of two layers:

(i) Papillary layers, which adjoins the outer skin and whose surface consist of a particularly fine and closely packed fibre network, the grain.

(ii) The reticular layer, which also lies below the papillary layer.

The skin consists of mainly water, proteins, fat and mineral substances. Its dry substance contains approximately 50%C and 25% Oxygen, 7% Hidrogey, 17.8%Nitrogen and 0.2% mineral matter. The outer skin and hair on the other hand, consist of protein keratin; while the corium (dermis) contains up to about 99% of the protein collagen and about 1% elastin (calculated on the dry substance).

2.2. HISTORICAL BACKGROUND

The making of leather is one of the oldest crafts practiced by mankind. The production and use was identified with earliest artifacts and recorded history of every known

culture. Man had therefore known how to make leather for thousands of years. Infact, Cavemen made clothing and coverings for their bodies from leather that had its hair on it. The earliest Egyptians had made leather so well that, pieces over the years had been found perfectly preserved. Egyptians were so skillful in even dyeing the material in so many colours too. For several thousands of years and even up to today no articles are more familiar than that made of leather, thus, it had a long tradition of service. Infact, Inspite of the world wide trend to exploit an alternative material from other sources, this commodity still finds its bearing the world over.

2.3 HIDES AND SKINS PRODUCTION IN THE WORLD

The world produces 202 million hides and 484 million skins annually. The largest producers of hides are the Soviet Union (41 million), the United States (37 million) and India (28 million); goat skins, India and china, sheep skins, the Soviet union, Australia and New Zealand.With an expected increase of 40 percent over that of previous years in meat the supply of raw hides and skins will increase to meet the increased demand for leather.

	Country	Amount
1.	The Soviet Union	41,000,000
2.	The United States	37,000,000
3.	India	28,000,000

Source: The Encyclopedia Britannica, Benton William (1973).

The world leather trade is largely concentrated in the advanced countries (mostly in the organization for economic co-operation and Development group) that trade among themselves. The major exporters also of the finished leather are the France, the United Kingdom, Germany, United States of America and Italy, who is also the biggest footwear exporter, followed by Japan. The scarcity and high cost of labour, the reluctance of labour to perform dirty operations as well as realization that every developing nation is anxious to develop its own industry, have however, forced these advanced countries to by more and more leather in place of the raw hides and skins from the developing nations.

2.3.1 The raw hide as a Commercial Product

There are three main categories of raw hides: -

Hides: Cow ox, steer, house, pig, buffalo hides etc.

Small skins: Calf, sheep, goat, lamb, rabbit skins etc.

Reptile skins: Snake, crocodile and lizard skins.

Fish and bird are also sometimes used, but only in very small quantities.

2.3.2 Hides and Calfskins are classified and traded according to weight. The hides of domestic cattle, mainly from Europe and America, are called Native hides, while the

hides of animals kept in a semi wild state in South America, Africa, India, China et are known as exotic hides. Kips are lighter cattle hides, mostly from India.

2.3.3 Goat skins and Sheep skins are calculated per piece (in dozens or hundreds). The most important sources of supply are Spain, England, Greece, Turkey, Iran, Indian, Pakistan, Gangladesh, Indonesia, North and South Africa, Nigeria, Australia, and new Zealand. The best skins with regard to grain quality however, come from Europe.

Pickled pelts In the case of sheep skins, the wool is often removed in the country of origin. The pelts are then pickled to preserve them nd shipped to the processing countries.

Persions come from a breed of sheep found in India and in the near East. In most cases, they are given a vegetable pretannage before being exported. Until recently, they were sued principally i the manufacture of clothing nappa, clothing suede, bag leather and lining leather, but they are now also being made into shoe upper leather.

Wet blues are chrome-tanned cattle hides and small skins which are shipped in a moist state and slightly preserved in polyethy lene bags Wet blus are being produced in increasing quantities not only overseas, but also in Europe and in the

United States of America in specialized leather processing industries which are often connected to the abattoirs. The retannage, dyeing, fatliquoring and finishing are carried out in the processing countries.

Crust material is tanned and dried in the producing continues and finished in the processing countries. There are two type - Chrome-tanned and retained) and "vegetable crust" (Vegetable/synthetic-tanned).

2.4 DIVISION OF HIDES INTO SECTIONS, HIDE PATTERN

The different parts of animal skins vary widely in their thickness and histological structure. The most valuable, most uniform and largest part of the skin is the butt. (See Fig. 1). The bellies have a looser fibre structure and not so thick. The shoulder is more loosely structured than the butt, is of similar thickness.

Hides are considered to be of good quality if they are of relatively uniform thickness and fibre structure. Poor-quality hides ar those with lose, non-uniform fibre structure and substantial differences in thickness between the butt and belly section.

Depending on the type of leather to be produced and the hide pattern, hides are processed as whole hides, sides, butts, shoulders, bellies, etc.... Cattle and horse hides are often split horizontally into two or more layers in the pelt

state or after the chrome tannage. The grain split is used for shoe uppers, clothing, furniture upholstery and bag leather, while the flesh split is made into suede spits, insoles, case leather and such like.

2.4.1 Types of Leather

Descriptions of the types properties of the differences types of leather and indicates the type of raw material used for each.

Bag leather is made from small skins, hides and pigskins with a vegetable/synthetic, chromic or combination tannage.

Bookbinding leather is made from vegetable/synthetic -tanned thinly split sheep skins, goatskins and pigskins.

Sole leather is used for the lower part to shoes.
Box calf is an elephant, chrome-tanned upper leather made from calfskins. It is very supple and has a typical, handle.

Chamois leather is made from dear, sheep or rabbit skins given a chamois tannage with fish oil.

Clothing leathers are purely chrome-tanned or combination-tanned, thin, soft and supple grain leather on suede made from sheepskins, goatskins calfskins, and vealeer as well as pigskins and other large hides.

Corrected grain side leather is side leather where the appearance of the grain has been corrected by buffing.

Fancying leathers are vegetable/synthetic or combination tanned leathers, mostly from sheepskins or goatskins, for all kinds of fancy goods (wallets, purses, diaries, book spines).

Full grain side leathers are split hides made from the grain splits.

Furniture upholstery leathers are thin, chrome-tanned leathers made from large cattle hides.

Gas meter leather is made from goatskins, usually combination-tanned.

Glazed kind is a very elegant, chrome-tanned, soft, supple and fine-grained upper leather made from goatskins and used mainly for ladies shoes. Previously, it was produced exclusively by the chrome- two bath tanning method.

Grain leathers still have the natural grain surface (as opposed to corrected grain leathers).

Harness leather is a strong, full grain leather made from vegetable/synthetic-tanned, combination-tanned or chrome-tanned large hides and used for harnesses and saddles.

Hydraulic leathers are chrome-tanned or combination-tanned large hides for industrial applications.

Imitation kind is made from sheepskins or large goat-skins which are not suitable for glazed kind.

Industrial leathers include leathers for driving belts, textile machines, gas meters, and sealers. Depending on the requirements, they are made from different types of raw material using different tanning methods.

Insole leather is vegetable/synthetic, combination or chrome-tanned leather made from cattle shoulders, bellies, or splits and used for the inner part of the shoes.

Lining leather is a relatively thin, vegetable/synthetic chrome or combination-tanned leather made from goat or sheepskins, pickled sheep pelts, side splits or flesh splits and used for inner part of shoes.

Morocco is a vegetable tanned leather for bags.usually made from East Indian Persians, with a characteristics "Boarding" grain.

Nappa is a very soft, thin type of leather for shoes, leather clothing and upholstery.

Nubuck leathers are chrome-tanned, slightly retanned calfskins or side leathers, the grain sides of which are buffed to give them a velvet-like nap. Used for shoes, leather clothing, belts etc.

Patent leathers are side leathers, calfskins and goatskin leathers finished with polyurethane lackquers by the BAYGEN process; used for shoes, handbags and other fancy goods.

Protective clothing leathers are leathers for protective workswear (shoes, gloves, aprons) made from chrome-tanned splits, side leather or pigskin leather, often with a spica finish (flame-retardant, oil repellent).

Reptile skins are obtained from snakes, lizards, crocodiles and other reptiles. The skins are chrome-tanned or tanned with purely synthetic tanning materials and used for shoes, handbags and fancy goods.

Shrunken grain leathers are produced mainly from cattle shoulders, calfskins, vealers and goatskins by means of a shrunken grain tannage with astringent, synthetic tanning materials and a subsequent chrome tannage. The have a very characteristics grain pattern and are used for shoes and handbags.

Side leather is a fallgrain, chrome-tannee upper leather made from large hides (grain split). Particularly soft types are known as softer sides.

Skivers are thin, vegetable-tanned grains splits from sheepskins and pigskins which are used for bookbindings and as shoe-lining leather, in the latter case laminated, if necessary, to make them stronger.

Softy leathers are particularly soft shoes upper leathers.

Sole leathers are vegetable-tanned or combination-tanned butts from splits large hides.

Splits are made from the middle and bottom layers of large hides obtained by splitting.

Splits hides are relatively thin, large, full grain or corrected grain, vegetable-tanned or combination-tanned side leathers for document cases, furniture upholstery, case, etc.

Strap leathers are strong, vegetable-tanned side leathers from military articles (straps, belts) and rustic chair seats.

Suedes are chrome-tanned calfskins, goatskins, side leathers or side splits (sued spits) buffed on the flesh side for shoes and clothing.

Swat band leather for hats, protective helmets, etc is made from vegetable/synthetic-tanned small skins.

Upholstery leather, furniture upholstery leather, split hides.

Upper leather is a collective term for all types of leather which are suitable for the upper part of shoes.

Veal box is a type of leather similar to box calf and made from light hides and vealers.

Waterproof leather are vegetable/synthetic-tanned or combination-tanned leathers for use in shoe manufacture. The welt is the part which attaches the upper leather to the sole on certain types of shoe.

2.5 MARKETING OF HIDES AND SKINS

Hides are purchased for their leather-making properties. A tanner purchases hides that will most economically produce

the type of leather he wants to manufacture.

Hides are purchased by weight, but the leather produced from them is sold by area. if a thin garment is being manufactured, then the best starting material is a thin hide. To make a heavy boot or sole leather a heavier hide is used. The hide is composed of a surface grain layer and a thicker corium layer underneath as earlier on mentioned. The inherent strength of leather is derived from the corrium and its esthetics value from the grain layer. As the proportion of grain to corium increases in a piece of leather, it becomes weaker. Starting with a thin hie to make light leather reduces the proportion of grain layer to corium.

The most prevalent hides on the world market being cattle hides.

2.5.1 Standard for cattlehide marketing

Hides are divided first into two groups, namely:

(a) Mechanically flayed

(b) Hand layed. The former are referred to as a packer hides and the latter as small packer hides. It is implied that the packer hides have better quality takeoff, although individual cases, this is certainly not always true.

The first standard for delivery is that all hide weights are determined at time of shipment from point of origin. Salt-cured hides tend to loss moisture during shipping. However, this is due to moisture changes, not to a loose in

leather-making material. Unless the hides is overdried, this water can be put back into the hide when it is soaked prior to unhairing (removal of hair).

1. **Hide trimming**

The hide must be trimmed to either the standard trim or modern trim. The standard hide trim refers to conventional hides. To fit this standard, horns, snouts, lips, ears, tail-bone, sinews, tendons, are excessive meat and fat should be removed prior to salting. Modern hide trim refers to hides that have been mechanically fleshed to removed the veins. In additional earns, ear butts, shouts, lips, fat and muscle tissue should be removed from the pate side of the head by cutting through the eyehole. The narrow side of the head should be trimmed thought the eye in a similar manner. All raged edges should be removed, and cow bages, teats, cool bags should also be removed, preserving a standard pattern. Tails may not be over 150mm long, and Kosher heads should be removed by cutting across the top of the Ksoher cut.

2. **Hide grading**

Hides are all graded it to No. 1, No. 2, No. 3 A No. 1 hide is free of holes, cuts, deep scores or guages more than half way through the hide, visible rain defected and brong grain, and these hides must have a correct pattern. The No.2 hides is andy hide that is off pattern, contains up to four

holes or cuts, a deep score or gouges, a grain break or wants up to one-third of the area of the side. A No. 3 hide contains hairslip, five or more holes and/or deep scores and gouges, one hole or cut over 150mm or a pepper box (concentrated grub area covering 300mm^2 or more), wants or any other defect covering more than one-third of hide. Harslip refers to the easy removal of hair from the hide just by rubbing the surface. It is generally associated with microbial deterioration. Hies grading as No. 3s should not be sent without the buyer's consent.

These are the basic rules with some additional/minor conditions. O course, any buyer and seller can mutually agree to any other standards.

2.6 CURING/PRESERVATION OF RAW HIDES AND SKINS

While other minor uses may be cited, the economically most important use of animal hides and skins is for leather manufacturing. There are only a few type of commercial tanning processes used currently, and the problems encountered in preserving skins for the manufacture of leather are common to all hides and skins.

Curing is most of the time used to simply imply the general preservation of the animal skin, including air-drying but, technically speaking, curing implies the use of common salt in the preservation of skins against bacterial attack, while preservation of skins means, the use of all means

including common salt and insecticides to protect the good quality of the animal skin protein until they are converted into leather. The skin like any other part of a living animal, is subject to rapid deterioration once an animal dis. On the living animal, it is an extremely effective barrier to microorganisms and provides effective protection against abrasion. However, once death occurs, the surface of the skin is rapidly invaded by bacteria. The same bacteria that had no effect on the living animals can begin to deterioration of the skin in a matter of hours. If one type of preservation treatment is not applied to the hide within 12 hours after slaughter, the quality of the leather made from that hide or skin will begin to deteriorate. The higher the outside temperature during the interim period between flaying and preservation, more extensive the damage. The grain surface of the hide is particularly sensitive. If tanning is initiated immediately after the removal of the skin from the animal, the most serious obstacles to producing a highly-quality piece of either are eliminated. If the green or raw hide or ski hoover, is not proceeded immediately after the flaying, then it must be preserved; as to protect it from naturally decomposition and putrefaction; as well as insect and mould attack.

2.6.1 **Preservation Methods**

Against putrefaction are:

1. Air drying, which is also subdivided into:-
   (a) Suspension drying
   (b) Ground drying
2 Curing: this also is subdivided into the following types:-
   (A) Wet salting
      (i) Braining
      (ii) Pack salting
      (iii) Drum salting
   (B) Dry salting
3. Pickling for storage
4. Refrigeration or cooling
5. Short-term preservation using bactericides

1. **AIR DRYING**

Air drying implies the use of air current in the preservation of hides and skins. This could also take place in the shade if possible. The two main acceptable methods to achieving this are:

(i) Suspension drying:-
   (a) frame dying, this is very important for hides. The hides are perforated at the edges and laced up by means of about on 0.2 - 0.3mm thick ropes to the wooden or iron frame. Efforts are made to avoid

the hide making any other contact with any solid object. In other words, it is suspended: as well as avoiding the rays of the sun striking it directly.

(b) Suspension drying in sheds, this is most efficient for drying skins. The idea here is that the skin is protected completely from the effect of the sun. Under the shed, they are suspended over a three wire system that provides a pyramidal shape; the apex and the base wires. The base wires separates the adjacent belly parts of the skin from making contact with each other, thereby facilitating free movement of air on both sides.

(ii) Ground drying

This is the major source of most putrefactive defects at the beam house. Putrefaction steps is easily here because, there is no free circulation of air on both sides. The side making contact with the ground constantly remains wet; as well as the hide or the skin pick up dirt and dungs easily, and this promotes rapid growth of bacteria.

2. **CURING**

Common salt chemically known as sodium chloride (NACL) is the main curing material for reshyly flayed hides and skins.

Sometimes, other salts such as khari salt, and Bittern-salts are used as substitute to common salt. Common salt in solution has the peropertis of preventing bacterial cells from growing and multiplying. Sometimes, the bacterial cells are killed. But in this case the correct quantity of salt must be used to obtain the best result. In any case of curing, exception in dry salting, about 25 – 30 % of the salt is required per the weight of the skin. A solution of salt in water is known as brine. In all curing process, it is certain that this solution must be formed before curing takes place.

(1) Wet salting: Among his type of salting, there is what we called:-

(a) Braining – This process involves immersing the hide in a saturated solution of brine and leaving it overnight before they are piled, drained and packed.

(b) Pack salting: When hides are freshly flayed, they are freshly played, they are sprinkled with about 1/3 of weight of skins with salt crystals and piled flesh side up, until a pack of about 1200mm is built.

(c) Drum salting: This method, provides another case of braining. The brine is forced into the hide by the up and down movement of the skin inside the drum. The advantage here is that it quickens the time. Usually, a slow running drum about 2 – 3 rpm

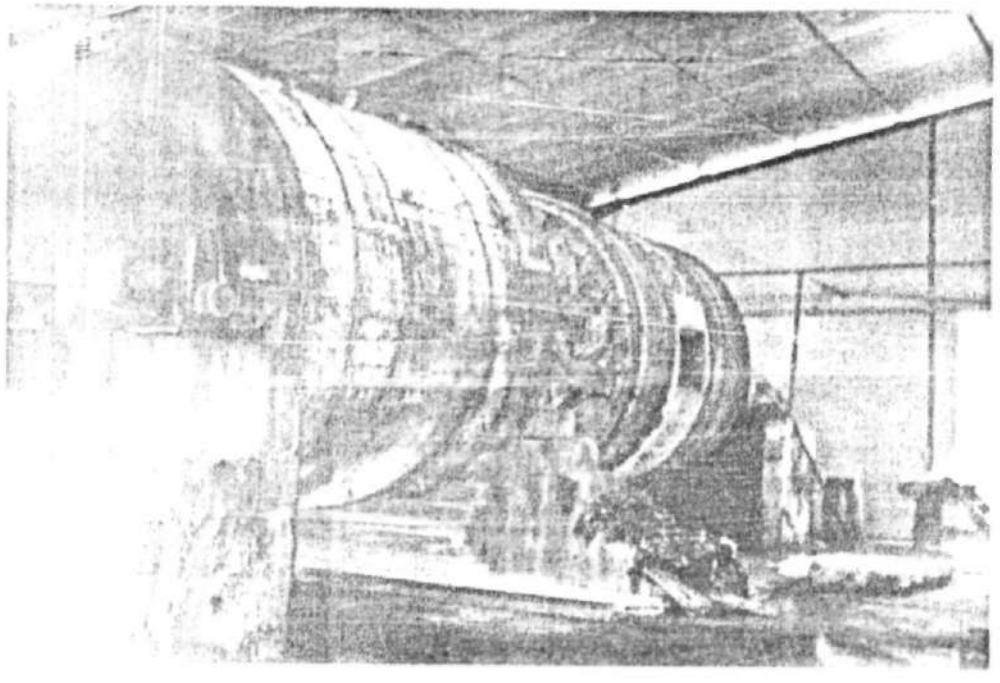


FIG. 2.0 DRUMS

is used. The drum should be run intermittently.

(ii) **DRY SLATING**

This curing method involves, treatment with brine followed with air drying. The quantity of salt used her is relatively small.

3. **PICKLING FOR STORAGE**

This is another important method of skin preservation, of thwich, if properly carried out will minimise a lot of risks that are usually encountered in air dried and slat cured hides and skins. The process is usually carried out with sheep skins where the wool has been removed already. However, it is common to find this practice carried out in commercial tanneries for export trade in Nigeria. It is important to note that common salt is also used in this process as follows:

Normal recipe

200% water

20% common salt

2% sulphaic acid

Drum 6 - 8 hours. Avoid high temperature in process and storage.

4. **REFRIGERATION OR COOLING**

As a condition for optimum growth of bacterial cells, a temperature of $40^{0}C$ is a prerequisite. It is common knowledge that as the temperature falls, the rate of the activity of

bacteria reduces rapidly. It has been established that a raw skin can be effectively preserved for a reasonable time if colled below 10^0C. In this case the temperature must be maintained at a constant range.

5. SHORT TERM PRESERVATIONS

This approach of preservation is recommended only when the process of preservation (air drying or curing) etc cannot be commenced immediately due to lace of space, and facilities. When used as an interim measure, to prevent putrefaction, the hides and skins are immediately after flaying, sprayed with this short term preservatives. It has been established that skins under this treatment can remain up to maximum one week before they are reprocessed on properly preserved.

But preservation against insect attack, mould, it is as follows:

The hide beetle is known as to attack the animals skin at its early stage of development in their lives. At the larval stage any skin that is not adequately protected will be eaten up very fast resulting in huge financial loss. Different types of insecticides have been developed for this purpose, however, they must be of the type that are approved in writing by the Chief Veterinary Officer of the States involved. Insecticides considered effective by most Nigerian hides and skins laws are:

(i) *Pyrethrum*

(ii) D.D.T. (Dichloro diphenyl trichloroethane)

(iii) B.H.C. (Benzene hexachloride)

(iv) Sodium silicofluoride

(v) Arsenous oxide (White arsenic)

The commonly used insecticide in Nigeria in the past years was white arsenic. For optimum use, its strength should not exceed 0.2% A_{s2}. The skin is dipped inside the tank and allowed from 3 - 6 hours for skins and 8 - 12 hours for dried hides. Of recent, modern insecticides have proved very useful, although not known to have been approved very useful although required by hides and skins laws. Actellic, a proprietary product from ICI, have proved very efficient in this regard.

For moulds, moulding of air dried hides and skins is most common under unfavourable storage condition. This usually reported during rainy seasons when the relative humidity in the air is high. The moulds grow to dark colouration on the flesh side of skin. The moulds liberate enzymes which are capable of hydrolysing the skin protein resulting into paddles on the grain. A common antimould agent is sodium pentrachlorophenate.

Another significant alternative to salt preservation, which in commercial use today, is to process hides and skins into leather immediately after slaughter. As mentioned earlier, larger packers have sorted hides off the kill floor

by weight, conveyed them into drum or paddles, and started the process within 6 - 8 hours after slaughter.

Cattle slaughter is not constant on a day-to-day basis; therefore, fresh hide supplies cannot be relied upon. Most leather processing industries that process fresh i=hies also process cured hides to maintain constant production.

2.6.2 Future of Hide and Skin Preservation and Marketing

The future of hide trading will be shaped by a variety of factors. The largest changes, some of which are already apparent, will be due to the changing nature of the meat industry. As red meat consumption continues to decline, so will the availability of hides. As a result, their value can only increase. The high cost of raw material has caused the process industry to become capital intensive rather than labor-intensive. This means that low labor costs in other parts of the world have less and less effect on the competitiveness. The market will be shaped by future regulations dealing with pollution, particularly with respect to dissolved solids. As more and more areas become impacted by the regulation of salt in the effluent, the pressure for a non-salt preservation method will become more intense.

In the future, there is potential for a high-tech preservation procedure using electron-beam irradiation. Beam irradiation process has been demonstrated to preserve hides for long periods of time with little impact on the leather

produced. It is superior to salt in terms of pollution abatement, but would require transport in sealed containers.

Another development, still on the drawing boards, is the removal of hair from the carcass on the kill floor before the hide is removed from the animal. If successfully implemented, this will greatly alter the current system of grading hides and will probably require a completely new marketing system for hides.

7.7 BASIC RAW MATERIALS (HIDES & SKINS)

The working material predominantly in the production of leather are dry or freshly flayed hides and skins from slaughtered cattle, sheep and goats. It must be noted that the presence of cattle, sheep, goats etc. in large scale is of great importance as far as the raw material is concerned.

From the slaughtered animals consumed daily, hides and skins are produced for use in this proposed leather processing industry.

Currents data from Jigawa State Ministry of Trades and Industries shows that Nigeria has a production of over one and a half (1,500,000) million cattle hides, one million (1,000,000) goats skins, and about two (2,000,000) million sheep skins annually.

Out of this, Jigawa State alone produces about:

10% cattle hides = 150,000 hides

15% goats skins = 150,000 goat skins

10% sheep skins = 200,000 sheep skins

The Jigawa State Government of Nigeria is planning to establish a leather processing industry in Shiwarin because of the abundant unutilized raw materials in the State. It is also the intention of Jigawa State Government to encourage cattle rearing both at cottage level and animal husbandry treatment in all location of the State so as to meet the increasing demand, thus, providing more raw materials for the proposed factory.

2.8 TRADITIONAL METHOD OF LEATHER MANUFACTURE

Raw materials in the leather processing industry do not end with only hides an skins. This process of converting hides and skins into leather will have to make use of so many additives products from the tanniferous plants (n the case of traditional tanning methods) and these plus other chemicals in the mechanised commercial leather processing industries. J. Minnoch (1969) said "Scientific principles have transformed leather processing from an art into an industrial process that can be carried out wherever suitable raw materials are available". The present methods of leather processing or manufacturing are the result of many centuries of experience. They have a large empirical content. The only indigenous raw materials used by these advanced industrial processing, apart from hides and skins is to lesser extent "Bagaruwa" tannis

from the pods of Acacia nilotiaca. However, the tarditional rural leather processing use the indigenous material prevalent in their surroundings in all their processes and stages of leather manufacture. These are the most common among them:

1. Hides and skins from cattle, horses, wild games, goats, sheep, crocodile, alligator, lizard, rabbit etc.
2. Wood ash, millet and guinea-corn-stal ash, Amazoro, wastes from Welders shops and their mixture.
3. Fataka, Gaba-Gaba and Tagiri, pigeon dung as well as Gwazarma.
4. Bagaruwa (Acacia nilotica V. Adansoni), Manke.
5. Groundnut oil.
6. Nono (raw cow milk)
7. Dry stalk of guinea-corn.

At the pretanning tags, of leather manufacture, dry raw hides and skins are soaked in water for a day or two. They are subsequently taken in a aqueous suspension of wood ash collected from the private house or millet-stalk ash or guinea-corn stalk ash or mixture of them all. The resulting suspension commonly regarded as the lime liquor is usually made in 2 – 4 pots or pits. Each pot or pit is replenished with more ash and water as the level and concentration fall with use. Wood ash is commonly used in Kano and Jigawa, with occasional addition of wastes from welder's shops as sharpener. For example, in Sokoto, majority of the rural tanners use a local lime called Amazoro. It is prepared from

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limestone by bring together limestone and logs of wood in alternating positions in shallow pit followed by sprinkling of water resulting in white to grey lime powder which turns brownish upon exposure. Other materials used in Sokoto, Zaria included fataka, Gaba-Gaba, Gwazarma, pigeon dung and Tagiri. These are used to reduce slipperiness of the pelt resulting from the effect of using lime liquor.

A common tannage given to pelts by traditional tanners uses the pods of a local plant called Bagaruwa and the bark of marike. These materials are prevalent in the Sahel region of this country with greater concentration in places like Katsina, Azare, Potiskum, Maiduguri, Niger republic, Damatur and Shendam as well as Sokoto and Kano.

During this traditional methods of processing hides and skins to leather, the hides or skin are subjected to various harsh treatments like liming which could easily saponify the natural fat contained in the hide or skin. Such skin or hide when finished with replenishing the oil would become harsh and even difficult to work on by the primary users. To remedy this situation, traditional tanners apply doses of groundnut oil on the grain side of the crust with the aid of a duster after the second tannage before the curst is finally stretched and twisted to dry out. In some cases, groundnut oil is applied to a semi-dry curst after the first tannage but before resoaking an reattange. Since the interval between oiling and retannage is usually short, most off the oil does not

penetrate the fibres of the curst, but would have done so if applied after retannage and prior to final drying. It has however been found that groundnut oil would penetrate the leather curst fibres much faster and exhibit better plasticising effect when it is emulsified after sulphation.

2.9 MODERN LEATHER MANUFACTURE

Although any hide or skin can be tanned into leather, those most often used aom from cattle, buffalor, sheep, goats and sometimes horses, camels, crocodiles, snakes and lizards. Skins of animals such as elephant, zebra, leopard, and tiger bring high prices. Animal skins vary in size, shape , texture, thickness, and quality. Quality depends on how and why the animal was reared, whether it died of old age or wa slaughtered, and its age, sex , and environment. Damages of many kinds reduced the values of hides and skins. The most common defects encountered are those produced on the live animal by parasites and diseases, old age, and malnutrition; brand marks and barbed wire scratches and on the dead animals by poor stripping of the skin, handling, and storage. With proper attention, many of these defects can be avoided.

Fresh hides are composed of 60-70 percent water by weight, 30-35 percent proteins, about 2 percent lipids, 0.5 percent carbohydrates, and 1 percent mineral salts and other substances such as pigments of the solid matter, 90 - 95 percent is made up of proteins, both fibrous and non-fibrous.

Of the fibrous protein, collagen accounts of over 85 percent of corium, elastin and reticulin are present in small quantities; hair and wool are made up of keratinous (horn-producing), globulin (soluble is salt solutions), and mucins, mucoids or glycoproteins (soluble in dilute alkalies). All soluble proteins are removed before tanning the fibrous protein chains are held in position by chemical bonds giving a cohesive structure that may be broken down by heat and hydrolysis to form glue or strengthened by tanning to produce leather. Actually, the science of skin proteins and their interaction with acids, bases, salts, and organic and inorganic tanning agents.

Through the developing nations of Asia, Africa and latin-America raise 60 percent of the world's cattle, 50 percent of the goats and 33 percent of the sheep, they do not realize the full value of the hides produced because slaughter is inefficient and poorly organized. Developing nations export mostly rawhides and skins and some leathers; they import finished goods. Tanning is still craft industry on the cottage level in the developing nations.

But modern technology promises to allow the developing nations a more full use of their animal resources; through the establishment of efficient slaughter houses, and large-scale, manufacturing or processing units. the development of their tanning industries will enable these nations to meet their own internal demands for leather and become exporters of leather

and finished leather goods. Thus, the leather industry may undergo a significant shift from advanced countries to the developing nations.

The first operation in any leather processing industry begins at the beam house; or pretainning stage. The purpose of pretanning or beamhouse operations is to remove undesirable constituents and to conditions or replace the water removed from the raw hide or skin during the preservation process. This operation is normally called soaking. The soaking may take from a few hours to several days depending on the type of preservation and the method of the soaking used. The soaking provides favourable conditions for the growth of micro-organisms, which damage the hide. To prevent the hide substance from being damaged in this way, the duration of the soaking is reduced by working at an elevated temperature (up to 30°c) and soaking liquor, an auxiliary which accelerates wetting and has a bacteriostatic effect. The soaking operation consist of the use of paddles to provide vigorous circulation of water round the skin or to facilitate flexing the skin in the water. This is an important factor in achieving through soaking in an economical time. For the soaked skin or hide to absorb water into the skin structure certain chemicals are used to facilitate this absorption, as well as to have a fairly gentle effect in promoting the uptake of this water. Examples of these chemicals are soaps and anti-bacteria. The soap is similar to our household detergent, while the anti-

bacteria chemical is used primarily to minimise petrifaction during soaking process.

7.9.1 Unhairing Liming

The aext essential preparatory state is loosing and removing the hair from the grain (outer) surface. In this liming process, the liming chemicals either destroy the hair and epidemics completely.. Normally the skins and hides are immense in the solutio o lime and water inside the paddles. The liming is usually carried out with hydrated lime (C_aOH_2 and sodium sulphide (Na_2S) or sodium hydrosulphide (NaHS), which has a less pronounced plumbing effect. For ecological reasons, liming liquors with enzymes and so called low sulphide liming liquors with sulphurous organic compounds are becoming increasingly important. Amine liming liquors (with dimethylamine sulphate and lime) and oxidative liming liquors with sodium chlorite ($NaCLO_2$) are used in special cases. Occasionally, the liming is carried out exclusively with hydrated lime ("straight white-lime"). This gives particularly soft fine-grained leathers. Straight white limes are also sometimes used for reliming following, liming with lime/sodium sulphide, if particularly soft leathers are required or if especially good opening up of the fibre structure is necessary.

With lime and sodium sulphide the liming process takes only 12-24 hours, depending on the temperature, addition of

chemicals and length of liquor. Depending on the concentration of the sodium sulphide, the hairs are either completely destroyed or loosened to such an extent that they can be removed mechanically without any difficulty. 1% sodium sulphide liming liquor (on 60% goods) is sufficient to destroy the hair. ($NaS_2HNO = NaHS + NaOH$).

Objectives of liming unhairing could be summary as follows:-

(a) To remove the hair or wool and the epidemics

(b) To open up the fibres and fibrils of the skin structure by alkaline swelling so that they may have more freedom of movement, giving a softer, more flexible finished leather.

(c) Digestion and removal of inter-fibrillary protein

(d) Saponification of natural grease.

Sodium sulphide is used as a sharpness modern unhairing and liming processes. It is particularly effective not only in speeding up the unhairing process but it has a manked effect on the second important objective of swelling the fibre structure.

When dissolved in water, sodium sulphidehydrolysic as follows:

NaS_2 + H_2O = Na HS + NAOH
(Sodium Salphide Water (Sod. hydrosulphide Sod.hydroxide

Attackshair and epidemics — Swells hair Structure

It must be emphasised, that, in a swollen condition hide and skin substances are very susceptible to damage by too much mechanical action, that is why the paddles are run intermittently throughout the liming process. The more gentle paddle liming is preferred.

2.9.2 Fleshing

The next stage of operation is fleshing. Fleshing means the removal of the flesh that has been cut with the skin during the flaying process. This process is carried out with a machine (fleshing machine).

The main objectives of fleshing are:-

(a) To remove the unwanted fat and flesh particles from the skin.

2.9.3 Deliming:

After liming operation, the lime or any other alkali in the skins is no longer required and in most cases, it has a detrimental effect on the next coming operation is tannage. With chrome tanning, it gives a hard, green inflexible leather and prevents proper tannage. Once the hair and epidermis are

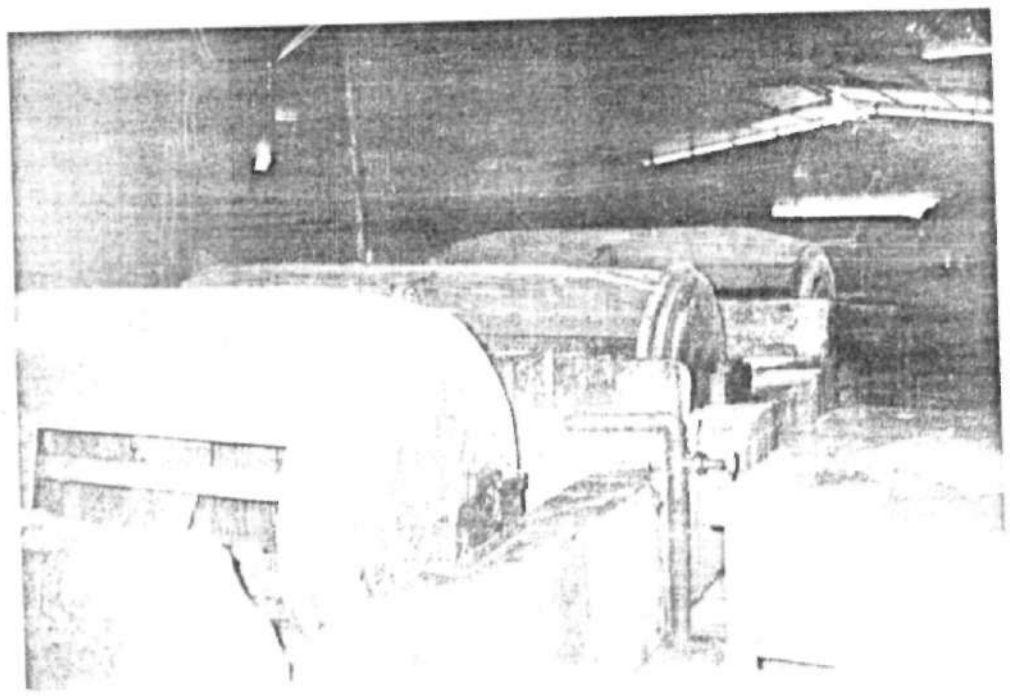


FIG. 2.1 PADDLES.

removed and the structure opened up by swelling, the strong alkalinity must be progressively reduced into acid range, which is ineffective range for the great majority of tanning.

However, it would seem logical to use a strong acid to reach the required acid range by neutralizing the alkalinity directly but this is not possible at this stage for two reasons:-

i) the deliming process may be followed by an enzyme process, bating, using an enzyme whose optimum activity occurs at PHS - 8.5. It is necessary initially to adjust the PH of the goods to this range in the deliming process if bating is to be effective.

ii) Even if the use of strong acids should be controlled, there would be a danger of replacing alkaline swelline which would be most undesirable and would lead to a hard leather with weak grain after tannage. For this reasons, deliming chemicals are chosen which will give the correct range of PH. for bating operation, with the minimum of control necessary and even if used in excess, will not cause permanent damage, hence the choice of Ammonium salts (ammonium sulphate) - acid salts.

The deliming effects is tested by applying a few drops of a 0.1% alcohol solution of the indicator phenolphthalein onto the cross-section of the pelt. Areas which are not yet delimed will turn red. If deliming is complete, the cross section of the Pelt will remain colorless.

The main objective of deliming is just to neutralize the alkali from liming process.

The chemicals used for deliming operations, have the following effects:

(a) ammonium sulphate:- It is an ammonium salt which is cheap and safe to use on hides or skins. The theory of its action is that it reacts with the strong alkalines in the hides or skins to produce the weaker alkali ammonium hydroxide and a buffer system is produced which stabilizes the PH. within the required range.

(b) Sodium meta bissulphite:- An acid salt which is added to the deliming liquor to produce some bleaching effect by removing any uneven or patchy color due to natural pigments remaining in the grain.

A simple deliming operations consists the following:

(1) Weighing out the following chemicals based on the weight of the lot accordingly.
   - Ammonium sulphate or ammonium chloride
   - Calcium chloride
   - Ammonium metal bisulphite

(2) Obtaining the other materials and tools needed for deliming operation.

(3) Loading the pelts in the drums and open water value to allow water flow into the drum.

(4) When the correct volume of water is attained, water value is cleared and weighed deliming chemicals are added.

(5) Drum is closed and start the drum from the control switch and note the starting time.

(6) Run the drum for the specified time, after this time out. Test the PH. of the liquor with phenolphthalein paper or indicator. If PH is okay according to job specification, stop the drum ready for the next operation - bating.

2.9.4 Bating

Deliming is followed by bating, which is usually carried out in the same drum.

The origin of bating process goes back many years: when liming was not a common practice, and when it was discovered that running the hides or skins with an infusion of dog or chicken dung produced a very soft flaccid and silky pelt with a very smooth grain surface. It is probable, that the effect was first observed when a dirty vessel contaminated with dung from the hides or skins was used and later dog and chicken dung become bating agent.

It is now understood, that the bating effect was due to digestive enzymes occurring in the dung. These enzymes have been isolated and produced in pure commercial quantities supplied as standard bating compounds.

The main purpose for bating is to further remove and loosen the inter-fibrillary protein and to make skins softer and cleaner.

Enzymes as bating agents:-

Enzymes are biological catalysts which accelerate the reactions without themselves being modified. Enzymes which act specifically on protein are protease like:

(a) Pancreas Protease

(b) Mould fungus protease

(c) Bacteria Protease

Some enzymes develop their optimum effect in slightly alkaline media and temperature is 30-37^{0}C but above can cause damage to skin. They also loosen the remaining hair roots, epidermal structure, pigment and fatty cells.

(d) Sodium chloride (salt) or ammonium sulphate (salt).

Some bating process requires the application of salt in order to bring about effective bating. Salt is added to the solution to facilitate the dissolution of the unwanted fibrellary protein. It also aids penetration of the solution into the skin. The application of salt further help to stop the reaction of the bate agent.

A simple bating operations run thus:

(1) Check the Pelts inside the drum and ensure that the delimed pelts are now ready for bating, and then open the drum.

(2) Add specified quantity of the bate into the drum according to the job specifications, close the drum and start it from control switch.

(3) Note the starting time and run the drum of specified time accordingly.

(4) After this time out, open the drum and check for porosity and thumb print of the pelts. If okey, get ready for the next process - Pickling.

(5) If however, the bating condition is not okay, continue with the bating process and control until it meets the specification required.

2.9.5 Pickling

This process consists of bringing the stock to a condition of equilibrium in the bath of sulfuric acid (H_2SO_4). Sulphuric acid is a very corrosive chemical used for pickling. The addition of this chemical is to adjust the PH of the pelt before chrome tannage. Diluted sulphuric acid is carefully and slowly poured into the liquor, taking care that no splashes of acid land directly on the skins or the operator. The pelts are run inside the drum for specified time to obtain thorough penetration. The acidity of the pickled pelts may then be checked and may be corrected by further additions acids if required to do so. The skins or pelts are drummed in salt and water solution until the salt has dissolved and diffused evenly before the addition of the sulphuric acid. Salt is actually added into the solution to prevent the skin swelling under high acidity. Infact, the presence of large quantity of

salt is not only to prevent acid swelling but to cause also some decrease in thickness of the skins which are not white scoff and flaccid.

PICKLING METHODS

I) Salt - containing pickle system Common salt (sodium chloride) with concentration of 6^0BE

II) Salt - containing poor pickle system

III) short picking methods

Pickling operational procedure, starts with ensuring that the bated pelts and liquor are ready inside the drum for pickling. After that, ensure that you obtain the specified weight of salt and keep near the drum. Then, open the drum containing the pelts and liquor, and add the salt into the drum and close it. Start the drum and note the starting time. The drum will keep on running for the specified time occurring to pickling specification. After this time out, stop and open the drum, to check the 'BE' of the salt solution. If 'BE' is OK, ready for addition of acid. At this level, measure out the specified volume of prediluted and cooled sulphuric acid, carefully pour this acid through the axle into the drum, ensuring that the acid does not drop directly on the pelts while the drum is running. Continue to run the drum for specified time depending of course on the pickling specification of the pelts lot. When the specified time is reached, stop the drum and check the PH. With PH indicator

paper. If the PH is Okay, according to the specification, leave the pickled pelts from the drum as the liqour in the drum is ready for the next process. However, do not remove the pickled Pelts from the drum as the liquor may form the basis for the next operational process.

In All leather processing procedures world wide, declined, bated. Stock is pickled with a mixture of sulphuric acid and salt in drums to either prepare for long storage or for mineral tannage. Fatty skins are however, decreased with detergent and paraffins solvents, washed and then finally picked. The temperature of pickling is very important consideration for any successful pickling.

Operation; with temperature below 27^{0}C (80^{0}F) being required to minimize hides or skins substance damage, including the potential of the hides or skins substance being dissolved. Commercial pickling processes may be overnight processes to attain equilibrium pickling of the stock and thorough PH. Lowering even the thicker portions of the stock.

Final pickle PH levels may vary from 1.5 to 3.0. The lower PH levels obviously increase the risk of protein damage. PH levels have been used where stock were being shipped and stored in the pickled state. However, the damage potential is high and PH levels over 2 with a biocide are prudent. For an integrated pickling and chrome tannage process, a pickle PH level of 2.5 to 3.0 is prudent commercial practice.

2.7.6 Tanning

After the beamhouse processes, the skins or hides are on the dry basis predominantly composed of the fibrous hide substance protein, and are now ready for the chemical conversion to a leather known as tanning. Tanning, like soaking is another gradual process from weak tanning agents to a more aneentrated solution so that the skins or hides may be properly tanned. In a more direct form, the tanning process actually convents the proteins of the hides or skins into a stable material which will not putrefy and suitable for a wide variety of purposes. There is a vast array of tanning methods and materials. The choice depends chiefly on the properties required in the finished leather.

OBJECTIVES OF TANNING. Tanning process is to bring about irreversible stabilisation of the hide or skin substance that is ordinarily prone putrefaction. But, the actual object of converting hide or skin into leather by tanning is to:-

(a) Stabilise it against enzymatic degradation and increase its resistance to chemicals.

(b) Raise its shrinkage temperature and increase its resistance to hot water.

(c) Reduce or eliminate its ability to swell.

(d) Enhance its strength properties

(e) Lower its density by isolating the fibres

(f) Reduce its deformity

Hides and skins are rendered non-putrefiable or they can not decompose again. The oldest system of tanning relied on the action of vegetable material containing tannin, but modern technology developed a large number of chemical agents and processes to finally be able to produce leather.

7.2.7 Tannage Methods: The following are some of the tanning methods that can be applied:-

1. Vegetable tannage: Vegetable tannage is still an important tanning method. Delimed pelts are treated with infusions of vegetable tanstuffs resulting in firm, fall, solid leather. Vegetable tanned leather can be produced from a variety of raw materials also. However, the major vegetable tanned leathers are bags, case, strap and shoe solving leathers produced from heavy cattle hides. The vegetable tanning are:-

Complex phenolic extracts from woods, banks and other plant parts.

There are two major classes of vegetable tanning materials; the condensed and the hydrolyzable tanning materials. The commercial extracts include a complex mixture of polyphenolic components. The hydrolyzable materials, such as chestnut, extract, contain glucose in their molecular structure; hence they are fermonting substances and break down more readily by hydrolysis into

simple structures. The commercial materials are often used in mixtures to optimize the leather qualities.

Tanning material is ground, leached with water, and concentrated into solid or powdered extract. Some times it is sulfite and bleached to yield more soluble and light colored extracts. Vegetable tanstuffs contains tannis, which are amorphous, stringent complex mixtures of polyphenols; and nontainning materials including carbohydrates, salts and acids, which also contribute to leather quality.

(2) Chrome tannage: Tanning with chrome compounds came to be the most important method in volume of production. Chrome tanning simply consists of neutralizing the acid of chromium sulfate by adding sodium carbonate. That is the reason why it is based on a very stable cross-linking via principal valency bonds, whereby the carboxyl groups -COOH of the collagen react with the chrome tannin. On account of the stability of this bond, chrome leather is resistant even to boiling water for prolong periods. The "boil test" often serves as the criterian for testing whether a chrome tannage has been carried out successfully.

The actual complex coordination chemistry of trivalent chromium compounds includes many complex ionic relationships (Harford 1979). The trivalent chromium is known to coordinate with nearly all electron pair donors and with chelating

agents. Chromium tannage processes utilize the complex coordination chemistry of trivalent chromium to control the uptake of chromium complexes by the skins and hides and the chromium fixation in the fibrous collagen matrix. Formate ions from formic acid or sodium formate are commonly added either during pickling or in chromium tannage step to modify the uptake of the chrominus complexes. the goal of the process is to secure fairly uniform chromium distributors within the hides or skins thickness and to promote penetration of the chromium complexes into the molecular domain of the collagen.

The chromium tannage process increases the resistance of the fibrous hide substance to hydrolytic deterioration. This change is measured by the empirical shrinkage temperature determination. Although hide collagen may shrink at 65^0C (149^0F). the tannel hide substance will not shrink in boiling water under the same empirical conditions.

The tanned hides or skins are blue in color and are commonly called chrome-in-the-blue or wet-blue stock. Recent analytical data from menden + nutland (1988) have shown that 17 commercial wet blue samples had an as-received moisture content ranging from 50.7 to 65.5%. The level of chromium in the stock is commonly expressed as percent of Cr_2O_3. Chrome-in-the-blue (wet-blue) has of revent become an article of commence worldwide. Some tanners carry out the beaming and chrome-tanning process at one location in third world countries for example and convent this wet-blue stock to

finished leather in Europe and United states. Tanners and hide and skin processing firms also sell the wet-blue stock for concession into finished leathers by other tanneries.

Chrome tanning involves drumming , the pickled pelt in pickle or a separate drum with basic chrome liquor marking and other agents are added before, during or after chrome tanning for special effects. Today the trend is toward the use of salt-free, masked, dry powder tannages. When tannage is completed in three or four hours, a small pieces of the leather is tested by plunging into boiling water for two to three minutes as earlier on mentioned.

Chrome tannage condition:

(a) PH. The normal PH value for chrome tannage is 3-3.8. At PH. 2.0, the skins or hides carries a maximum positive change without the negative group to fix the chrome. While, at PH 3, half the acid group are 50% changed. The chrome complex are attracted to the anionic group in the skins or hider. The acid side chain will displace water from the Cr complex and coordinate to the complex reducing its affinity for pelt and thus increasing the rote of penetration. (See chemical structure of chrome tanning compound).

The charge on the chrome will be reduced and to compensate for this, some SO_4 group is taken up by the NH_3^+

(b) Basification:

During basification process the PH of the liquor is adjusted, the size of the chrome complex is increased due to

olation.

(c) Piling: During piling operation the chrome becomes more concentrated. Sulphate radicals will enter the complex displacing water and making tanned leather less cationic, at the same time if any free fatty acid is present. They could coordinate to the Cr to form chrome soap thus making the wetting back of the leather difficult.

(d) Precipitation/dark green coloration

This effect occurs when the float during tanning is not up to the ample float necessary for tanning. Also when bicarbonate is not properly dissolved and added is bits, harsh, insoluble sodium sulphate results giving rise to a defect called CHROME PRECIPATION.

(e) It is noteworthy that no matter the % of chrome used to tan the skin or hide, no more than 50% of the quantity of the chrome will enter the skin or hide. Also the maxinim % of chrome to be used to achieve a full chrome upper leather is only 10%. Note that other reactions taking place during chrome tannage happen inside the drums.

Chrome tanning operational procedure:

(a) First, obtain the required job instruction from the supervisor, and then continue to check ensuring that the working drums are in good condition. There after, supply all that is required, examples are tools and materials to tanning area.

(b) Weigh out the tanning agents/chemical additives accordingly, and bring them to the specific drum to be used.

The common chemicals used are:-

- chromium sulphate or chloride
- sodium bicarbonate

(c) Add chrome into the pelts inside the drums and start the drums, to run for the specified time according to the job specifications.

(d) Then stoip, open and remove sample of the leather, to examine and check the PH of the liquor. If PH is okay, and no stains or patches on the leather, then it means the chromium has adequately fixed to the skins fibres. Also inspect for the color of the WET BLUE, if it is okay, then proceed to the next process of basification (if required)

(e) Weigh and dissolve basifying agent and add if slowly through the drum axle to neutralize (to basify) the acid in the skins or hides. With the drum still running for a specified time, check the PH of the liquor. If it is okay, depending of course on the job specification, stop the drum. Open it and discharge both tanned leather and liquor on the floor.

(f) Remove the pieces of tanned leathers (wet blue) from the floor, then pile them the grain-on-grain and fleshside-on- fleshside, and allowing the pile of the tanned

leather to stay in that position for a specified duration (ageing) depending on the job specification for proper chrome fixation. Instruct the attendants to pack the finally tanned leather wet blue for seeting (machine) operation.

3. Alum tannage: Although an old alum tawing method is still used for dressing (urs basic aluminum sulfate marked with atrate or tartrate is more effective. aluminum salts often are used in combination with formaldehyde to produce funs and white leathers; pickling and pretannage for chrome; and in pretannage and retannage of vegetable leathers to give soft, full nappaleathers and perspiration resistant insole leathers.
4. Oil tannage: Oil tannage have long been employed for the production of chamois leathers. Oil tannage is distinct process which is different from oil in tanned leather for lubrication effects. Modern chamois leather production processes utilize unsaturated oils e.g. raw cod-liver oil, which are partially oxidized in heated air rotating drums. This type of leathers unlike other leathers can be repeatedly wetted and dried without detrimental effects. The special properties of chamois leather result from its open structure. Chamois leathers is tanned with aldehydes and peroxides and created with polymers from oxidation of fish oil used in the tanning process. Long liming, bating, and mechanical pressing open up and split the

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fibres, stocking and pounding with fish oil and hanging in heated rooms oxidizes the fish oil. Compounds of copper, manganese, and cobalt accelerate oxidation. Excess oil is washed off with washing soda solution or wetting agents pretanning with formaldehyde is common. Though cod oil is favoured, sardine, rape, and saf-flower oils are also used.

5. Aldehyde tannage: Aldehyde tannages are used on certain specially leathers. Commercially accepted aldehyde tannages includes formaldehyde, glutaraldehyde and dialdehycle starch. Bated pelts are tanned with formaldehyde solution for two to four hours and excess flesh and bacteria/matter in the hides is mainly used in combination with other tannages. Glutaraldehyde tanning gives leather a yellow color and high resistance to perspiration and washing with soap, making it superior and suitable for shoe and glove leathers.

6. Synthetic tannage: Synthetic tans originated from studies of the effect of formaldehyde on vegetable tanning materials. The first of them, patented in 1911, was based on phenols and cresols. Later, naphthalene was used. Synthetic tans must have a large polymer molecule and must also be soluble in water. They are made by condensing (forming into polymer) simple phenol molecules and adding a sulfonate group to make the product soluble. This process also work in reverse, with sulfonation first

leather is sorted selection according to the grades; and types of leather it will produce. Hides or skins are all grades into #1, #2, or #3. A grade #1, hides or skins are free of holes, cuts, deep scores or gouges more than half way through the hide or skin, visible grain defects and broken grain, and these hides or skins must have a correct pattern. While #2 hide or skin is any one that is off pattern, contains up to four holes or cuts, a deep score or gourge, a grain break or wants up to one-third of the area of the side. A #3 hide or skin contains hairslip, five or more holes and /or deep scores and gouges, one hole or cut over 150mm or a pepper box (concentrated grub area covering 300mm^2 or more), wants or any other defect covering more than one-third of hide or skin. Hairslip refers to the easy removal of hair from the hide or skin just by rubbing the surface. It is generally associated with microbial deterioration. Hides or skins grading as #3B should not be sent without the buyer's consent, therefore these are the grades the normally go for retannage operation In the same tannery, while the #2, and #1 are packed on pallet, stored and exported as a wet blue. These are the basic rules with some additional minor conditions. Of course, any buyer and seller can mutually agree to any other standards.

The selection for export and retaining are classified or selected by gender, weight range etc. Within each classification, hides or skins as earlier on mentioned, are grade as #1, #2, #3, of course, this is quality assessment

based on quality of takeoff pattern, the number of holes due to butcher cuts, or grubs, and the overall quality of the hide or skin. Each combination of quality and selection grade has a market, and the price fluctuations depend largely upon the supply of the hides or skins and the demand at that particular time of the leather.

For those grades to be retain, the big ones may be split and then shared to a uniform thickness. The shaving determines the final thickness of the different types of leather. The following are some examples of the usual showing substances:

i) "Stretch" leather	0.4 - 0.5mm
ii) Clothing nappa	0.6 - 0.9mm
iii) Furniture nappa	0.8 - 1.2mm
iv) Shoe nappa	1.0 - 1.4mm
v) Softy upper leather	1.5 - 2.4mm
vi) Full grain and corrected grain side leather	1.8 - 2.3mm
vii) Heavy upper leather for Sports Shoes	2.3 - 2.8mm

When determining the showing substance, the effect of the dry method used on the thickness of the leather must be taken into consideration.

After showing, then the next process is dyeing. Leathers dyes are classified as follows:

1. Cationic (basic) dyes, used mainly for vegetable or

synthetically tanned leathers.

2. Anionic (acid and direct) dyes, used on chrome, vegetable and aluminum tanned leathers; direct dyes give god surface dyeing with no affinity to vegetable leathers.
3. Amphoteric dyes, which easily penetrate chrome but not vegetable leathers.
4. Chrome mordant dyes, which give deep and fast shades; used in gloving leathers.
5. Metal incorporated premetallized dyes, which are slow to penetrate but give good levelling and color fastness despite exposure to alkali and washing.
6. Reactive dyes, which will not run when dry cleaned; used mainly for suede and gloves leathers.

The dyestuffs have been customarily secured in dry form and levels of use from 1% to 3% may be necessary to produce the leather color onto which the finish will be required. The suede leathers require more dyestuffs and as much as 15% may be necessary. The dissolved dyes are customarily applied in rotary drums containing the retained stock.

The specific dye choice is of course, primarily based on the color desired in the leather. Shade, strength, brilliance and penetration are important factors in dye selection. Dyestuff fixation and exhaustion is promoted by addition of up to 1% formic acid.

Dyes are applied to leather by brushing on one side, tray

dyeing, drum dyeing, spray dyeing , solvent dyeing, vacuum dyeing, or dyeing through tank and squeeze-rollers.

LUBRICATION OR FATLIQUORING: Unless lubricated, leather dries hard, dyed leathers are treated with oils and fats for lubrication, softness, strength and water proofing. Oils and fats are incorporated individually, or in blends, in natural condition, as emulsion or in solvents, by hand or in a drum. Vegetable tanned leather (light) are oiled by swabbing groundnut (peanut) oil on the grain surface. Sole leather is drummed with a mixture of vegetable oil, mineral oil and small amount of sulfated oil, epsom salts, and glucose. The oil keeps loose tanning material from rising to the grain during drying and produces supple, light-colored leather. Belting leathers is treated by hand or in a heated drum with a mixture of cod oil, tallow, wool grease, steamine and paraffin wax. Carrying is similar, incorporating such mixtures as a hot melt.

Light leathers are fat liquored in a drum with an oil and water emulsion. The uniform penetration of the leather by fat liquor gives soft, stretchy, loose-grained leather if the fat liquor is deposited only on the surface, the leather is resilient and tight. Raws oils mixed with emulsifiers give desired properties of softness and pliability to suede. Raw oil mixed with soap on sulfated oils are commonly used. The use of newer synthetic tannis, impregnants and finishes along

with vulcanizing and cementing of shoes. makes constant new demands upon leather lubricants. Workmen must be careful not to use too much soap or the leather will be discolored. After fat-liquoring the leather is removed from the drum and horse up.

SAMMING SETTING OUT

After a successful fat-liquoring. the leathers are removed from the drums and horse up for the water to be drained natural before finally being placed on a samming machine; that further remove the excess water. iron out wrinkles and press down the grain.

DRYING

After from the retannage and fatliquoring. the method of drying also has a decisive influence on the final quality of the leather. In fact. after dyeing and fat-liquoring. the leathers must have contains 45 to 60 percent water and is dried to about 14 percent moisture. chemical and physical reactions taking place. When leather dries to a pale shade. loose tannis. dyes and oils spread uniformly. penetrate deeply and are fixed firmly. Uneven drying causes the migration of unfixed tannin dye and oil to the surface. resulting in dark stains in loose areas. During drying leathers tends to shrink. particularly when the water content falls below 25 percent and drying temperatures are high. Vegetable tanned leathers

shrink less than others.

Humidity and temperature control are imperative ingredients in drying process in order to maintain proper hygroscopic balance to avoid deformation of the surface and fibres by non-uniform evaporation of moisture and to condition the leather for subsequent stages of manufacture.

DRYING TECHNIQUES

Among the most popular drying techniques are:-

(a) Air drying: here skins or hides are hung from hooks or on sticks or are placed on horizontal racks and allowed to dry by natural passage of air or with the help of overhead fans. Vegetable tanned leather sare air-dried. This process is cheap and yields slow drying and gives uniform light colored product, but the productivity is very low. To ensure a round, soft handle, the water content hare should not be less than 20% when the leather sare removed from the racks.

(b) Vacuum drying: This drying method is particularly suitable for all full grain upper and bag leathers, giving the best result as regards handle, fine grain and smoothness. In this type of drying, leather is spread out, grain down on a smooth polished metal plate heated by a built-in thermostatically controlled heat exchanger, covered by an airtight hood. The air is then removed from under the hood Drying to 14 percent moisture is complete

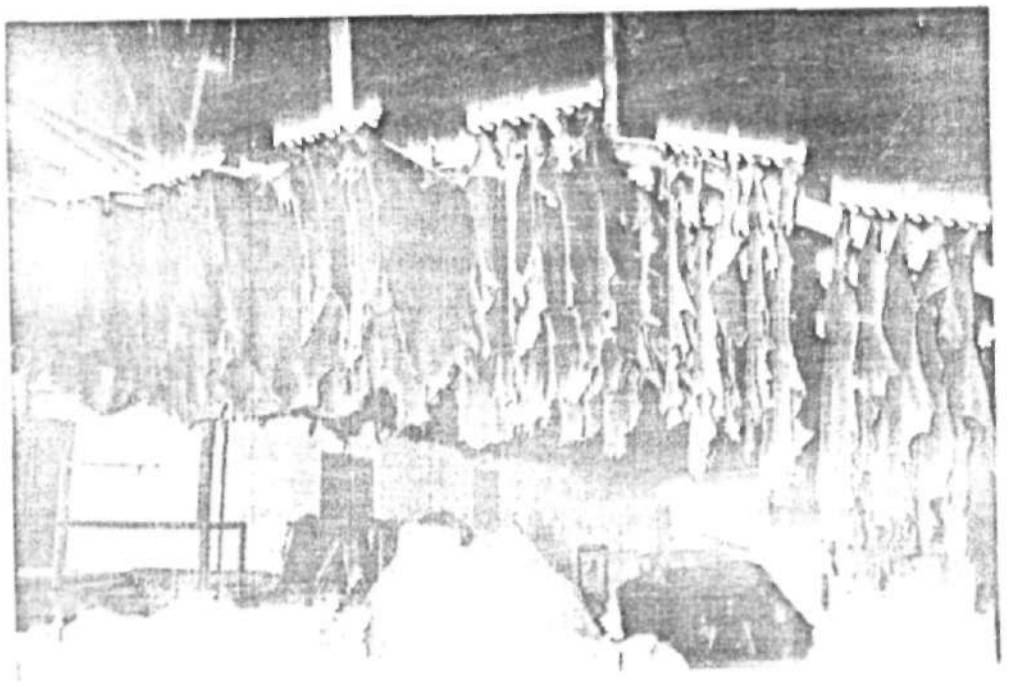


FIG.2.2(a) PASTE DRYING.

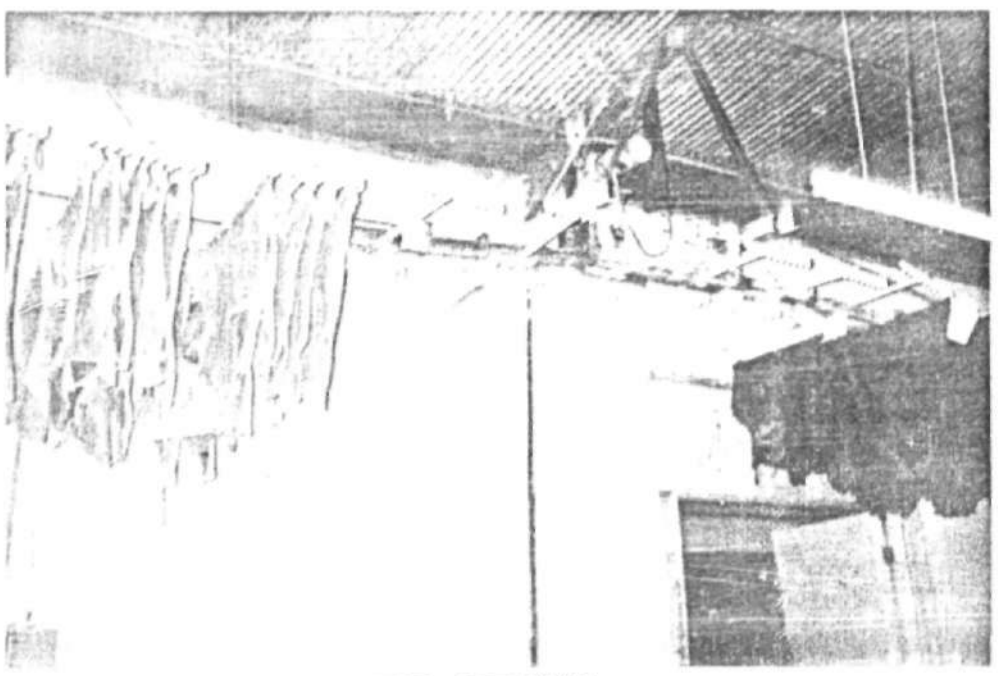


FIG.2.2(b) PASTE DRYING.

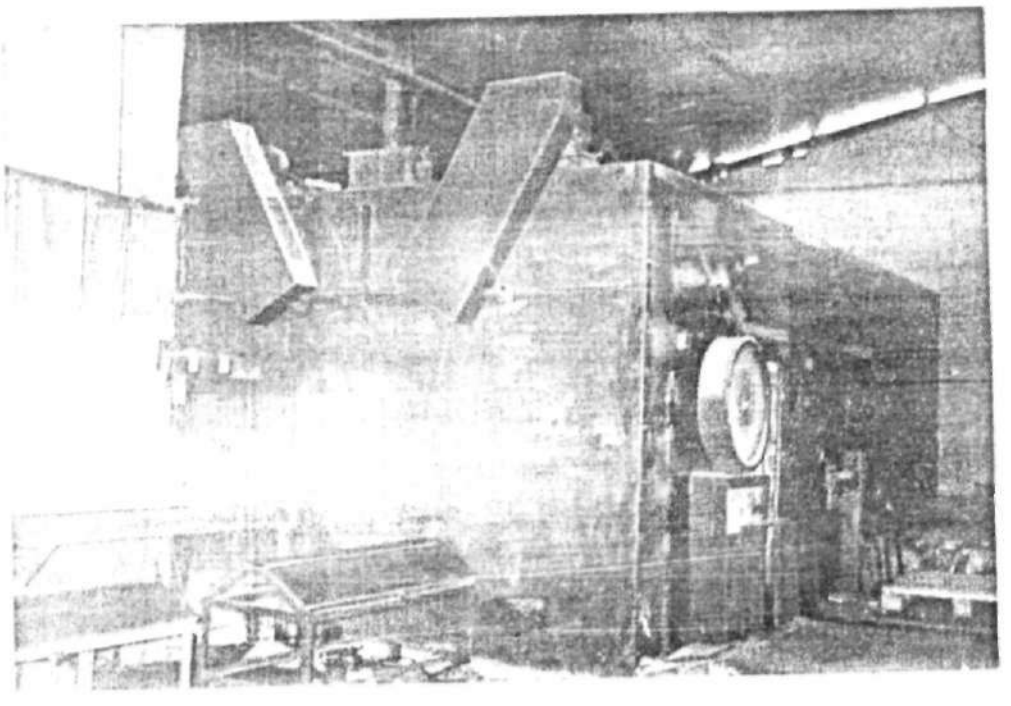


FIG. 2.3(a) TURNER DRYER

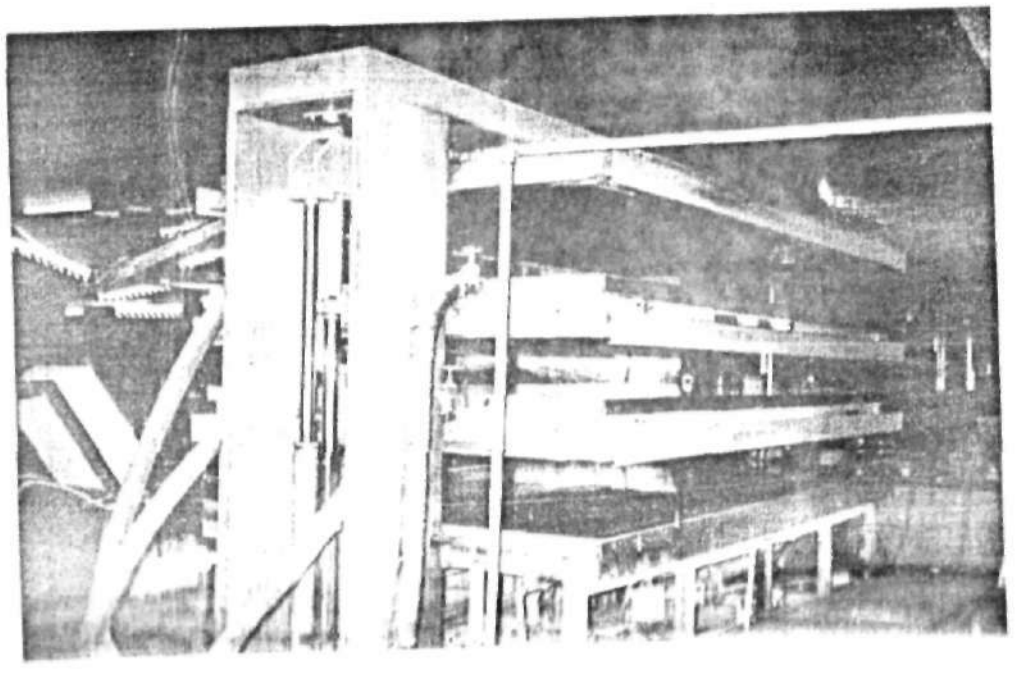


FIG. 2.3(b) VACUUM DRYER

kin ten minutes for vegetable tanned leathers at 50°C (125°F) and three minutes for chrome leather at 80°C (180°F) Vacuum driers are very costly, but operate independently of weather conditions and productivity is very high. But very efficient, and very fast, as 1 - 2 minutes drying time at 75 - 80°C is allowed for every 1mm leather thickness. The leathers are then suspension-drifed at 30 - 50°C.

(C) Tunnel or cabinet. Counter Current Drying:

Here drying tunnels or cabinets with controlled temperature and humidity and counter current air circulation provide efficient drying. In tunnel drying, the hides or skins may either be moving continuously on stationery through an enclosed tunnel under heated fans. Fresh dry warm air meets dry leather and subsequently moves towards wet leathers. Leathers may be hooked to a moving chain or being held on moving toggle frames or plates.

(d) Drying under tension. Leathers are stretched on a perforated metal frame by toggles or grip clips and allowed to dry by either process (a) or (c).

(e) Paste drying: This method is the most economical for all upper leathers which are buffed and for splits. To ensure a round, soft handle, the water content should not be more than 20% when the leathers are finally removed from glass plates. Leathers are pasted by the grain side on

both sides of the large plates of glass, porcelain, or metal and then travel through a tunnel drier consisting of four to eight zones of controlled temperature and humidity. In three to six hours, the dry leather is stripped off pasting units are expensive, thus, they are used largely for upper, split and lining leathers. They yield flat, smooth grain and larger area.

(f) Others: dyed, seasoned, finished leathers are dried by moving through a tunnel heated by infrared heaters. Radio-frequency heating has the potential of removing water without heating the leather itself.

(g) Suspension drying: This method is also particularly suitable for all thin nappa leathers and for thick, especially soft softly leathers. It gives the best results as regards softness, and fullness, but the area yield is unsatisfactory compared with other drying methods, especially in the case of thicker leathers.

CONDITIONING: In this process, after drying, water is sprayed on the leathers that are too dry to attain the surface required humidity needed.

STACKING: This is a mechanical process designed to soften further more the leather. Here, the leather is stretched and made firm and flat.

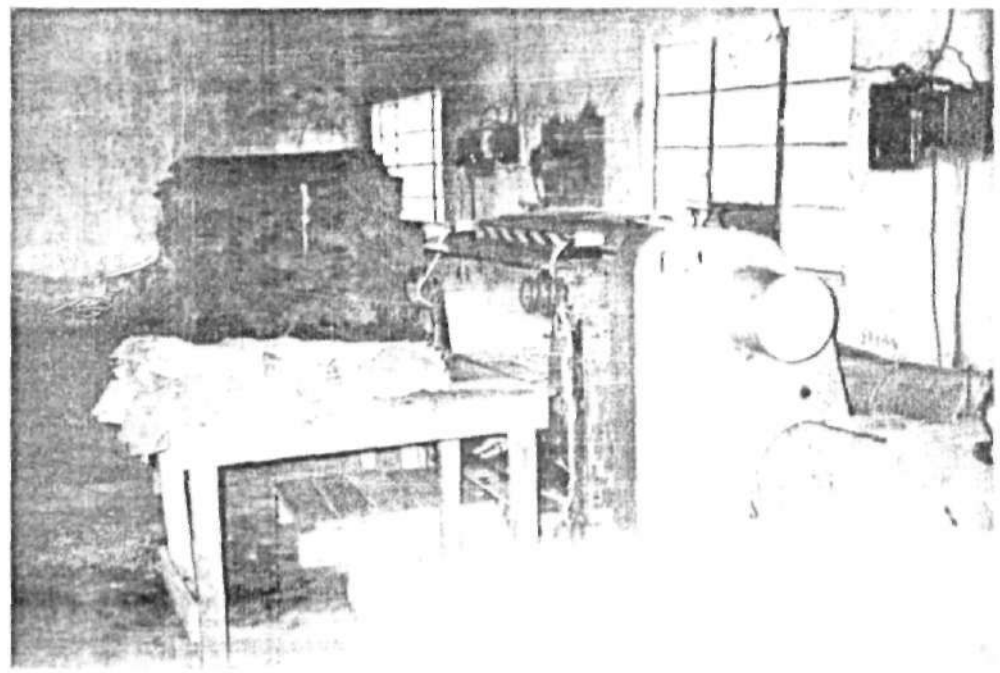


FIG. 2,4 STACKING MACHINE

TOGGLING: This simply means stretching further the leather, making it firm and flat. The leather may e in toggle (pinned)

on a special frame which has holes in it. Toggled leather dries in about 5 minutes.

TRIMMING: The hides or skins must be trimmed to either the standard trim or modern trim. The standard trims of hides or skins refers to conventional trim where horns, snouts, lips ears, tailsbone, tendons and uneven shape is removed as to have a hide or skin of acceptable shape. The trimming is done manually to meet a standard pattern and make it ready for the next process stage.

At this stage (after trimming), local hides and skins may go glazing finish without necessarily passing through buffing. But, for the international orders, the hides or skins will accordingly go to the next stage (BUFFING).

BUFFING: Buffing is mechanically done with a buffing machine, so as to smoothen the grain or upper surface of the leather. This is usually done mostly to leathers that are meant to suede because, the nap fibres are hereby removed.

DEDUSTING: Immediately after buffing, it rising up of the nap fibres of the skins or hides in form of dust. the next operation or processing stage is dedusting. Dedusting machine

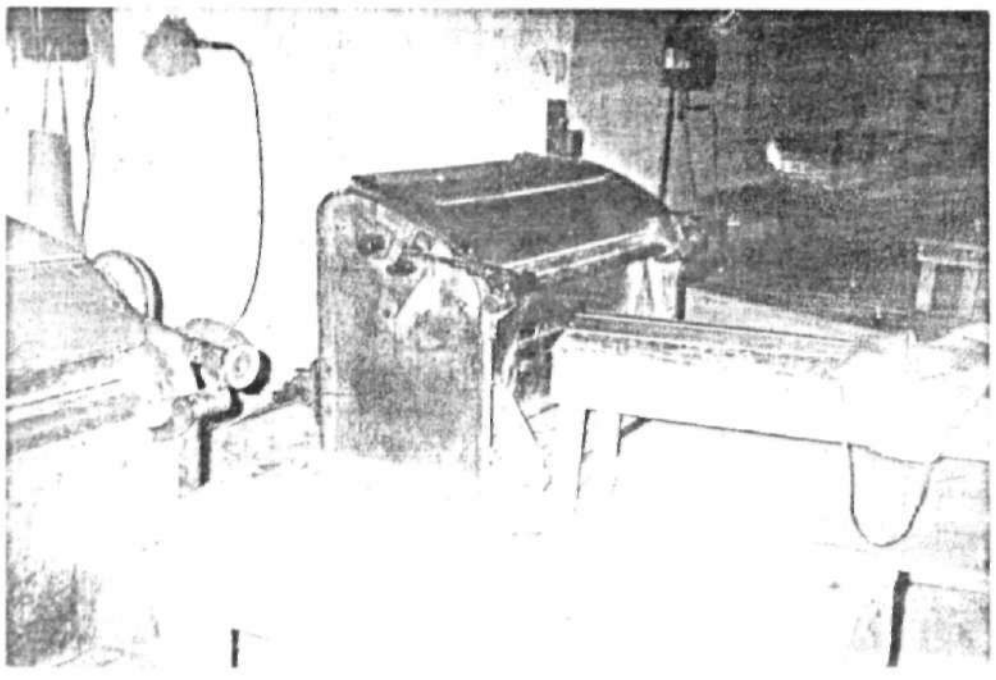


FIG.2.5 DEDUSTING MACHINE

is used to remove all the dust on the leather, so as to allow smooth coloring of the leather.

At this level another product called CRUST LEATHER is produced. From this stage, all dedusted leathers will go for selection to grades of various size and quality. Grade #1 and #2, will go for packing and finally for export. While the rest of the grades will go to the next process.

2.9.7 Finishing of Leather

Finishing processes which may be employed on crust leather includes applying special liquids mixtures to the grain surface. The impregnation; which is so mechanical is meant to modify the surface aspect of the leather. These operational procedures, which may be repetitive, are selected to produce surface characterisitics in the finished leather that are required by the specific leather type or style needed to fulfil customer orders. Some leathers are impregnated with synthetic resins (acrylics, butadience and polyurethanes) to improve their properties. Leather is further finished by coating the grain surface. A good coating adheres well to the leather surface, is elastic, and resist abrassion, cracking, peeling, rubbing, light heat, cold, and moisture. A wide variety of colors, pigments, resigns lacquers, and waxes are used. Other mixtures of pigments may includes casein, shellac, blood serum, milk, gum tragacanth flaxseed, irismss,

alphaprotein, (a soyabean product) Japan wax, car nauba wax, candelilla wax, sulfated oil, pigmanents of all kinds, and aniline dyes. As many as seven coats of the finishing solution are applied to the finest kinds of finished leather. Between their applications, machines roll, glaze, and smooth the leather.

Finishing coat application is accomplished while the leathers moves on a seasoning machine, using mechanical padding on a conveyor system. The spraying gun spray the leathers on this conveyor. Conveyonized applications of the finishing coat use either rotaring or reciprocating sprays. The application of the finish electronically restricted to the leather surface.

The colorants used in the finishing processes may either be soluble dyestuffs or insoluble pigment dispersion. Finishing systems using dyestuffs colorants are employed on full-groin leathers where characteristics excellent grain quality and hair follicle pattern is visible in the finished leather.

GENERAL, TYPES OF FINISHING

The different types of finishing can be distinguished as follows:

i) According to their covering power.
ii) Aniline finish

Translucent finish which may be dyed to level out the drum dyeing

iii) Aniline-effect finish

Finish with transparent pigments for hiding slight grain damage.

iv) Opaque finish

Finish with covering pigments for hiding severe grain damage or very uneven drum dyeings.

v) Semi-aniline finish

Opaque finish which is subsequently given an aniline appearance by applying transparent pigments.

vi) According to the products used aqueous casein finish

Based on proteins; screen-like surface; no film formation.

vii Aqueous polymer finish (Resin Finish)

Based on polymer emulsions. The polymer particles of the finish form a film on hot plating. With buffed leathers, the film replaces the natural grain surface.

viii) Nitrocellulose finish

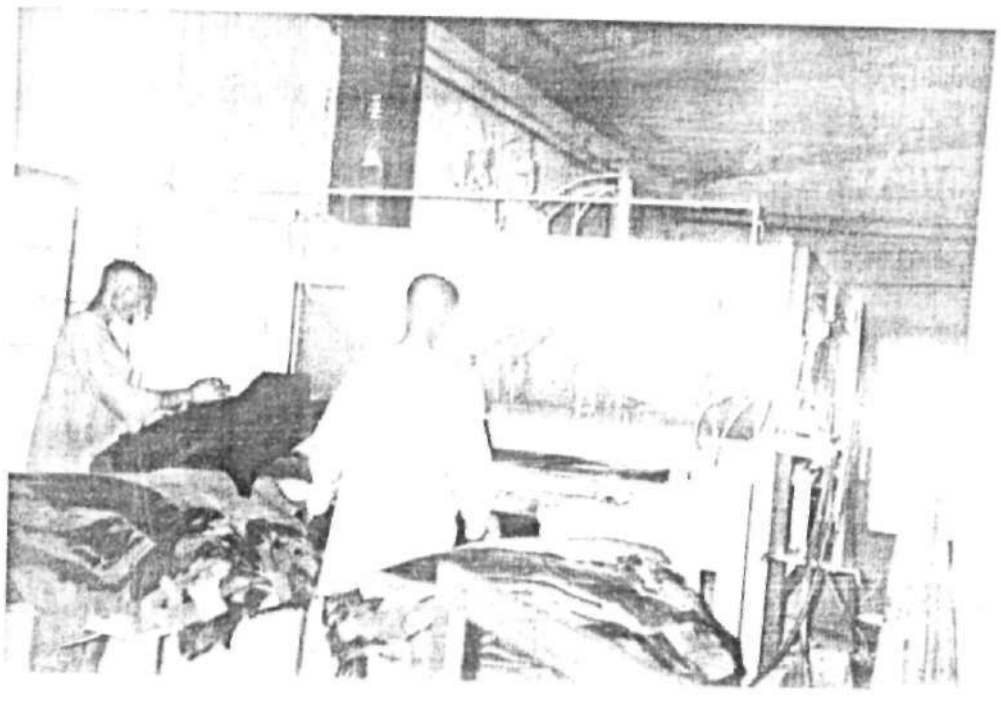


FIG.2.6 FRONT OE PIGMENTING MACHINE

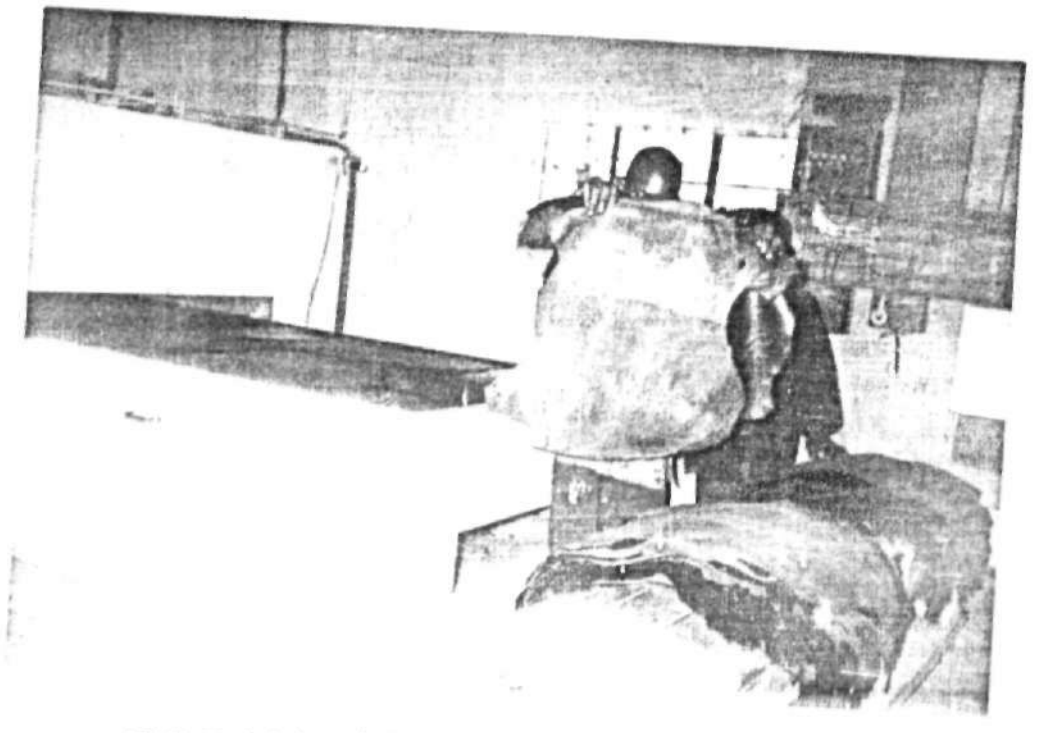


FIG.2.6(b) END OF PIGMENTING MACHINE

based on nitrocellulose on evaporation of the solvents, the finish forms a cohesive film.

ix) Combined finishes

(a) Combination of glazing finish and plating finish

(b) Combination of resin finish and nitrocellulose finish.

x) Polynrethane finishes

Finisher with reactive or non-reactive polyrethane systems e.g. patent finishes.

xi) According to the Mechanical Treatment

xii) Glazing finish

Only possible for straight casein finishes and nitrocellulose finishes.

xiii Plating Finish

Most common method for all types of leather and finishing. Pigment finished leather is leather finished with formulae containing opaque pigments which more or less conceal the grain pattern.

The surface appearance of the finished leather is developed by mechanical methods during and after the finishing

processes. A boarding machine rolls the feather upon itself, repetitively, producing characteristics grain patterns on the leather. Plating may employ either smooth plates or plates with characteristics surface pattern (embossed leather). High pressures and temperature up to 250^{0}F can achieve a permanent pattern on the leather grain surface.

IRONING: This is a way of pressing a leather further more as to fixed the coats applied and make the leather more resistant to water.

7.9.8 Measuring and Packaging

The well pressed leathers are sold in areas, so the final measurement is in area, which is done by a measuring machine. This is better way or method of evaluating or sorting for cutting yield quality by visual inspection against the order specifications of the customers.

PACKAGING/STORAGE

The finished leather surface are measured and packed grain to grain or outer part to outpart (this is to avoid abrasion on the finished leather) and boxed for shipment.

DISPATCH: The dispatch vehicle will come into the storage (in case of rain) through the main entrance or gate to the dispatching operation. After the vehicle receive the goods, it follows the main entrance out to the overseas markets (Shipment to overseas customers).

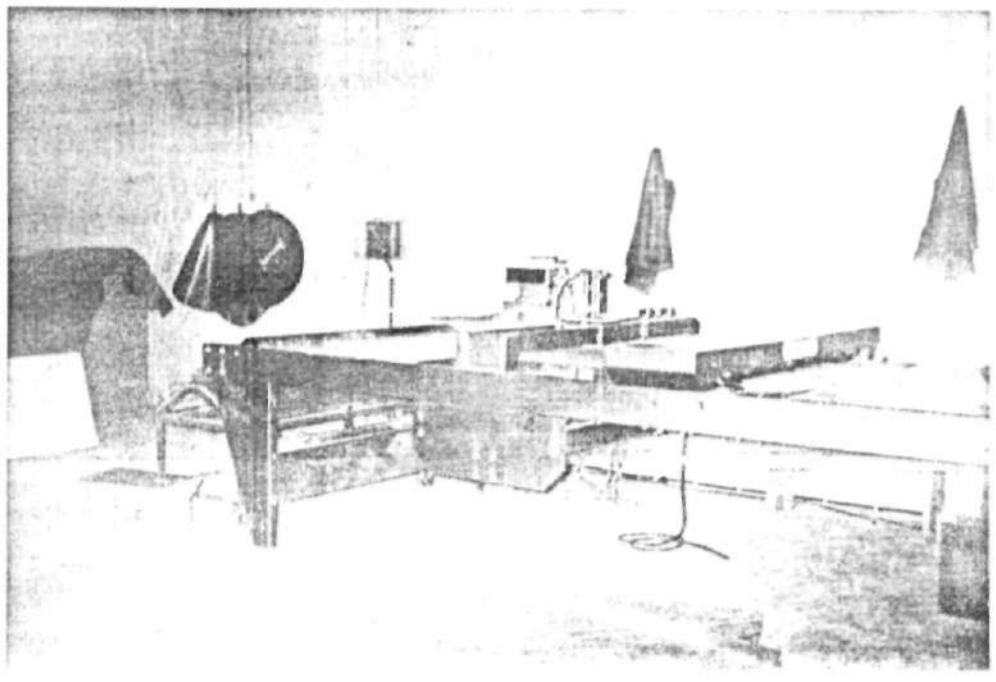


FIG. 2.7 MEASURING MACHINE.

CHAPTER THREE

3.0 INTRODUCTION TO DESIGN THAT MINIMIZE THE RISK OF FIRE

Today, an increase in the responsibility of the designer for the fire safety of the occupants of a building is being experienced. There is a growing awareness that ways for minimising the risk of fire should be integrated with the initial design taking advantage of flexibility rather than recommendation applied at the end of a design process at the risk of distorting the designers original intention.

This should give the profession the opportunity to have a sound knowledge in fire safety and prevention measures thereby minimising the risk and possibility of fire outbreaks, ensuring the rapid evacuation of occupants, and the eventual control of such fire. Heat gains from lighting, machinery and processing activities are of major significance special care must be taken in the design of such industries like (leather processing industries) that are either inudued in production, storage on usuage of high flammable chemicals.

Fire control is a very important part of factory design. It influences the location of buildings on the site process layouts, the choice of materials and the detailing of building elements. The architect's role is to ensure that the design of the industry conform with the statutory requirements of saving life and with those of the insurers, i.e. to minimize losses. Fires are largely a result of carelessness and a lack of knowledge of the risks by the factory user. The designer can

therefore help to minimize these risks by identifying potential hazards and making provisions accordingly.

To minimise the loss of life and property, as well as sufferings from fire outbreaks, fires must be minimized only through the proper investigation of each fire can the true cause be determined. And only after these causes are known can steps be taken to prevent or to minimize similar fires from occurring. Not all fires burn in the same manner, since each has its own environment. Many times, it is the environment that determines and encourage how a fire will behave.

There are three elements of fire: fuel, heat and oxygen, forming what is known as fire triangle: Fuel is probably the most important member of the fire triangle to the fire investigator, fuel is what burns. Fuels come in forms: solid, liquid and gaseous, all are affected by heat, but each has its own characteristics. Solid fuels have definite volume and shape. Liquid fuels have definite volume, but no shape: they assume the shape of the container. Gases have neither definite volume nor shape and volume of any vessel in which they confine. Once the fuel becomes ignited, the characteristics of the fire that follows depend upon the chemical make up of the fuel. A fire causes involve the two controllable conditions, the fuel supply and heat source: the oxygen supply is always present. Some types of fuel supplies are:

i) flammable and combustible liquids.

ii) combustible solids and metals

iii) Combustible gases

iv) Combustible dusts

Some heat sources, include:

i) Open flames - spontaneous heating

ii) hot surfaces - lightening

iii) electricity - friction

iv) Mechanical/sparks - static electricity

v) chemical reactions (polymerization oxidizing agent)

It has been noticed that despite the fire fighting gadgets made available to burning buildings of the past, the first-aid supplied by these gadgets are not enough to keep the fire within easily controllable limits when the fire service men reach the scene of fire. The problem is compounded when the fire service men had been crawling with their barely manageable vehicle to reach the fire science only to find that their water tank is empty.

Realising all these problems, and eventualities, the only solution to fire problem in buildings should begin with the design and construction of fire-safe industries. The codes and standards on fire protection or minimizing in buildings have a number of weaknesses and provide only the barest minimum.

3.1 FIRE BEHAVIOUR

Heat Transfer

Fires do communicate and heat is transferred by three methods: Conduction, convection and radiation.

Conduction: Heat travels through solids or between solids in contact with each other. The rate of conduction depends upon the temperature difference and density of the solid. The material itself is not in motion.

Convection: Heat travels by moving from one molecule to another, but the particles or molecules are themselves not in motion. This is more or less ventilation in a building.

Radiation: Heat energy is radiated from a hot body to a cold body. Light is a visible form of radiation. Radiant heat has been responsible for the communication of fire between buildings almost 30 metres apart. The radiation is absorbed by the combustible surfaces of the exposed structure. No need for a medium to exist, for this type of heat transfer. Heat may travel by conduction and radiation in any direction; convection currents always tend to rise on travel upwards.

3.2 THE PHASES OF FIRE

a fire is usually considered to consist of three phase: The initial or incipient phase; the free-burning phase, and smoldering phase.

Incipient phase: Here, the base of the fire has a temperature of 222^0C - 444^0C. It is the ignition or the beginning of a fire. The room has a normal temperature, and has the heat from the fire rises, the ambient temperature cools it until the ceiling temperature is about 111^0C. Water vapors and carbondioxide are the products in this phase.

Free-burning phase: The temperature of the base of the fire may reach 444^{0}C - 555^{0}C and at the ceiling, 666^{0}C - 888^{0}C. The heat builds up and rises, and as it rises, it fans out. It is during this phase that the maximum heat and destructive capabilities of the fire develop.

Smoldering phase: should the air and oxygen become exhausted in the area of the fire, other changes take place in the fire behaviour. When the oxygen content drops to below 13 percent, the fire can no longer support flames. As the flame production ceases, fire begins to smolder and glow, which is the hot carbon remaining after physis. These glowing coals produces large quantities of carbon monoxide.

3.3 CAUSES OF FIRE

There are basically three known causes of fire. These are:

An act of God or providential origin

An accidental origin, and

An incendiary origin.

Natural fire causes (Acts of God): Lightening, spontaneous heating, and the rays of the sun are examples of providential cause of fire lightening strikes will result in fires only when sufficient heat is produced to ignite combustible materials. It strikes objects such as trees, and structures because they contain materials that better electrical conductors than the air.

Spontaneous heating is the result of the slow oxidation of a combustible materials. Fires have also been cause by the rays of the sun, mostly as the result of the sun shining through older window panes containing "bubbles". More recently, there have been reports of sun's rays coming through a window and hitting a concave mirror concentrating the light on combustible materials and igniting them. They are fires above mamies power, no control exist here, it occurs naturally. This is generally controlled by the use of copper wire conductor, to conduct the electrostatic changes down to the earth.

Accidental fire causes: These are fires from cigarette smoking, electrical sparking/overheating and arcing, as well as flammable.

Cigarette smoking is one of the common causes of fire according to available statistics.

The source of almost electrical fires can be classified as originating from three conditions of arcing, sparking and overheating.

Arcing: if a short circuit or break in an electrical conductor occurs, the electric current tries to continue to flow in the open space, created. As the current jumps across this open space, it creates an arc. The intensity of the arc depends upon the voltage and the amount of current flowing.

Sparking: most commonly occur as the result of electric (arc) welding operations or from the arcing of short circuits. Many of large industrial fires have been caused by either careless welding, cutting operations etc.

Overheating: Damage to electrical conductors can result from heat, exposing them in two ways. The fire that heats the conductor from the outside and overheating from an internal source.

Incendiary Fire Causes

Refuse disposal areas causes fire that the origin is unknown. All the nooks and corners of the building spaces, which are not visited often, as well as ducts, are hazards to fire outbreak. Equip incendiary areas with both smoke and heat detectors.

3.4 CLASSIFICATION OF FIRE

Fire is basically classified into four (4) main groups:

Group 1:

The fire involving some combustible materials. These materials includes: wood, cloth, paper etc.

Group 2:

Fire involving flammable liquids and chemicals (in the case of Leather processing industries) petrol, Kerosine,

nitrocellulous, formaldehyde etc. or smothering effects or agents which excludes oxygen, are most effective to prevent or minimize fire.

Group 3:

Fire involving lived electrical cables, machinery where the non-conductivity of extinguishing agents is of paramount importance towards suppressing it.

Group 4:

Fire involving metals such as steel, aluminum, copper, zinc, lead etc.

3.5 FIRE MINIMIZING PRECAUTIONS IN DESIGN

The aim in taking precaution is to minimize the overall risk of fire loss through an efficient fire minimizing design and planning. For this reason, basic factors are to be considered.

To minimize or eliminate the risk of personal injury or death.

To minimize total loss of structure, plants and goods.

These objectives can be accomplished going by the "Fire protection tree". This embodies fire prevention and precautionary strategies risk.

3.5.1 **Passive Defence in Fire Minimizing**

Passive defence has to do with structural precautions an fire service facilities and these influence architectural and environmental design and construction. it is achieved through the following ways:

1. SITE PLANNING FOR FIRE

Generally, there are four (4) characteristics of a successful planning:

(i) The promotion of accessibility. In this case, the accessibility for fire fighting trucks, aid, to and from location of the fire.

(ii) The employment of resources as economically as possible.

(iii) The separation of compatible land uses from each other, association of compatible or mutually helpful uses.

(iv) The carrying out of all development in as visually pleasing a manner as possible.

Of these characteristics, that which is of considerable concern to the fire conscious designer is the separation of incompatible land uses. In design, wind direction should be considered when locating fire risk functions within the site. Such functions should be placed at the leeward side of the site so that eventual fires are not blown over towards the rest of the complex by the prevailing winds.

In addition, there should be the provision of access roads for fire fighting appliances which should provide room for effective manoeuvre of fire trucks during emergency situation. The building site plant should provide enough drive ways, turning vadii and parking space on firm level surfaces for fire apparatus. Avoid man-made and natural barriers that could interfere with the movement of the fire vehicles. Fire apparatus turning radii varies typically from 9 - 13 metres (for T-junctions) and vehicle lengths: 13 - 20 metres for ladder truck, 7 - 13 metres for the pumper.

Spatial separation of buildings is another effective site planning factor, which reduces the dangerous effect of fire propagation by radiation and provides sufficient allowance for fire fighting operations. However, this spatial separation is not directly proportional to the heights of adjacent buildings since it would be improper to provide undue spaces between adjacent buildings in the complex.

Segregation

Electrical fittings and apparatus are put outside of fire hazard area. Cables and ducts should pass through air-tight seals. Places could also be segregated based on health hazards e.g. the fume chambers where toxic gases are prepared.

Compartmentation

The goal in compartmentation is to ensure that the fire can be contained or confined to the space in which it starts. This largely help the occupants escape/evacuation before the fire breaks into other compartments. This is done by means of compartment of walls.

Identify High Risk Areas

High risk areas may be identified and as much as possible separated from the building or be constructed specially with high rate fire resisting construction materials, with special provision of automatic smoke detectors.

Fire Points

They are fire-fighting equipments, and should include alarms, hose reel, water extinguisher, special purpose extinguisher, fire bucket and fire blanket. Where employed, they should not be more than 30 metres apart.

Fire drill

Provision of fire protection devices in any building should include periodical training of its occupants on the locations, which to be used and how to use them.

Building Materials

In the early days of the industrial revolution, factories and warehouses were constructed with timber floors and roofs. Increassant fires occurred because the predominant sources of

light and heat were oil lamps an open fires. The most devastating of such fires was that which occurred in the month of October, 1871 in Chicago. Subsequent reconstruction commenced, this time with a great emphasis on genuine fire proof construction.

With the introduction of the steel truss, it was thought that damage to building by fires would be greatly lessened. It turned out that steel roofs collapsed as quickly as timber under fire.

Finally, it was discovered that when a roof of steel truss is protected by concrete the risk of structural collapse was greatly reduced. This introduced the concept of structural fire protection, which involves a design process which ensures that building elements such as walls, columns, beams, floors nd roofs are designed with specific materials or combination of materials whum fire endurance ratings.

Structural steel members can be fire-protected with membrane enclosures, for example, mineral wool, gypsum board, spray-on materials like gypsum plaster and mineral wool fibres, magnesium oxychloride, inorganic coating sand concrete or brick encasement.

Poke through penetration in floor slabs can be an unwanted path for the vertical spread of fire and smoke. All these may be protected by packing the opening with mineral wool fibres or silicone elastomer foams, metal frame units or fire-resistant adhesive tapes which are vinyl coated.

Ignition Sources

Potential ignition sources includes smouldering combustion and flames, e.g. Cigarettes and matches, hot surface, mechanical sparks, electrical sparks and electrostatic discharges. Operations that give rise to any of these must be strictly controlled in hazardous areas. Examples include welding and cutting.

Flammable Atmosphere

These ar those in which a flammable gas, vapour, mist or spray or even and explosible dust or fuel is mixed intimately with air within the limits of flammability. The act of ignition causes the flame to propagate spherically through the flammable atmosphere consuming the fuel and converting it into combustible products at high temperature. If the gas is enclosed with a building structure, the increase in temperature is accompanied by a substantial increase in pressure which theoretically can measure up to 700 KN/m^2, known as an explosion. No building structure can withstand

such an enomors pressures, but careful planning and design can prevent such pressures from developing.

Sparks from electrostatic discharges or mechanical friction or impact and have sufficient energy to ignite a flammable atmosphere.

Explosion Control

Explosion relief ventilation allows explosion forces to be dissipated to the outside air rather than being contained in the building, thus reducing damage in and around it. Such ventilation in a building is effected by creating large openings in the building envelope using weak or weekly fastened cladding which will be blown off at an early stage in the explosion, and thereby allowing excess pressure, flame and unburnt material; to escape into outside air. Preferably the entire building envelope should be designated for use as explosion relief ventilators. The suppression of an explosion depends largely upon the very rapid releases of chemicals into the propagating flame at a very early state of the explosion.

The subject al design in area product to explosion is very complex and will normally require the services of a structural consultants.

Ventilation

Efficient ventilation of hazard zones to remove inflammable gases ane chemicals in the atmosphere is an important part of explosion prevention. Simple cross-ventilation may be sufficient to low risk areas.

Heat ventilators, mechanically operated and located on the roof of the building, may be utilized in the presence of flammable material which are lighter than air to increase ventilation rates. Where gases, vapours are considerably

heavier than air, additional ventilation outlets should be mounted at low level to ensure that the air at that level is change frequently.

A Laminar flow system is the ideal whereby supply and extract grilles are equal to the cross-sectional area of the room to be ventilated.

3.5.7 Active Defence in Fire Precaution

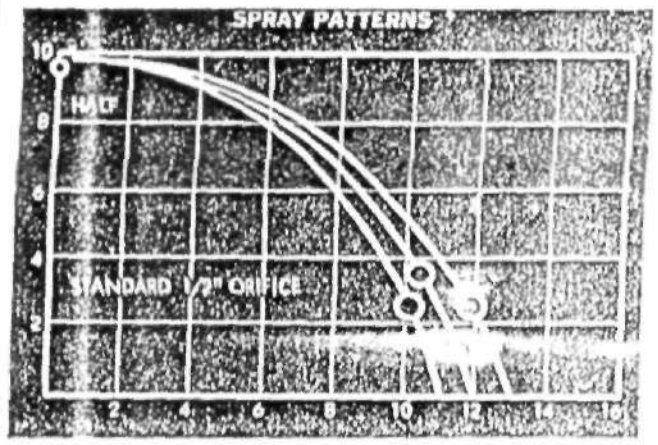
Active defence involves manual and automatic operation of fire-fighting equipment to suppress particularly, early fire outbreak in a building. Fire detectors are justified, in that they operate very quickly , sensing a fire early enough for extinguishing.

Fire Escape Routes

Rapid and safe evacuation depends on early warning of an outbreak of fire and the provision of clearly indicated escape routes. As a general rue, the following three conditions must be satisfied before escape route can be considered as adequate:

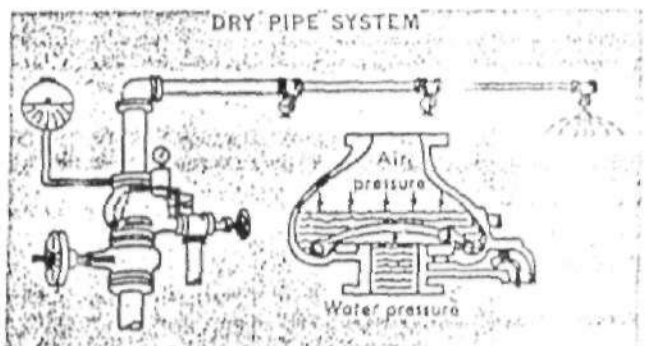
(i) No occupant should need to go towards the fire in a bid to escape from same.

(ii) All escape routes should be as short as possible, of adequate capacity and should lead to open air at ground level either directly or by way of a fire-resisting enclosure.





In the preaction system, all sprinklers are closed, and normally there is no water in the piping. At the time of a fire, a supplementary detection system senses the fire and automatically opens a water control valve. This allows water to flow into the piping system. Subsequent water discharge occurs from individual sprinklers as they respond to the heat of the fire. The system uses H.A.D. (Heat Actuate Device) detectors. A drop weight release to open the valve.



This system uses automatic sprinklers that are attached to a piping system containing air under pressure. When the air is released from the opening of the sprinklers, the water pressure is allowed to open a valve known as a "dry-pipe valve." The water then flows into the piping system and out the opened sprinklers. This system provides protection in areas subject to below-freezing temperatures.

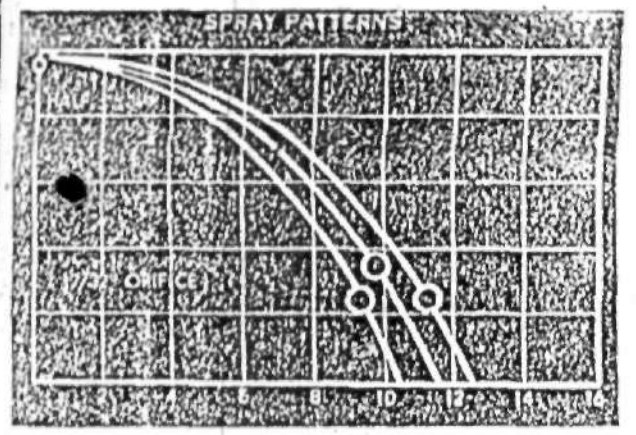
Figure 3-1 95(a)

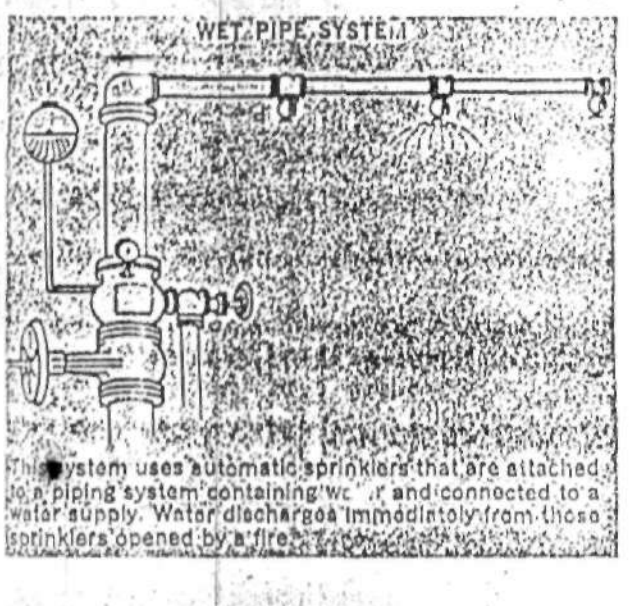
Four Basic System Types

The wet-pipe system is the simplest automatic sprinkler system. Water is constantly present in each automatic sprinkler, and when the sprinkler opens, the fire is immediately sprayed. Only those sprinklers nearest the fire will go into operation. The wet-pipe system should be used where water damage will be negligible and operation will indicate a fire in its primary combustion. Because the piping is constantly filled with water, this system should not be used where freezing conditions are likely to occur.

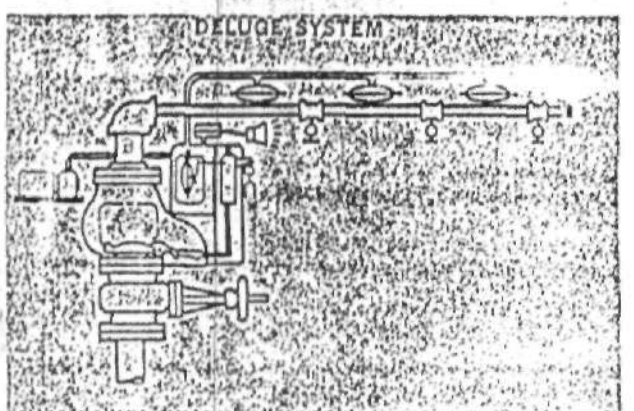
The dry-pipe sprinkler system is used in unheated buildings. The piping is filled with air under pressure. When fire occurs, the sprinklers open, releasing the air pressure and allowing water into the system. Because of the delay between opening of sprinklers and the arrival of water, additional sprinklers are expected to operate.

The air supply must be of a size capable of rapid resetting of the dry-pipe sprinkler system by an automatically controlled electrical air compressor plant air supply. The compressor capacity in cubic feet per minute should be large enough to rapidly pump up the system so protection can be restored in the least time possible. Provision must be made for total drainage of water from sprinkler pipes after each operation. Piping must be installed to pitch with auxiliary drain valves wherever water or condensate can accumulate or freeze. Heated valve houses are provided to protect the dry-





This system uses automatic sprinklers that are attached to a piping system containing water and connected to a water supply. Water discharges immediately from those sprinklers opened by a fire.



In the deluge system all sprinklers are open, and normally there is no water in the piping. At the time of a fire, a supplementary detection system senses the fire and automatically opens a water control valve. This allows water to flow through the piping system to all sprinklers. Water then flows from all sprinklers in the system. The system shown uses H.A.D. (Heat Actuate Device) detectors and a drop-weight release to open the valve.

FIGURE 3.2

pipe valve and auxiliary equipment. Electric, steam, or hot water heat should be thermostatically controlled to limit temperatures between 40° and 70° F.

The preaction sprinkler system eliminates the possibility of premature discharge of water no matter the cause of sprinkler operation. Preaction features are appreciated by computer operators, department store owners, office building occupants, and managers of operations particularly vulnerable to delayed fire detection or to accidental water discharge. In this system, two events must take place before water will discharge from the sprinklers: First, a heat-sensitive detector must actuate the controlling valve to admit water to the dry piping and sound an early fire alarm; second, water will flow from the sprinklers only if fire extinguishers or other manual efforts at fire extinguishment are not effective.

The deluge system is operated by sensitive heat detectors; it simultaneously discharges water from open sprinklers connected to the overhead piping. Actuation is usually by heat-sensitive detectors. It is used, for example, where flammable liquid fires are expected to spread rapidly and envelop occupants, structural elements, storage tanks, and processing equipment. Rapid detection of fire and immediate wetting, blanketing, and cooling are necessary to prevent damage by heat, to prevent the spread of fire and to extinguish or control the burning. Airplane hangars, chemical-process and storage facilities, oil-filled power transformers and switchgear are examples of deluge-protected occupancies and equipment.

Specially Designed Systems

Modern exotic fuels and processes demand new approaches to fire protection systems. Tailor-made fire protection systems can be geared almost to anticipate the start of fire and to initiate fire safety operations with only a few milliseconds delay. Requirements for water densities or for unique extinguishing techniques are developed through large-scale experimentation. The cost of these one-of-a-kind research programs is small when compared to the potential cost of a single day's loss of production or difficult-to-replace process equipment.

Matching rapid detection to rapid actuation of the extinguishing process and to the proper extinguishing agent has produced fire protection systems that are a solution to previously hopeless problems. It is now possible to stop the rapid propagation of fire in such intimately mixed fuels and oxidizers as rocket propellants, pyrotechnics, dust suspensions and flammable gases.

(iii) Protected parts of the escape routes should not be exposed at any point to penetration by smoke or fire under ideal situation. at least two escape routes leading in opposite directions should be available to every occupant.

Escape corridors stairways and exits should be sufficient in width and number to permit all the occupants of a building to leave quickly and without confusion in a maximum of about 4 minutes. Where the space is restricted ladders and spiral stairs may be provide as external means of escape for a limited number of able bodied, people.

Fire drill notices or fire procedure should be disntly all over an industrial complex, but no one is likely to pause to read this under the panic situation of a fire occurrence. hence, factory workers should be adequately drilled on evacuation and suppression actions in the event of a fire.

Fire and Hazard Detection

In the event of a fire, early detection and alarm warning are essential to prevent or minimize loss of life or harm of building occupants. If the time needed to detect fire ignition and warn the building occupants is reduced, a corresponding vital margin of safety for evacuation can be provided. An integrated alarm and defence system allows the fire to be contained before the arrival of the fire fighting authorities. Detection system operates on one or more of the characteristics of smoke, heat and flame. Criteria for selection of detector system are:

(i) The nature of the risks; flammable solids or liquids e.g. Nitrocellulous (solvent).

(ii) The fire characteristics: Clean burning like alcohol or smoke like plastics.

(iii) Speed of fire growth.

(iv) Potential loss

Total reliance on an automatic alarm system is not acceptable. Alarm systems must also be fitted with manual controls.

The presence of flammable gasses, mist or vapour or even dust in the atmosphere may be identified by detectors. These work either on light dispersal and obscuration or on air sampling.

Detectors can be employed to produce audible or visible warnings, to shut down equipment which may present, a hazard during emergencies (e.g. to shut off electrical mains) and to activate emergency explosion prevention systems. Detectors are pre-set to operate below the lower level at which ignition might take place.

Areas that should be protected by smoke detectors include every part of the building. Detectors should be located mostly on ceilings or upper wall surfaces an in such a way as to consider the room air flow patterns from mechanical air distribution systems.

Fire Control and Suppression

Eventual fires may be controlled either manually or by automatic suppression systems. Automatic fire fighting system should be protected from the effects of pressure, projectiles and falling debris during an explosion. Water sprinklers are the most commonly used automatic suppression systems in an industrial complexes. Sprinkler heads are activated at 680^{0}C.

Supply pipelines should not be fitted to light weight overhead steel work as these often fail during an explosion and may fracture supply piping. Heavy gauge pipe fixed to structural members will reduce the occurrence of damage and where possible, piping should be mounted behind heavy structural members relative to the direction of any expected blast.

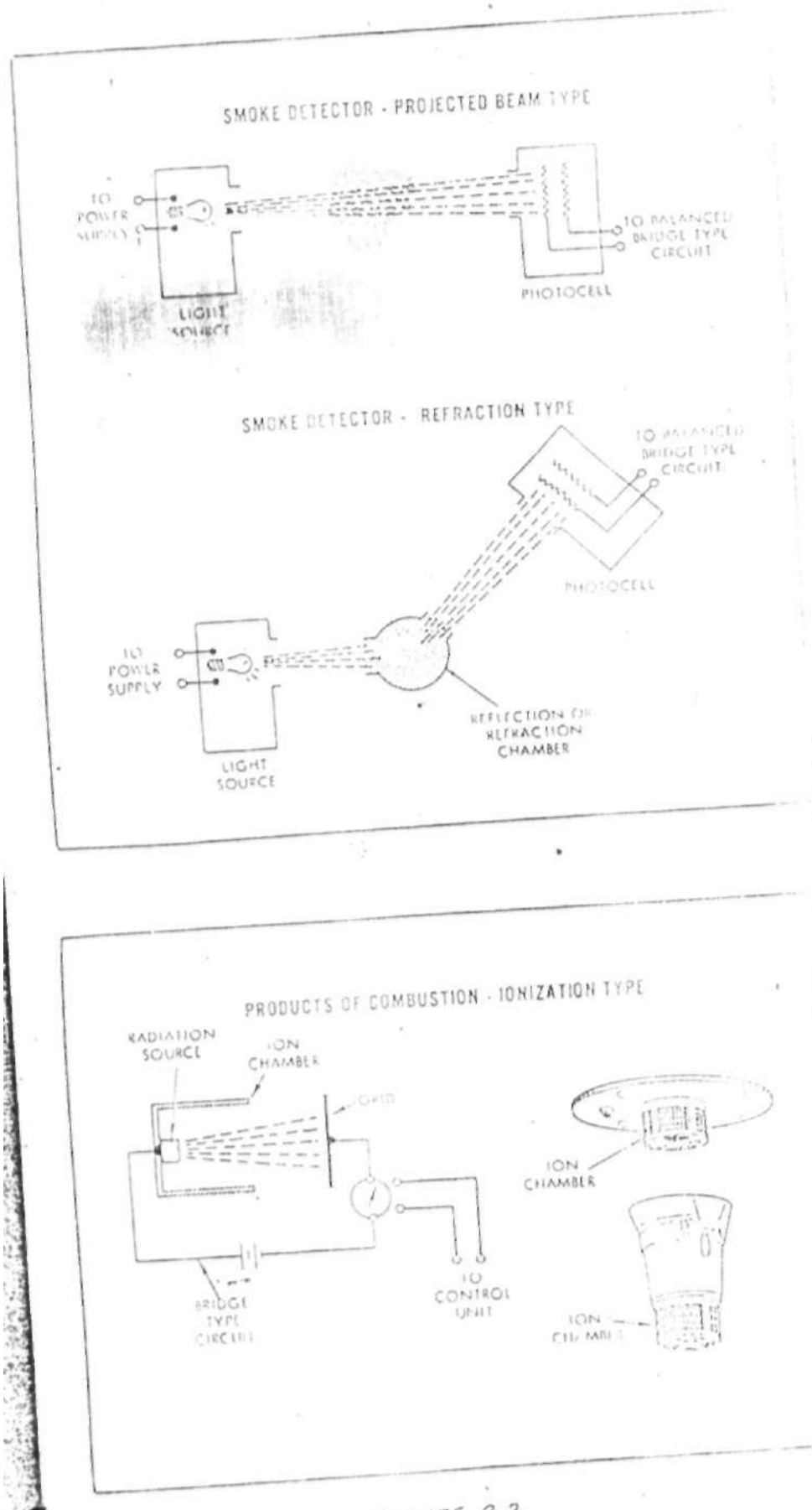

SMOKE DETECTOR - PROJECTED BEAM TYPE
TO POWER SUPPLY
LIGHT SOURCE
PHOTOCELL
TO BALANCED BRIDGE TYPE CIRCUIT
SMOKE DETECTOR - REFRACTION TYPE
TO BALANCED BRIDGE TYPE CIRCUIT
PHOTOCELL
TO POWER SUPPLY
LIGHT SOURCE
REFLECTION OR REFRACTION CHAMBER
PRODUCTS OF COMBUSTION - IONIZATION TYPE
RADIATION SOURCE
ION CHAMBER
GRID
BRIDGE TYPE CIRCUIT
TO CONTROL UNIT
ION CHAMBER

FIGURE 3.3

Portable equipment should also be provided so that small fires can be extinguished before the sprinkler system is activated. Hose reels provide excellent protection and the waters should be automatically turned on when the house is extended. The maximum length of a house is 36.6 metres and no part of floor should be more than 6 meters from the end of the nozzle. Portable extinguishers are required for every industrial property as a first measure.

Fire Points

These are groupings of fire-fighting equipment and should include an alarm, hose reel, water extinguisher special purpose extinguisher, fire bucket and a fire blanket. Where employed, should not be more than 30 metres apart.

Hydrants

These are suitable in premises which are remotely located, so long as all parts of the industry are within 60 metres of the hydrant.

Water supply

Water supply for sprinkler systems must be automatic and have reliable flow and pressure. Such a supply must not be used for any other purpose and the capacity of such a storage should be calculated by mechanical services consultants. Sprinkler heads may be concealed in suspended ceilings and are

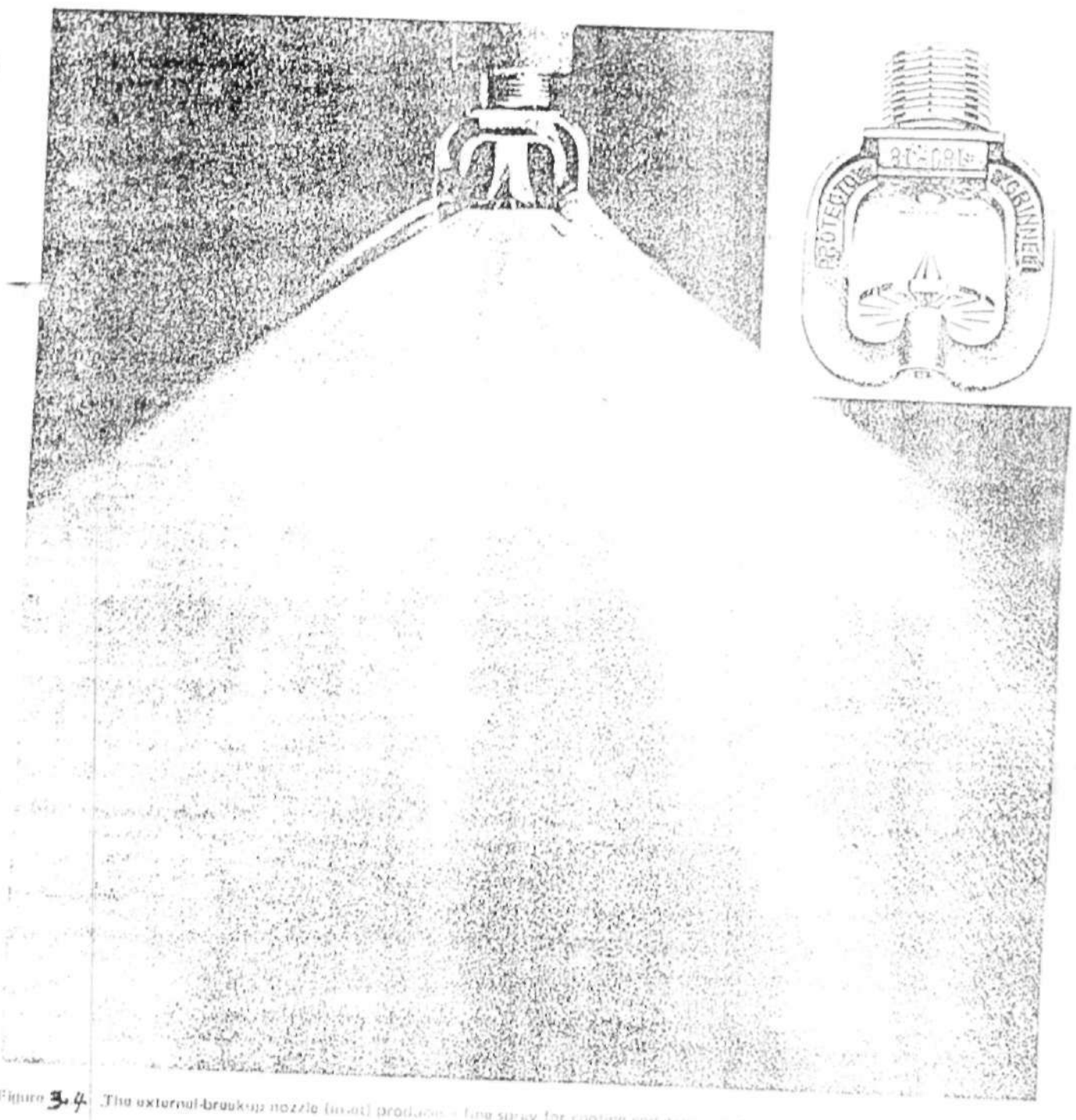


Figure 3.4 The external-breakup nozzle (inset) produces a fine spray for cooling and corrosion protection.

also available in decorative colours for use where aesthetic quality of the final design is of paramount importance.

Water sprays also exits as extinguishing systems but the risk of electrical shock and damage to sensitive equipment weight against it for specific uses.

Petroleum products e.g. being lighter than water may simply become displaced and overflow to spread the fire. Other systems includes foam systems, dry powder systems, carbon dioxide and halo gas systems.

Smoke Control

When fire occurs, the attendant smoke presents what my sometimes be a greater hazard to life than the fire itself. Escape areas are best designed as like free zones and traditional methods for controlling the spread of fire and smoke in buildings have relied on the strategic use of fire resisting doors and partitions. While this is generally a successful preventive means; this method does not necessarily prevent the movement of smoke and toxic gases which are a prime threat to life.

Fire Precautions

Typical Example of Arrangements for Factories and Offices:

Assessment - Because of the widely differing processes, substances and types of premises encountered in factories, the risk in the event of fire will vary drastically from one si.

In order to apply appropriate precautions a building is placed into one of three categories or risk - "high", "normal", or "low" - depending upon the activities involved and the construction of the building.

(i) Means of Escape

The distance of travel for means of escape is the actual distance that has to be travelled between any point in a building and the nearest:

- final exit; or
- door to a stairway which is protected route; or
- a door in a compartment wall.

In workrooms with only one direction of escape, the permitted distance of travel within the workroom varies from 6 meteres in high risk area to 25 metres in low risk areas. For normal risk areas and offices, the distance is 12 metres. (See "A" in table below).

Where escape from the workroom is possible in more than one direction, the permissible travel distance in factory workrooms are 12 metres, 25 metres and 35 meteres for 'high', 'normal' and 'low' risk areas respectively. (See 'B' in table below).

The total permissible distance of travel to a place of safety varies from 12 metres in high risk areas with only one

direction of escape to 6 metres in low risk areas with escape possible in more than one direction (See table below).

Table (a) and (b)

	Category of risk	Distance of travel	Total Distance of travel
A.	Escape in one Direction Only	(M)	(M)
	Factories: High	6m.	12m.
	Normal	12m.	25m.
	Low	25m.	45m.
	Offices	12m.	18m.
B.	Escape in one Direction Only	(M)	(M)
	Factories: High	12m.	25m.
	Normal	25m.	45m.
	Low	35m.	60m.
	Offices		45m.

(ii) **Number, width and Positioning of room Exits**

More than one exit from a room will be required if it is occupied by more than 60 persons or if the distance to be travelled from any point to the exit is more than the permitted distance of travel.

In factories, a wicket door in a larger door on a shutter is only satisfactory as a means of escape for 2 or 3 persons from a high risk areas or 10 - 15 persons from normal or low risk areas and provided that certain dimensional criteria are satisfied.

The width of an exit should normally not be less than 750mm and where more than one exit is necessary, the total

width of al exists is determined by the number of persons likely to use them.

The contents of a room should be so arranged that adequate gangways and passage ways are available.

(iii) Stairways

In multi-storey buildings, there should, i general, be more than one independent stairway providing alternative means of escape from the upper floors. However, a single stairway may be acceptable in certain limited cases.

In most cases, stairways must be separated from the remainder of the building by fire resisting construction and by fire resisting doors and escape routes must be so designed that a person does not need to pass through a stairway enclosure to reach an alternative escape route. A stairway should be at least 800mm wide.

Generally, absamen needs at least two stairways or other escape routes to safe places at ground level and where a stairway serving upper floors continues down to a basement, fire resisting doors should be fitted at the basement and ground floor level.

The following are acceptable as means of escape:

(a) escalator;

(b) ramps steeper than 1 in 10;

(c) lifts and hoists;

(d) wall and floor hatches.

In special circumstance, lowering lines, portable and throw out type ladders may be used where only one person is involved; fixed ladders are only suitable for not more than to persons descending 9 metres or less. Escape routes should not normally be upwards.

(iv) Corridors

The walls and partitions forming dead-end corridors and doors into the corridor should be fire resisting. a main corridor should be at least 1 metre wide.

In office premises, corridors exceeding 45 metres in length should be sub- divided by fire resisting doors into lengths not exceeding 45 metres. In factories, this length is reduced to 30 metres.

(v) Doors

A door used for escape means, should open in the direction of escape. Sliding doors may be acceptable in certain limited situations but not where the public is involved. Revolving doors are not acceptable. All fire resisting doors should be fitted with positive action self-closing devices. Where it is necessary to hold these doors open, it must be by means of automatic fail-safety devices provided with a manual override.

In factories, loading doors, goods doors, shutters, up-and-over doors and windows are not generally acceptable for

means of escape.

Door used for means of escape should be capable of being easily opened from the inside at all times when persons are in the building. They must be clearly labelled and kept clear.

(vi) Exit and Directional Signs

Escape routes should be clearly sign posted including direction indication where necessary. Where the natural lighting is poor, the signs should be illuminated.

(vii) Emergency Lighting

Emergency lighting to BS5266 part 1:1975 should be provided where natural lighting is insufficient.

Fire Alarm System

In any factory or office building requiring a fire certificate, there must be an effective fire alarm system. The audible any visual alarm signals should be distinctive and perceptible throughout the building. It must be properly maintained.

Electrical fire alarm systems should be of the release button type and so situated that no person should conform with British standard code of practice CP 1019:1972.

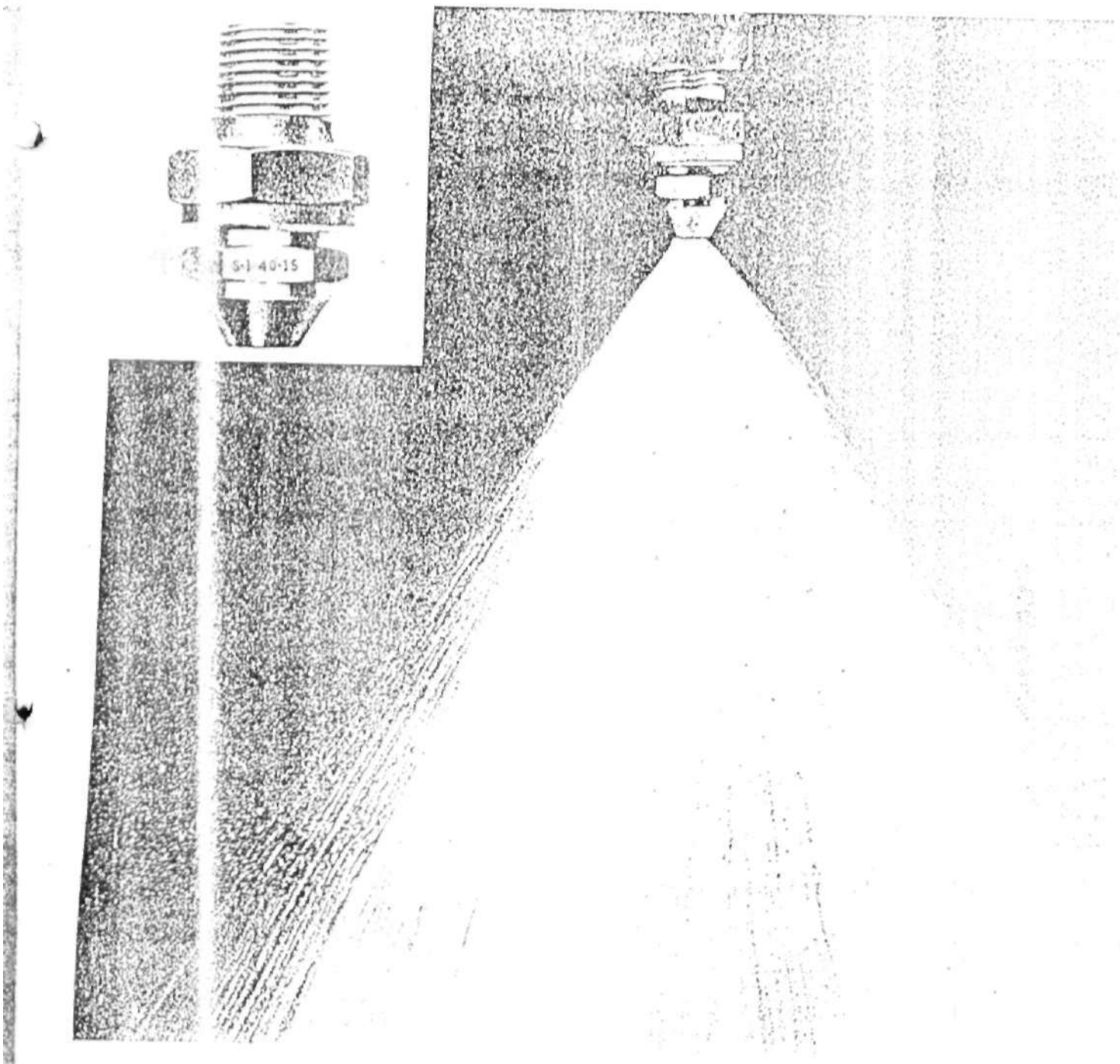


Figure 3.5 [illegible] used in systems needing a coarse spray for fire extinguishing.

Fire Fighting Equipment

All premises should be provided with appropriate means of fighting fire for use by persons in the building. Equipment should be placed in conspicuous positions, kept clear all times and regularly serviced and maintained. The two types of fires in general that are most likely to occur are:

Class A fires: Involving solid materials which burn with the formation of glowing embers, when water is the most effective extinguishing agent; and

Class B fires: Involving flammable liquids when suitable extinguishing agents are foam, carbon dioxide, halon or powder.

The Home Office guides should be referred to for recommended minimum quantities of extinguishing materials.

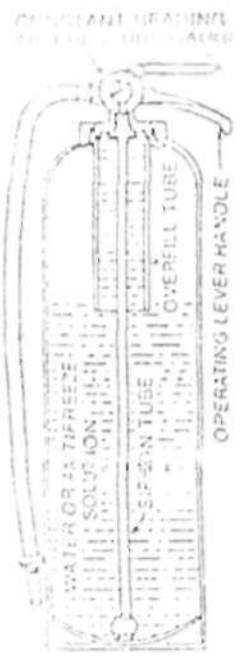
Fire Instruction and Drills

All person employed in buildings which require a fire certificate must RECEIVE INSTRUCTIONS AND TRAINING, PREFERABLY AT LEAST TWICE A YEAR on their responsibilities and the actio they must take in the event of a fire.

All employees should be aware of the location of fire fighting equipment and escape routes. Records should be made of all training and instructions given and a practice fire drill should be held at least once a year.

FIGURE 3.6 TYPES OF EXTINGUISHERS

FIG. 3.5



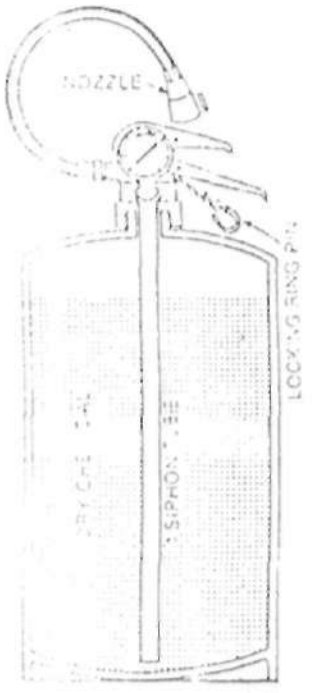
Stored-pressure water extinguisher



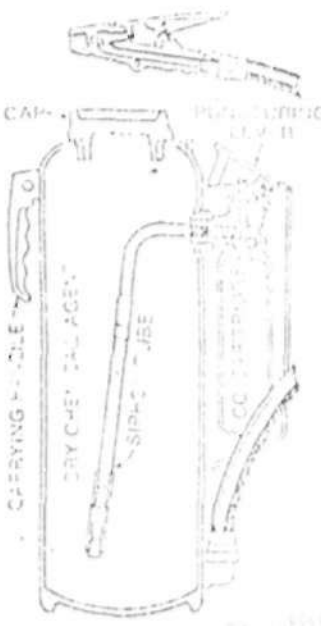
Carbon-dioxide extinguisher



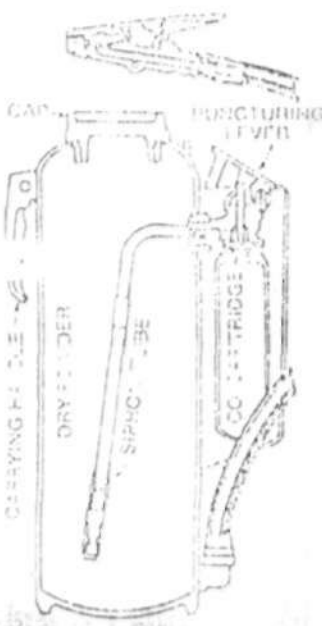
Stored-pressure dry chemical extinguisher



Stored-pressure dry chemical extinguisher



Cartridge-operated dry chemical extinguisher



Dry powder extinguisher

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Fire Instruction Notices

At conspicuous positions in a all part os building, printed notices should be posted stating, in precise terms, the essentials of the action to be taken upon discovering a fire or on hearing the alarm.

Disable Persons

Special precautions and consideration must be given at all times to the problems of disabled persons.

INDUSTRIAL PROCESSING CONTROL

When designing for fire safe operation of equipment that controls an industrial process, attention should be directed to the supplementary devices that take over when the normal operating controls fails. Such supplementary devices can be a major factor in minimizing or even preventing fires and explosions.

Process control may also involve properly designing ventilation systems or supplementary protective systems. The basic principles used to solve various industrial process control problems involve the design of controls or equipment to sense and overcome abnormal environmental conditions, e.g. heat, pressure, moisture etc.

CHAPTER FOUR

4.0 CASE STUDY

In addition to investigations through texts, it is of great aid for the researcher to study in detail, existing projects which bear a resemblance. The case studies enable the researcher acquire first hand and practical information which on analysis, help him to utilize the merits of the case studies, avoid the demerits. Three case studies are documented. The most important information being sought after in these case studies is the production process, to get an optimum production process for the design proposal based on production capacity and technology capacity and technology. Facilities that support the production processes were equally investigated, as well as their structural systems with respect to their ability to resist fire.

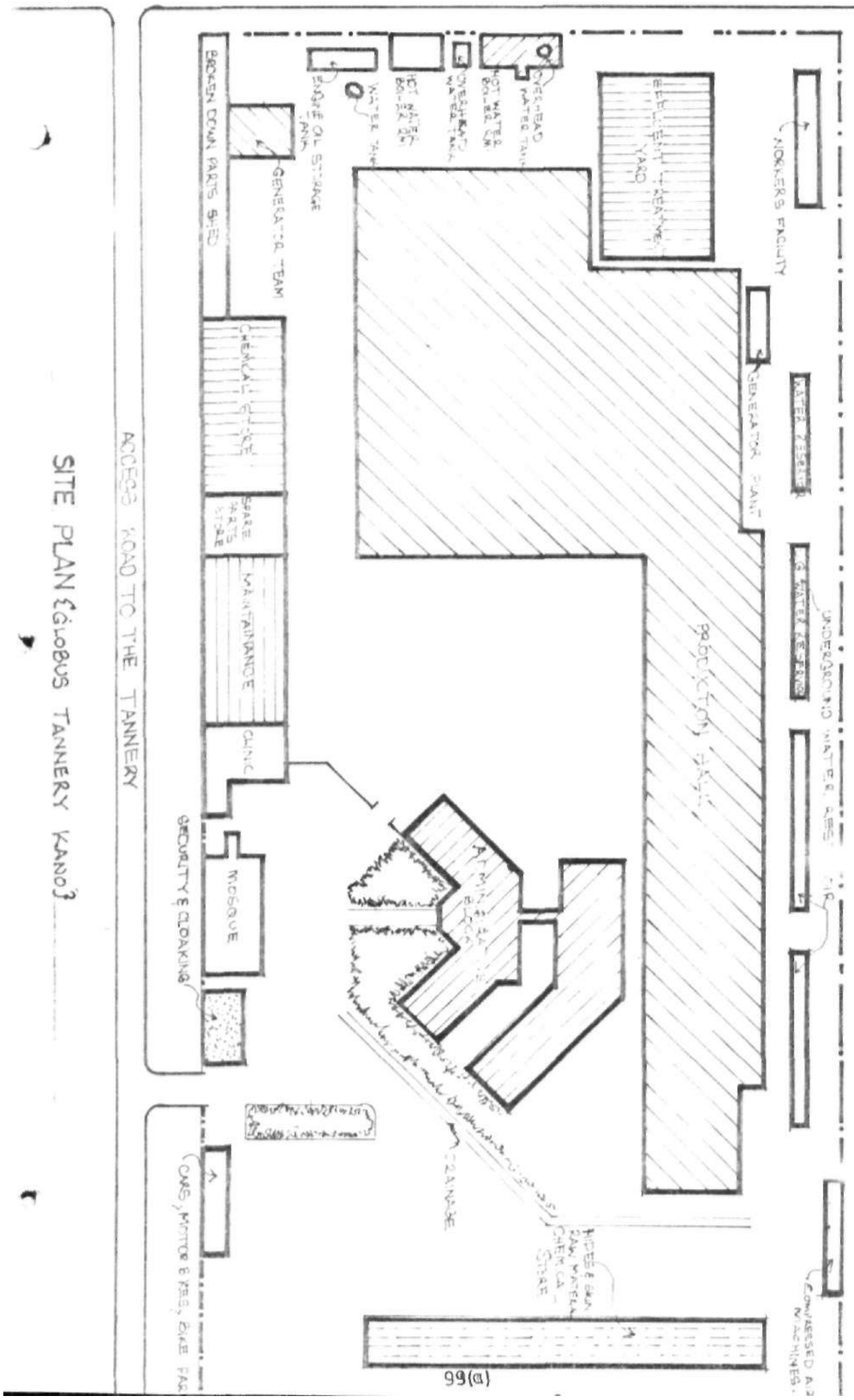
4.1 GLOBUS TANNERY, CHALLAWA INDUSTRIAL ESTATE, KANO NIGERIA

4.1 Historical Background

Tannery was established in 1991 by a Kano based business man to enhance government policy of encouraging local processing of hides and skins from raw materia to finished products for both local needs as well as for export.

Globus tannery, a division of Globus Enterprise, is located at Challawa industrial estate, Kano; a distance of about 13 Kilometres South of Kano.

FIG. 4.1



SITE PLAN (Globus Tannery Kano)

The plant was designed to process 200 skins and 75 hides to a wet-blue finish. Presently it processes 1500 skins and 500 hides to either wet blue, crust and final finishings i.e (pigmenting finishes)

4.1.1 Facilities and planning

The entire factory layout is strongly linked together, and zoned accordingly.

Basically, there are two gates leading to the factory, one serving as service gate or Generators fuel as well as discharging of wastes. While the other serving raw materials, workers, visitors and customers.

Owing to the expansions taken place over the years, the nature of the planning look like more or less an after thought with its difficult but factional layout. (Fig. 4.1).

The main gate leading to the defined routes are raw materials stores, cloaking room, petrol and kerosine tanks. While on the opposite side are mosque, clinic leaind tonon-defined routes where the workshops are placed. All repairs and construction of new drums and paddles are done here in the workshops of single storey steel and sancret low walls hence good ventilation and natural lighting but poor security for materials and tools at the workshop because of absence of a door. The chemical store and spare parts stores are all located here, making it difficulty to even impossible to off-load chemicals without passing through the production hall.

4.1.2 Structure, Construction and Materials

Walls are built of sandcrete block work, having wide gates of steel. This walls are non-load bearing columns are spaced uniformly for adequate transmission of the loads to the foundation. The floors are of the two types. In the dirty-operation area, the floor is made of concrete to be able to carry the fork lifts moving on it. While in the clean operation area, the flooring of pre cast tereezzo tiles. The roof truss is steel and covered with long-span aluminum roofing sheets.

465798

4.1.3 Production Process

The factory has machines capable of achieving the production from delivery of hides or skins, the soaking/liming/unhairing are done in the beam house of the production hall. The fleshing, declining and dyeing also takes place in the beam house. While, setting, selection, shaving, slamming drying, conditioning, stacking, taggling, trimmings, buffing and pigmenting takes place in the finishing department. The measuring, packing and finished products storage is also provided.

4.1.4 Merits and demerits

Merits

(i) Column spacing is such that allows for free and unobstructed movements.

(ii) Expansion is taken fare of within the various components and it is reflected on the site.

(iii) site security is adequate as access to the factory is through two Gates, with only one always being used and the structure as a whole is enclosed by a pavamenter wall round.

(iv) The orientation of the buildings on site is quiet alright and accordingly.

(v) The production flow though difficult but functionally adequate.

Demerits

(i) The ventilation is the production hall is not adequate as most of the windows (low-level) are closed leaving only high level ones: as well as absent of a roof vent.

(ii) Nature lighting is almost absent leaving the entire operations on the mercy of artificial lighting both the day time and at night.

(iii) Landscaping is only in few areas (administrative block) thus leaving the remaining areas to generate more leather to the surrounding.

(iv) Workers facilities located or zoned to the extreme part of the site wrongly.

(v) Hygiene on the site is in adequate as oil litters around and waste treatment plant completely absent.

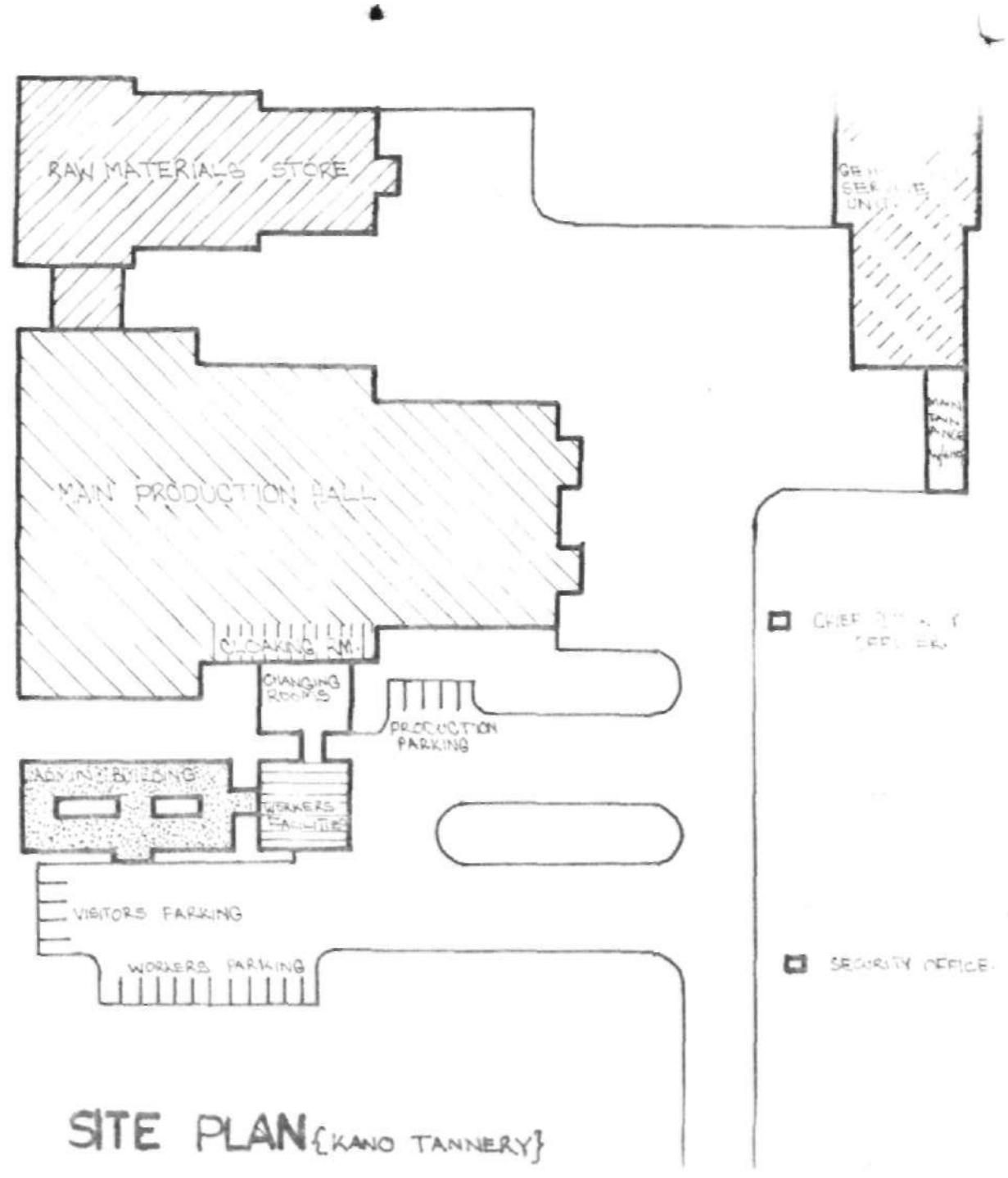
(vi) The factory buildings are not planned against fire and also steel members, walls etc. are not treated for fire.

4.2 Kano Tannery Limited

4.2.1 Historical Background

Kano tannery was established in the year 1991 by a Nigerian and a group of foreigners to contribute in the processing of leather first for local consumption and later for export to international markets.

The factory is located at Challawa industrial estate, a distance of batout 13 kilometers South-west of Kano metropolitan. Initially, it was established for the production of wet-blue to other tanneries in Kano and beyond; and up to today it did not expand beyond that. The factory was designed to process up to about 400 skins both (sheep an goats) and 120 hides.



SITE PLAN {KANO TANNERY}

4.2.2 Facilities and Planning

The whole factory consists of reserve raw materials store, day today raw materials store, administrative block changing rooms and workers facilities all haphazardly located.

The factory layout has a single gate and a gate house to control movements of vehicles into and out of the layout; but the gate house is far deep inside the factory which may not serve the security aspects of it.

Immediately after the gate house are parkings for both workers and visitors. (Fig. 4.2).

The whole factory has a defined routes. The main entrance gate leads to administrative block, workers facilities reserve raw materials store, raw materials store, as well as finished products store; and maintenance workshops. All the repairs can either be done in the these workshops of the production unit where the facility is located.

Usually the raw hide or skins are slipped into the tanyard which share a common wall with finishing store. The tan yard is most important unit of production because any failure may reflect in all the remaining production units.

The factory is a single storey framed building with its external walls cladded to help in minimising the risk of fire; as well as enhance the natural lighting and ventilation. After successful soaking/liming and unhairing operations, the pelt moves to fleshing machines where the excess meat or flesh

will be removed mechanically before final moving to deliming area to come out as a wet-blue.

4.2.3 Structure Construction and Materials

It involves simple construction and structure. The walls are made of sandcrete block work covered with aluminum cladding externally. The steel columns are well spaced giving un-obstructed floor spacing and the roof trusses are covered with aluminum roofing sheet. The floor is made up of simple concrete with cement finishes.

4.2.4 Production Process

The delivery of raw materials store was remotely located marking the smooth production flow almost impossible and improperly arranged.

4.2.5 Merits and Demerits

Merits

(i) The spacing of columns in the production area is well taken care of thus allowing free and un-obstructed floor movements.

(ii) Workers facilities like canteen, clinic and changing rooms for both male and females are provided and adequate.

(iii) The factory clear height within the production hall is adequate for both mechanical and manual system of operation.

(iv) Site security is well considered as the whole factory is accessed through a single gate thus allow proper supervision of vehicular and pedestrian movement within the entire complex.

Demerits

(i) Natural ventilation is quiet inadequate because of the absence of enough air-outlet in form of windows and roof vent.

(ii) Columns and other steel members are treated for fire as they are left exposed.

(iii) Even though the workers facilities are located on site, but the toilets are not centralized to minimize walking distance to workers in case of usage.

(iv) Proper zoning of the whole complex into private pubic and semi public was not taken care of adequately and accordingly.

(v) Landscaping of the whole complex was not at all attempted.

4.3 Tannarewa Limited

4.3.1 Historical Background

Tannerewa is tanning processing factory established in 1985 as (SCOA) tannery located at Bompai industrial area, but later renamed tannarewa and relocated to Sharada Industrial area phase III. It was one of the third generation of leather processing industry. The factory was designed like Kano tannery to produce only wet-blue to other tanneries in Europe and America, but with hope that one day it will be transformed into factory that may process, leather to finishes.

4.3.2 Facilities and Planning

This complex consist of production hall, Administrative block, reserve raw materials storage, service workshops, maintenance workshops, Generator plant, carpentry workshops, Boiler rooms, workers facilities and loading and off-loading bay; which are all properly located on site.

The factory has one entrance gate and no gate house to control the movements of vehicles into and out of the site. (See fig. ...)

The reserve raw materials store is completely detached from the production hall. The natural lighting within the

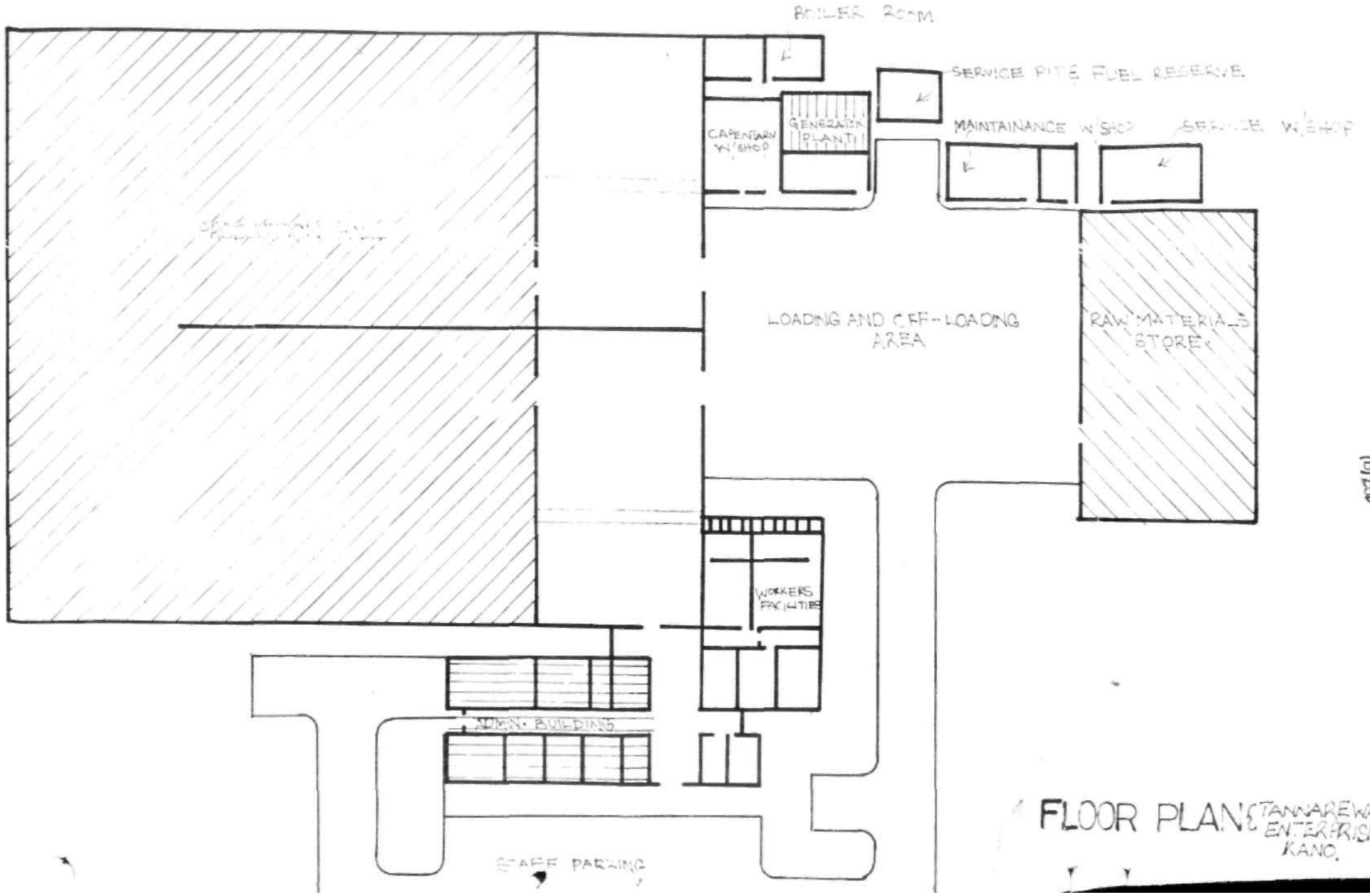


FIG. 4.3 FLOOR PLAN (TANNAREWA ENTERPRISE KANO.

store is very good with its framed walls cladding with aluminum roofing sheet.

4.3.3 Construction, Structure and Materials

The walls of the production hall are built in Sandcrete blocks. The columns spacing allows for free floor movement without any obstruction.

The floors are of cement screed finish. While roof is made of portal frames covered with long-span aluminum roofing sheets.

4.3.4 Production Process

The raw materials are first delivered to the reserve raw materials store which is completely detached from the whole complex. Then the materials move to raw materials store at head to production hall before moving to the beam house where soaking, liming, inhairing, fleshing and deliming takes place. No good drainage for both rain water and toxic liquid water. However, water provision is adequately taken care of.

4.3.5 Merits and Demerits

(i) There is adequate clean heights of the production units to allow for enough heights for forklifts, trucks and other machinery.

(ii) Site security is guarantee because of the single gate nature of the design, which allows for proper supervision of vehicular and pedestrian movement in and out of the factory; especially with the absence of a gate house.

(iii) Most of the buildings on site are adequately oriented towards North-South for the long sides of the buildings while the shorter sides are oriented to East-West without major openings at that direction.

(iv) Workers are adequately taken care of with completely functional workers facilities at the right zone.

(v) Columns spacing is considered as not to obstruct floor space.

Demerits

(i) As the factory was designed to process hides or skins to wet-blue only, expansion may result into a large complex with scattered operation units thus rendering the production flow ineffective and not smooth.

(ii) The Hygiene in the entire complex has not been taken care of as the littering of oils on floors and drainage not provided.

(iii) Landscape of the whole factory was only partially attempted.

(iv) Planning of the factory is not all that compact resulting into a scattered units on the site.

(v) All steel members and roofing trusses are not treated for fire.

(vi) The ventilation of most of the buildings are partially considered. No roof vent has been provided.

CHAPTER FIVE

5.0 THE SITE

5.1 PREAMBLE

The proposed leather processing industry in Jigawa State is to be located at Shiwarin in Kiyawa Local Government Area.

Shiwarin is a big town located just half kilometre to the North of Dutse, the Jigawa State capital. Being very close to Dutse, therefore it means being close to Kwanar Nuguma, a junction town off Kano-Maiduguri highway. Shiwarin is also know for its famous cattle market. Whereby people from Kano, Maiduguri, Yobe, Bauchi, and the neighbouring Niger republic come to that market.

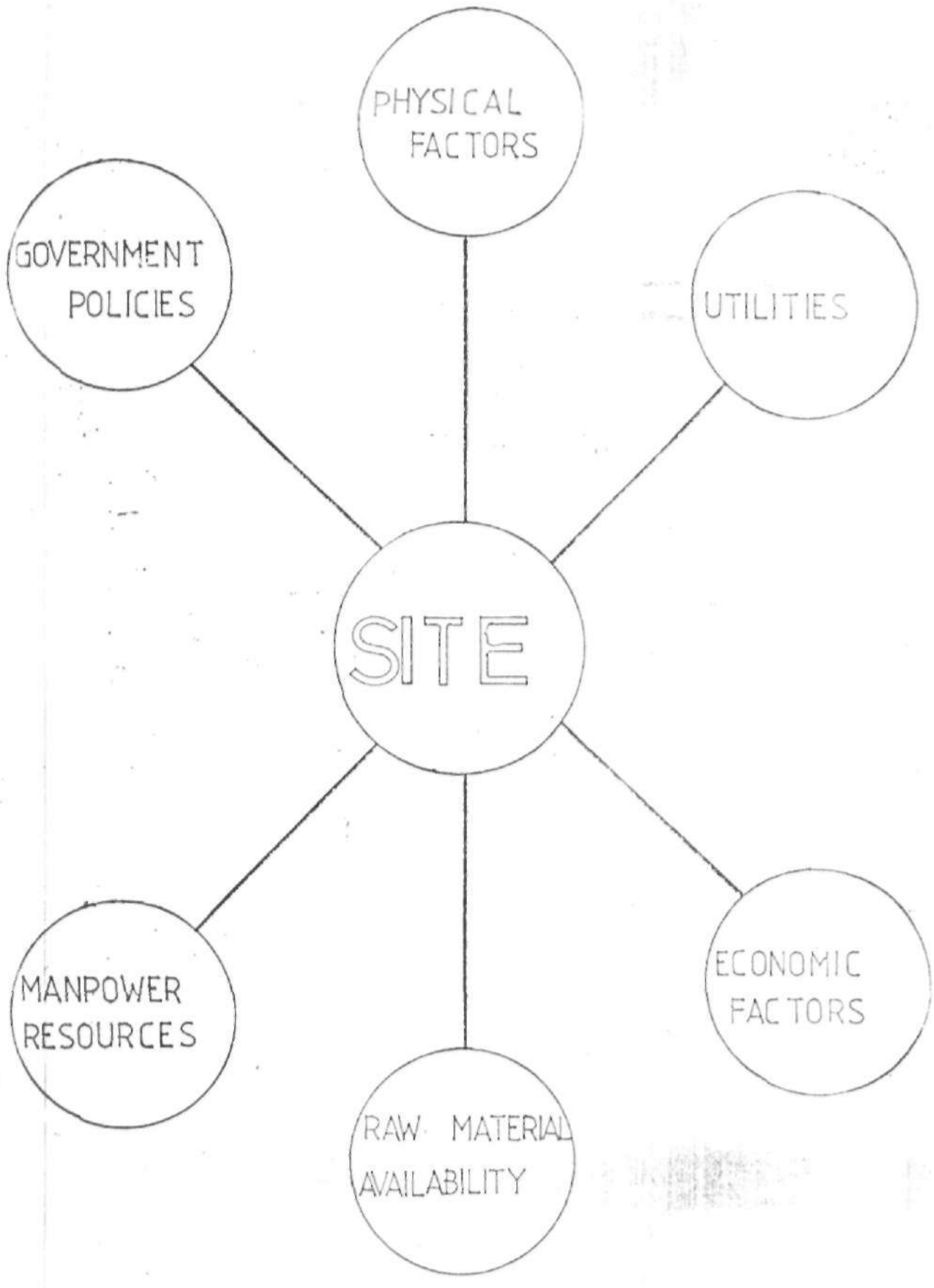
In planning a leather processing industry, suitable location for this project is very important. Also the site must be very appropriate meeting all the necessary prerequisite.

After this, it is also mandatory to make a detailed research on the proposed site as well as its environs: by enquiring, survey and inspection. This will help the architect to propose a design that will harmonize the terrain.

5.2. SITE SELECTION CRITERIA

There are vast number of factors that would actually influence the locatio of a leather processing industry. These factors would act together to provide a choice for the sitting of this industry. The industry is one which depend solely on

FIG.5.1



SITE SELECTION DETERMINANTS

abundant water supply for its operation. It also require closeness to its raw material. Thus, in Jigawa, there are large quantity of hides and skins which are yet to be utilized.

Also, this proposed site has for long been allocated to Jigawa State investment and properties for an establishment f a leather processing industry since 1994, but the idea is still on the State Government drawing board. Other factors considered are:

5.2.1 Economy

Jigawa State being a new created State in 1991, needs to diversify its economy in order to be self reliance economically. For this to be achieved, it must embark on sincere and bold programme of industrialization. Whereby the industrialization must start with ones that can source their raw material locally, thus, leather processing industry.

5.2.2 Transport

The industry should be located along traffic route which serves Gaya in Kano State, Jama'are and Azare in Bauchi State, Damaturu, Potiskum all in Yobe State as well as Maiduguri, Adamawa and Taraba State. Proximity to a water works and motor park is an advantage.

5.2.3 Main power Resources

There is a generous output of both skilled and unskilled worker from the numerous leather processing industries in Kano; as well as Jigawa State capital - Dutse. These people can be employed as skilled, semi-skilled and unskilled workers in the industry as well as many more. May be employed from the town of Shiwarin and its environs.

5.2.4 Availability of Raw Materials

Nearness to the source in sitting the industry is very important because alot of these raw materials are sold i Shiwarin market which take place every alternate day, as well as the daily slaughter of animal is getting higher an higher every now and then. Thus, in Jigawa State, there is abundance of the raw material, yet unutilized. Shiwarin of course is the best site choice because of its position being so closed to the site, there by reducing the cost of transporting the raw materials which will otherwise be reflected in a greater overhead cost of the industry.

5.2.5 Physical Features of the Site

Industrial sites are best flat on gently sloping as most industrial processes are carried out on a single level.

5.2.6. Power Supply

There must be an adequate supply of energy for the proposed leather processing industry to met its energy requirements. This may be in the form of electricity supply, petroleum, natural gas, kerosene etc. The leather processing industry demands the supply of adequate electricity to power its numerous and heavy machines, Natural gas for its Boilers, and Generator sets and kerosene for day to day operation (Processing).

5.2.7 Water Supply

The leather processing industry is an industry that uses alot of water for its operation; infact it depends so much on water supply for processing of leather from beginning to the end. This is the reason why, this type of industries have to be located near river or sources of water supply of an area, otherwise it may not be succeeding its functions

5.3 SITE LOCATION

Most cities reflects contemporary realities in their configuration, such as religious beliefs, economic power, political awareness, opinion of rulers and the ruled, among others. In Nigeria, this fact is evident as there are urban settlements with scattered high-rise buildings, or sometimes compact low-rise buildings and monuments, here and there. This whole science is laced with traffic, and cars parked



FIG. 5·2

MAP OF NIGERIA SHOWING JIGAWA STATE

114 (b)



FIG. 5.3
MAP OF JIGAWA STATE
SHOWING KIYAWA L.G.A. AND TOWN

everywhere. As well as industries (both clean and dirty industries). It is based on this group that Jigawa State Government intended to site its proposed leather processing industries at Shiwarin because that is the land allocated to all dirty industries to be established in the State. In fact, the land use map was designed by Department of Urban and Regional Planing of Ahmadu Bello University, Zaria in Kaduna State.

This land is located at Shiwarin of Kiyawa Local Government, a 10 Minutes drive from Dutse, the Jigawa State Capital; Just near the Jigawa Water Works and opposite Shiwarin (new Water Works) along Gaya Shiwarin road.

5.4 THE SITE

Based on the proposed Dutse master plan, the site or land has been located at Shiwarin along Gay-Shirawin road. It is a very vast land covering about * ------ area. It is trapezoidal in shape and is within the dirty industries zone of Jigawa State. It is bounded by access road from left, right and back from the main high way. From the Dutse Water Works, the site is just about one kilometre away from it. A prominent view from the site is Dutse Water Works.

5.5 SITE ANALYSIS

5.5.1 Geology

Most of the State is underlain by granite, schists genesis of the basement complex. Ancient apre-cambrian rocks ar separated form the younger sediments of the Chad basin by a line that runs through Kiyawa, Dutse and "Yankwashi" in Kazaure.

Basement rocks are often covered by a thin sheet of laterite iron stone. The Chad sediments are concealed by soil and sand and there are no surface exposures. The sandy beds confined by impervious clays of Chad from the main aqueous and are the chief source of water supply during the dry season. Bedded diatoms has been found in Gumel Emirate which may be beneficially used in low-cost houses building as is done in Iraq. Limestone deposits which may and indeed so, form the basis of local lime industry is said to be present in many localities in Gumel and Hadejia.

Among the newly created States, Jigawa is perhaps the most blessed in terms of abundant mineral resources. The mineral resource available in the State are as follows:

(i) Kaloine - has a large number of industrial uses, these incudes manufacture of white cement, white wash, drugs like mist-kaline, ceramics, tooth past and many others.

(ii) Potash - used in manufacture of drugs and expoilosives is available in Birniwa and Kirikasamma Local Government areas.

(iii) Refractory clay - is available at Hadejia, it is mainly used in pottering as a refractory clay or mould.

(iv) Fine clay deposit expected to contain high percentage of Aluminum and other valuable minerals is available at Gwaram Local Government area.

(v) Pedoshper - used in the manufacture of ceramic items, artificial teeth, cement, etc. It occurs in Birnin-Kudu Local Government area.

(vi) Others - used for various types of items and goods.

5.5.7 Topography

Shiwarin is about 131 kilometres South-East of Kano along Maiduguri - Kano highway, while it is only 70 kilometres along Gaya Shiwarin road from Kano. It lies between 11^0 30'N and 12^000'N latitude and 9^000'E longitude. The landscape is rocky in the Norther part and southern part as well; characterised by undulating plains of poorly drained soils. Some of the prominent hills includes Takur, Garu, Galadimawa, Kamfa etc.

The small scattered settlements in the vicinity are named after those hills. Other less prom hills include Bilai (Kachi), Jugurgur (Marajuwa) Bariki, Jirgal (Falamawa), Fagoji, Runu, Jigawar Sarki and Rankwace (Zai).

One of the most phenomenal problem os landform in Shawarin is the bad land topography owing to gully erosion due largely to other effect of running water on the loose soils down hill. Weathering and wind erosion have also been important factors in the devastated large tract of derelict land. Area mostly affected are in the south eastern portion comprising of Limawa, Katangare, Kasarau, Nifor site and areas North East of Garu along Kyawa road.

But actually, the area covered for the proposed leather processing industry is almost flat with gentles slope of contour and will be level where it is necessary. It also has few and scattered trees as well.

5.5.3 Hydrogy

Shiwarin is located in the boundary or transitional zone between the basement complex and Chad formation, comprising mainly granites of Jurassic age that provide a source of gravel for construction purposes. Other deposits includes kaolin used for ceramic and related uses. Traces of gold are also speculated.

Most of the area underlain by the basement complex is characterised by a thin discontinuous mantle of weathered rock

with thickness of about 15 metres; thus comprising a poor source o ground water. Water is sourced in areas covered by the Chad formation towards the headquarter of the local Government (Kiyawa town); in the north east, where the depth of wells reaches up to 6 metres. The water used even in Dutse is sourced rom Shiwarin (the location of the proposed leather processing industry) using pipelines. Presently a new set of dip well are constructed about 500 metres opposite the side to even facilitate the supply of the water supply to other area apart from the capital Dutse from Shiwarin; especially during the dry season. This is to be harvesting of surface water such as the War Wade pan located 20 kilometres to the south east of Shiwarin.

5.5.4 Climate and Vegetation

The area is covered by the Sudan Savannah vegetation type which consists of scattered trees and shrubs in a matric of short grasses that grow in tufts. This is associated with the hot and dry climate lasting for the greater part of the year and a short raining season. Day temperatures are often as high as 33^{0}C (110^0) in the dry season and could be as low as 21^{0}C (54^{0}F) during the harmattan period (December - February). The rainy seasons is associated with the equatorial maritime (Or South-West trade winds) and dry seasons with tropical continental air mass (or North-East Trade winds). The latter of course is cold and dust-bearing.

blowing (from the Sahara Desert during the month of December - February. While the South- Weterlies are rain- bearing and are dominant in the Shiwarin area from May/June - September. accounting for the rainfall peak i July and August. The average rainfall in Shiwarin is 672mm per year.

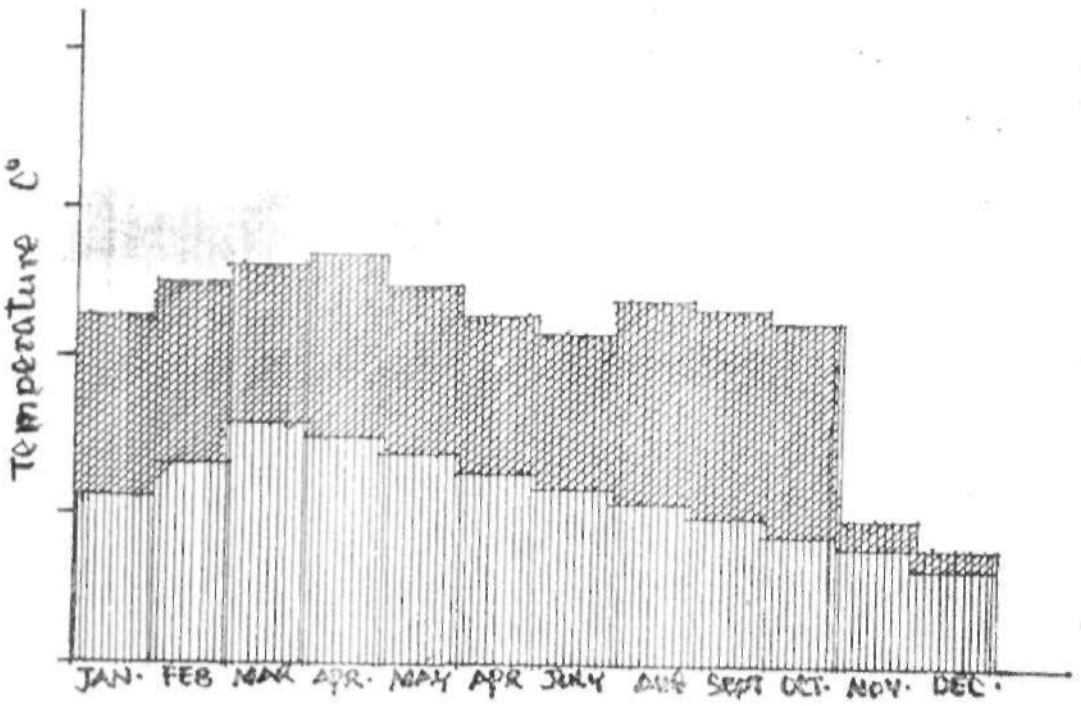
5.5.5 Soils

The soil type in the area is largely EUTRIC COMBISOL as the area falls along the transitional zone which separates the granites, schist and gneiss of the basement complex to the south - west and younger sediments of the Chad formation to the North - East. This type of soil (EUTRIC COMBI SOL) which is generally carse and moderately coarse-textured. They are somewhat excessively well-drained but in some case with finer texture and poorly drained. Covered with iron stones in some places, these soils are considered moderately suitable for dry season (Fadama) farming and easily cultivable.

5.5.6 Temperature and Humidity

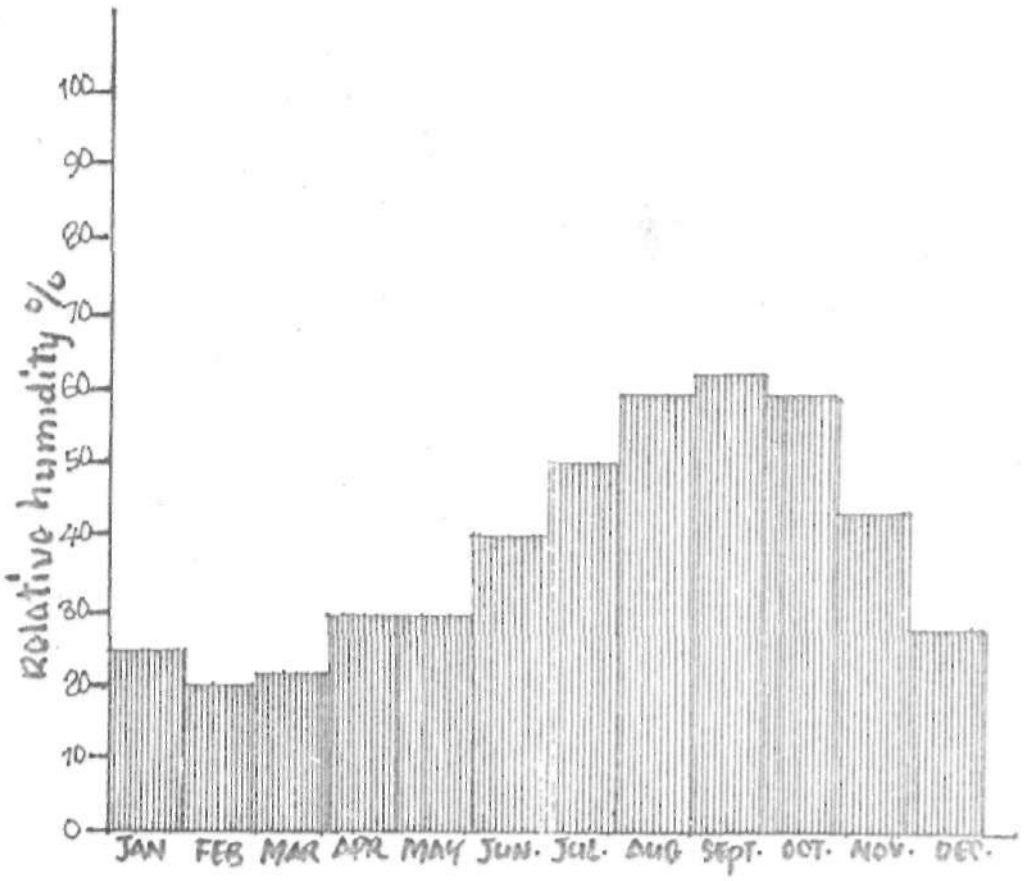
Usual day temperature are often as high as 33^{0}C (110^{0}F) in the dry season and could be as low as 21^{0}C (65^{0}F) during the harmattan period (December - February).

Human sensitivity to temperature is greatly affected by relative humidity (amount of water in the atmosphere). In Shiwarin, the relative humidity varies with the season. For example, in the dry season, when temperature are very high,



MEAN AVERAGE TEMPERATURE,
MAXIMUM AND MINIMUM.

TABLE 5.1



AVEGAGE MONTHLY RELATIVE HUMIDITY IN %.

TABLE 5.2

the relative humidity is very low. While relative humidity during the rainy season is higher because the temperature is low.

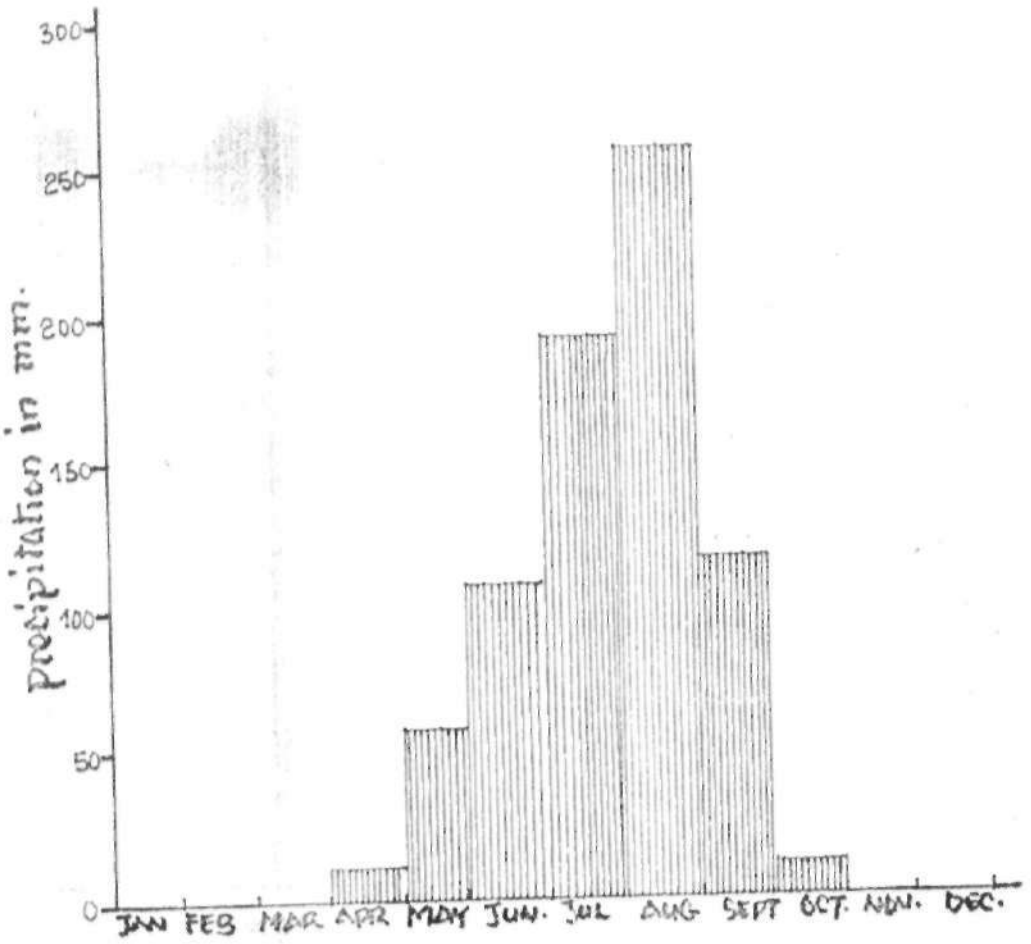
5.5.7 Rainfall

Rainy season is usually associated with equatorial maritime (South-West Trade Winds). This trade winds are actually rain-bearing and are dominant in Shiwarin town area from the months of May/ June to September accounting for the rainfall peak in the month of July and August, with an average rainfall of 762mm per year in the area.

The concentration of rainfall within certain aperids implies the need for drainage systems both in the structures and on the general site sa s whole, so that it can handle large volume of water very quickly. The roof members should be firmly fixed to the building structures to avoid any damage. A very good slope of the site can help drainage: of the area, providing a natural drainage along the sloping side. thus no problem will be encountered on drainage.

5.5.8. Wind Dust

The climate of the site is dominated by the tropical continental air mass which is develoved over the Sahara desert and therefore dry and dusty and normally blows from the North east to South-West direction.



MONTHLY RAINFALL IN mm.

TABLE 5.3

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In June, northerly flow of air has weakened and the southerly flow predominant. Moisture laden bring alot of rain. The North- East trade winds become the dominants wind from October to March, bringing with it the harmattan. There is also settling of desert particles which may reduce visibility to a hundred metres.

Building orientation should take advantage of the equatorial maritime, so that the long-side of the structure should be oriented towards the South-West direction nor South-North direction. While the shorter side should face East - West orientation with no major opening along that axis while in the former, all major openings should be along hat axis.

Passive control could be used for the control of winds and their accompaniments. Landscape and planting of trees o the site could be used to reduce the intensity and wind as a filter of dust particles. While a shading devices can also perform a dual purposes of protection of the interior from excessive sun rays and glare as well as dust from the North-East trade winds.

5.5.9 Design Implication

Thermal comfort is dependent upon temperature, humidity radiation and air movement as well as type of activities and the degree of acclimatization. The building envelope is thought of as a barrier between internal controlled environment and the external, perhaps undesirable conditions.

The task of the architect of this proposed project is to create the best possible indoor condition. A design should take advantage of the condition and mitigate the adverse characteristics of the site and its climatic features.

A Norther-East, South-West orientation would be best for a building, of course, with the North-East end shielded from the harsh harmattan winds by vegetation, but other site factors like the geometry in relation to orientation create a greater influence.

While the South - West winds should be taken advantage of and mechanical ventilation by the us air-conditioners and fas may also be employed. Openings in the direction of unfavourable winds should be minimized where possible and vegetation should be employed to temper the immediate environment to make it more favourable.

FIRE INVESTIGATION

The is no apparent record of any fire outbreak in a single building in Shiwarin town being the site location of the proposed leather processing industry. This is not withstanding, adequate fire minimizing, prevention and suppression devices will accompany the proposed factory. These devices would be both passive as well as active devices.

CHAPTER SIX

6.0 THE DESIGN

6.1 The most efficient instruments in the use for factory designs are:

1. Design factors
2. Functionality, flexibility and compatibility

1. **Design factors:**

In any factory design, emphasis is also placed on the following factors:-

(i) **Citing and layout of factory** - Its location with respect to a city is an important factor which determines whether it is economical to locate it or not. As its closeness to a city can make it utilize some city's facilities.

(ii) **Essential Services**

(a) Water - As the industry requires large quantity of water to operate, it is to be located near either a river, or a good source of water supply (Shiwarin in case of this proposal).

(b) Sewage and drainage - Sewage or waste disposal plant is to be provided and site conturs are to be considered much both drainage and waste disposal purposes.

(c) Electricity - Electricity supply is also available in the area.

(iii) **Transport and storage** - Position of loading area and off-loading is to be given due consideration and is best located close to the beginning and end of the production hall. Vehicles should have sufficient turning space and parking.

In general, a trailer length is 12 — 15 metres, width 2.6 metres, so for turning, it requires 15 metres radius. The storage hall is too be enclosed and its size will be proportional to the production capacity and nature of the materials.

(iv) **Planning of production hall** - planing of production hall shall be governed by:

- the type of machine, size and space required for both movement and keeping of leather.
- Production line should not be disturbed by cross traffic. There should be clear passage for workers movement, forklift and keeping of leather in process . Auxiliary facilities such as workshops, boiler room and generators room should be near the production hall.

(v) **Flooring** - Generally, in leather processing industry, there are two types of flooring:-

- Flooring system in the dirty operation area,

here the flooring is to be concrete with hardcore below; because it has to be able to carry heavy forklifts and trucks movement, as well as should not be slippery.

- While in the clean operation area lerrazzo tiles are used. Flooring should have sufficient slope towards drainage.

(vi) Social facilities for workers - These includes:

(a) Cloaking room and clinic.

(b) Changing rooms and conveniences (\toilets)

(c) Canteen, kitchen and store.

These facilities should preferably be attached and not far away from production hall entrance.

(vii) **Administrative Building** (the Office block) - An office is a place for work. The function of most offices is to be "the administrative headquarters of the business, which provides management with services of communications wand a record of past transactions and operations". This should preferably be separated from main production hall to avoid noise and disturbances, but should not be too far .

(viii) **Special Requirements** - As a basis for any design at all data must be determined for the external conditions likely to be experienced on the site and

for the interrenal environmental standards required in various zones of the building.

2. As earlier on mentioned, efficient instruments in use for factory design also includes factionality, flexibility and compatibility. In evolving a concept for this proposal, these tools were considered. The soning of the various units constituting this complex also affects the design concept. In all, the design goal is simplicity of form and concept.

(i) **Functionality of concept**

The following were considered:

(a) Light vehicles and pedestrians traffic are separated from heavy vehicles for safety of life.

(b) Vehicular traffic is restricted to certain areas of the site.

(c) Units are grouped together according to their close relationships.

(d) The whole complex is inter-linked.

(ii) **Zoning Concept**

Considerations are given to the following facts:

(a) Public area is easily accessible to users.

(b) Units are arranged according to noise level and privacy, viz: public and quite zone, semi-public and semi-quite zone: private and noisy

zone.

(c) No interruption of activities by intruders.

(iii) **Adopted Concept**

(a) The design concept grows almost entirely out of functional relationships of activities and requirements in both horizontal and vertical directions.

(b) Possibility to carry out future expansion in all the units of the entire complex.

6.2 Design Brief

The proposed Jigawa leather processing industry which is a complex shall be made up of:

(i) The administrative area;

(ii) Workers facilities;

(iii) Production hall;

(iv) Maintenance Workshops;

(v) Auxiliary services;

(vi) Waste treatment plant

6.3 Schedule of Accommodation

6.3.1 Administrative Block

Allotment	No. of users	Floor Areas (M^2)
Chairman	1	40.00
Chairman Toilet	1	4.50
Managing Director	1	40.00
Managing Director's Toilet	1	4.50
Managing Director's Staff/Waiting	6	20.00
Executive Director	1	20.00
Executive Director's Toilet	1	4.50
General Manager	1	20.00
General Manager's Staff/Waiting	3	20.00
Conference Room	15	40.00
Senior Staff Canteen	12	30.00
Display area	1	20.00
Kitchenette	1	20.00
Receptionist area	1	3.38
Waiting area	15	20.00
Staircase	2	20.00
Purchasing manager	1	20.00
Sales Manager	1	20.00
Sales Staff/Marketing	5	40.00
Production Manager	1	20.00
Ass. Production Manager	1	20.00
Accountant	1	20.00

	1	3.25
Accountant Toilet	4	20.00
Accounts Clerks	3	3.25
Male Toilets	2	3.25
Female Toilets	1	20.00
Tea room	1	20.00
Public Relation Officer	2	110.00
Corridor	1	20.00
Secret Registry	1	20.00
Telephone room	1	20.00
Company Sec.	3	40.00
Legal Staff	3	40.00
Open Registry	3	40.00
Computer Room	1	20.00
Chief Engineer	2	20.00
Ass. Chief Engineer	1	20.00
Production Engineer	3	25.00
Male Toilets	2	12.50
Female Toilet		

6.3.2 Workers facilities

Allotment	No. of users	Floor Areas (M^2)
Reception	10	33.00
Store	1	22.40
Canteen	45	80.00
Kitchen	1	40.00
Kitchen Store	-	18.00
Entrance lobby	-	4.50
Changing room male	87	216.00
Changing room female	22	108.00
Cloaking room	2	31.50
Clinic	5 beds	42.00
Clinic store	1	18.00
Entrance lobby	-	165.00

6.3.3 **Production Area**

Production Area	No. of users	Floor Areas (M^2)
Soaking/Liming/untanning	5	720
Fleshing	7	384
Delining	4	576
Pilling/setting	6	480
Selection	11	720
Wet-blue selection for export	5	480
Packaging	4	480
Shaving	2	50
Retanning	6	480
Samming	5	720
Drying	5	432
Conditioning	2	32
Stacking	2	15
Toggling	22	48
Trimming	22	16
Buffing	4	150
Testing area	6	50
Selection	8	360
Selection of curst for export	6	360
Packaging	4	480
Finishing	25	-
Measuring	4	480
Packaging	6	960

6.3.4 **Storage**

Wet-blue for export store	60
Raw hides and skins store	360
Chemical store	320
Spare parts store	240
Crust skin for export store	480
Finished products store	480
Underground tank	720
Hote-water tank	30
Cold water tank	120
Fuel tank	90
Gas tank	30
Kerosine tank	25

6.3.5 **Maintenance Workshop**

Mechanical Engineer	1	–
Mechanical attendants	6	–
Electrical attendant	3	–
Welders	2	–
Drum makers/repairers	4	–
Maintenance area	–	110

6.3.6 **Ancillary facilities**

Boilers rooms	1326
Generator sets area	1326
Compressed air area	72

6.4 Site zoning

The zoning of the site for the purpose of this industry is based on three main criteria, viz: Fire risk rate, noise level and function.

The site is zoned such that areas accessible to the factory is customers public area are those areas that will service the immediate needs of these customers, most especially the administration area. The production area is considered as a private zone, since customers are not expected there else on few occasions.

An intermediate zone which is considered to be semi-private is created, this area is to be used by workers and if necessary by customers as well, but basically for factory's staff.

This zoning criteria reduces rate of risk as it gives a clear distinction and makes easier to control customers movement. Zoning for fire also gives rise to the separation of vehicles access to the site, one for customers, staff are raw materials off-loading as well as finished products loading while the other one serve as gate for fire fighting and maintenance which is opened only on demand.

Function which is also a very important part of the design is well taken care of, as such, the site is zoned in line with production flow of leather processing industries and in cognizance with privacy and security. The site is zoned such at hides and skins which are the raw materials comes

SITE ZONING.

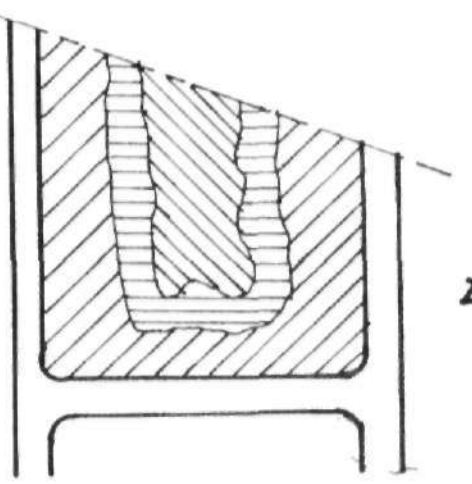
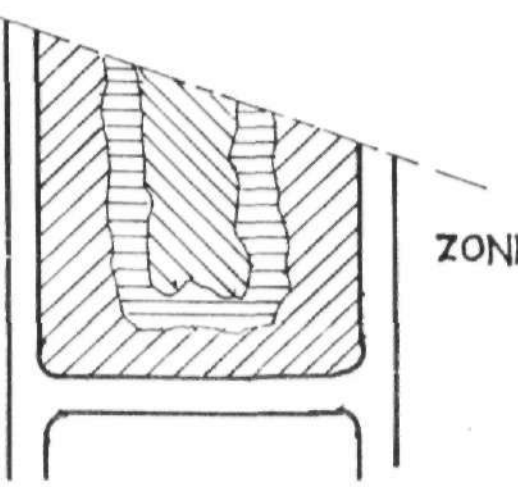


FIG. 6.1 {a}

ZONING BASED ON ACCESSI-
BILITY

MOST ACCESSIBLE PART OF THE SITE
ACCESSIBLE PART OF THE SITE
LEAST ACCESSIBLE PART OF THE SITE



{b}

ZONNING BASED ON NOISE

NOISY PART OF SITE
SEMI-NOISY PART OF SITE
QUIET PART OF SITE

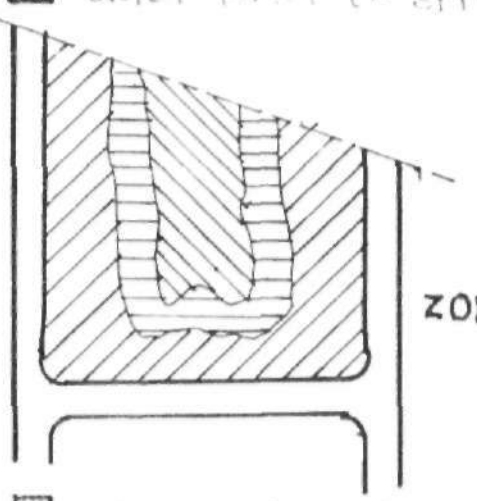


FIG. 6.1 {c}

ZONING BASED ON SECURITY

LEAST SECURED PART OF THE SITE
SECURED PART OF THE SITE
MOST SECURED PART OF THE SITE

through one entrance through the production process to storage, the storage area is serviced by the same road. The administration and workers facilities also shared that road.

Hence, the synthesis of fire minimizing, security and function produced a simple, functional and balanced site plan.

6.5 Design Concept

The design concept which is "Simplicity" was evolved and adopted so as to give rise to simple but functional site plan; with more emphasis on security.

In evolving the design concept, orientation, functionality and simplicity were taken into considerations in cognizance with the site zoning criteria, to achieve a simple and functional site with adequate security.

Access to the site is via two gates, one gate for customers, staff, loading and off-loading while the other one is just a service gate in case of maintenance work to b carried out on the extreme end or part of the site and in case of fire. This gate is rearly opened. The production hall, auxiliary services are orientated in such a way that long axis lies along the North-South with major opening enjoying this orientation with the shorter axis are facing East-West orientation. But in the case of Administrative block and workers facilities, the shorter side are facing the North-South orientation while the long axis are facing the East-West to allow sun rays into the offices in the morning hours during

VERDICT: Best alternative

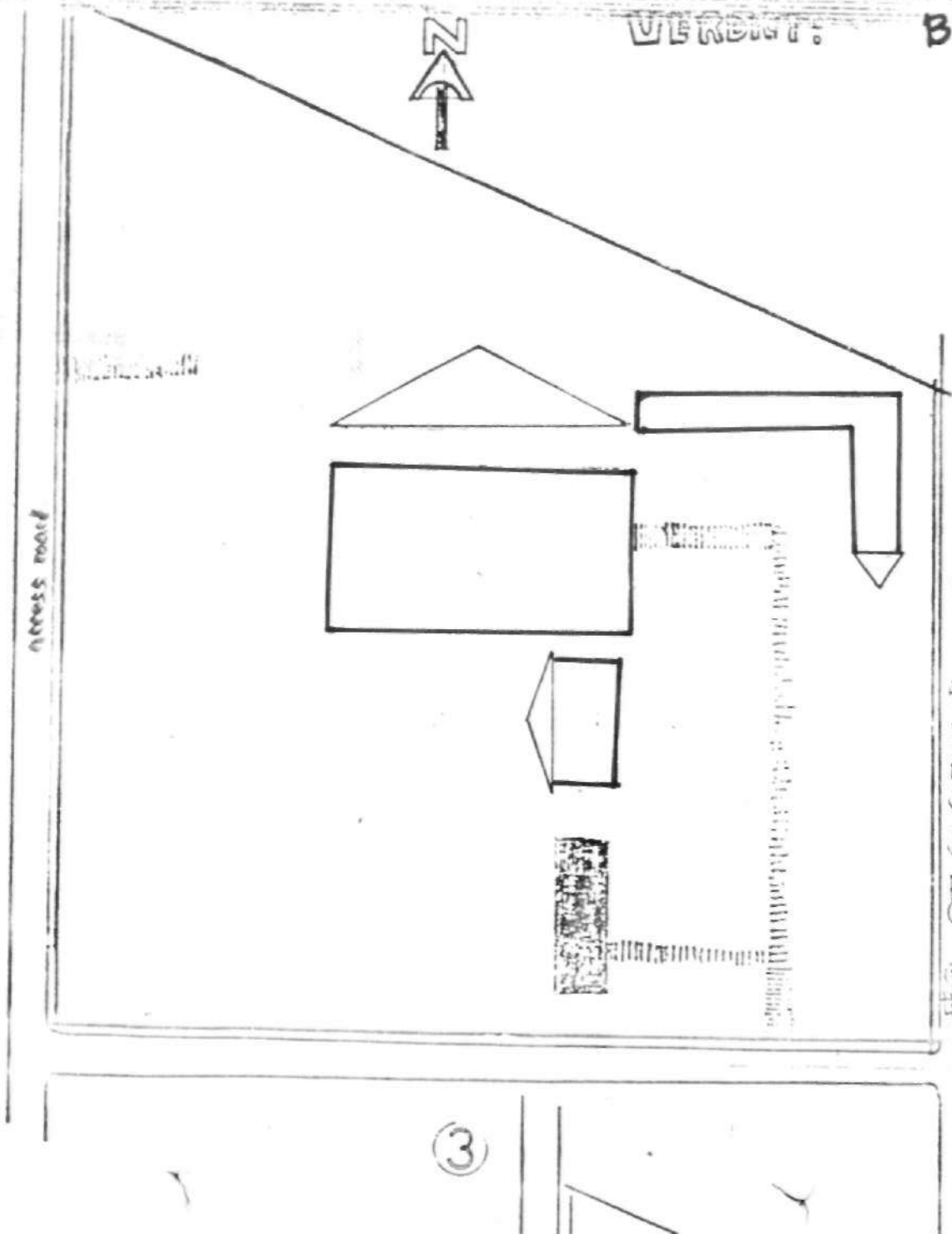


FIG. 6.2

ADVANTAGES

1. The is no direct access from the gate to the production hall, which is good for security.
2. The location maintenance workshop close to production hall will facilitate quick repairs of machines incase of any fault.
3. The various units are strongly link
4. The location of workers facilities close production hall will enhance productivity.
5. North-East winds can't affect the admin. thus, odour avoid.

DISADVANTAGES

1. The administrative block is too far to the production hall making people to travel for a distance before reaching it.

136[a]

PRODUCTION FLOW

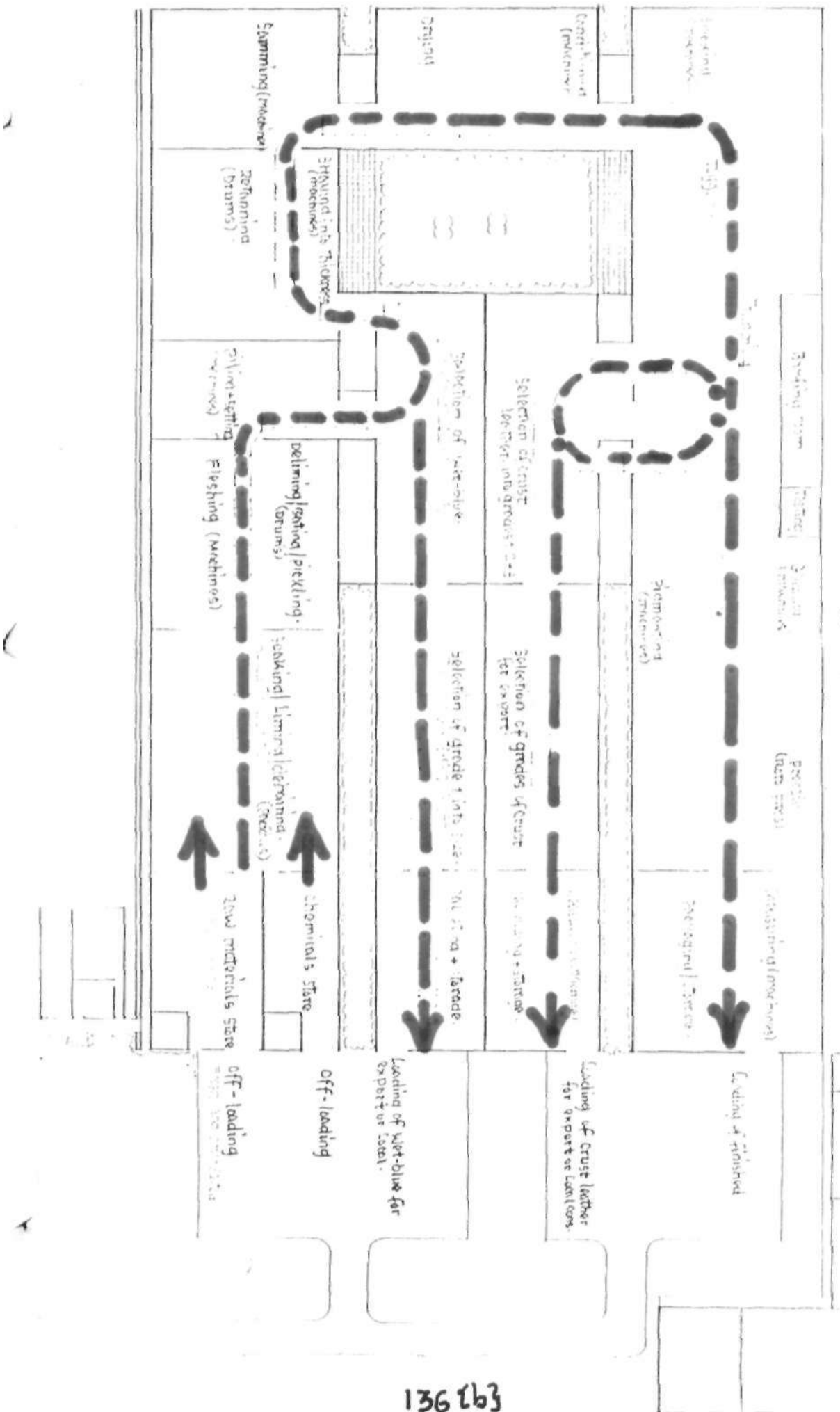


FIG. 6.3

136 (63

Hamattan, so as to make these offices comfortable for the long stay indoors: Jigawa being a very cold area during the dry-season.

In evolving the various floor plans and elevations, off the various buildings, their functions were first considered as such to sets of buildings evolved, viz: the industrial and non-industrial buildings. Then the incorporation of minimizing the risks of fire were thought of to achieve the objectives of this thesis.

The concept for the industrial buildings were based largely on function, as such a simple "rectangle" was adopted as their floor plants.

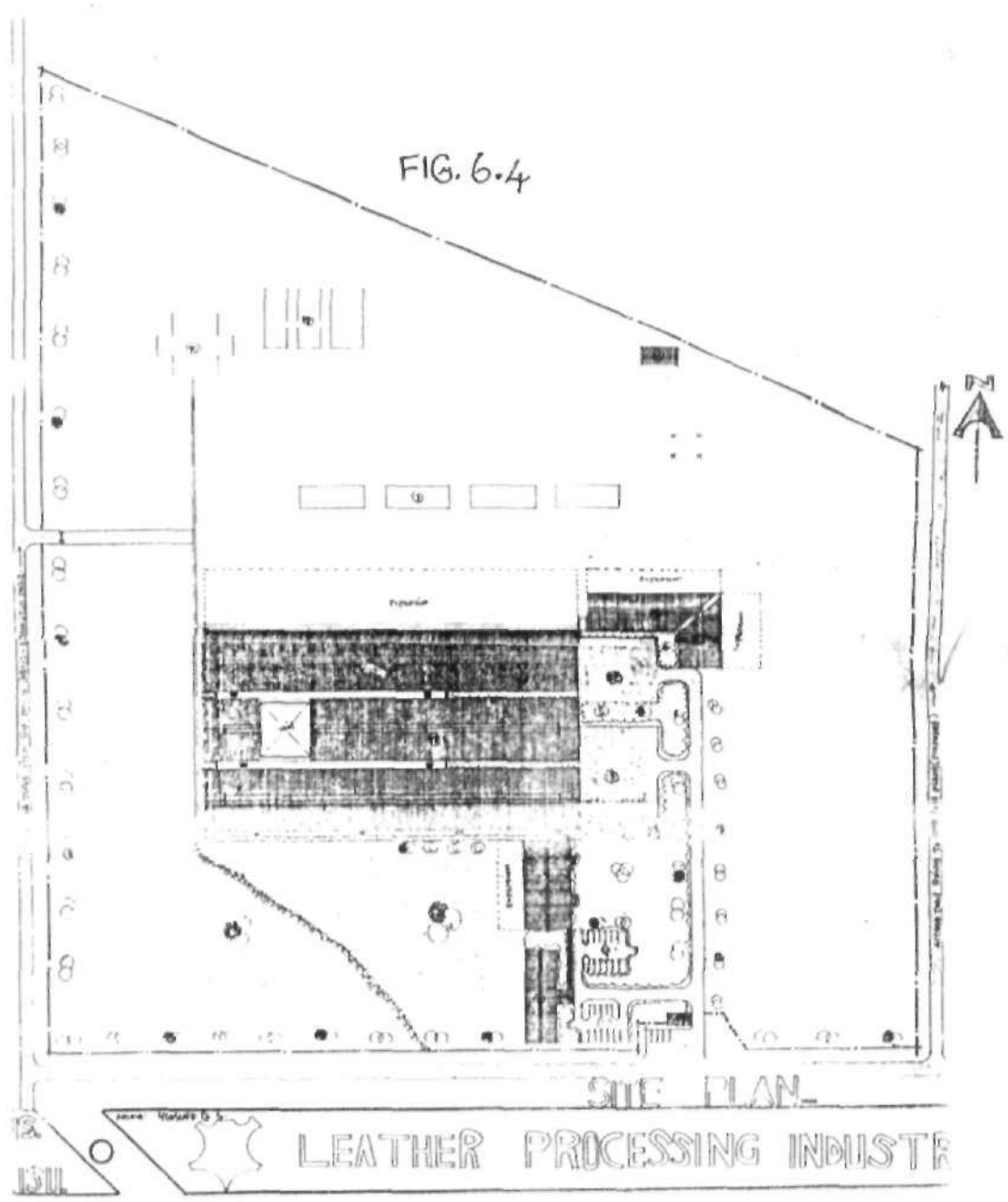
The administrative block was also conceived along the lines of simlicit, but with a view to make it "dominate" The factory skyline. As such, it has to be most attractive to sight. The offices in the administration block are doubled blanked to help in conserving energy during the Hamattan time.

6.6 Design Overview

6.6.1 Site Plan

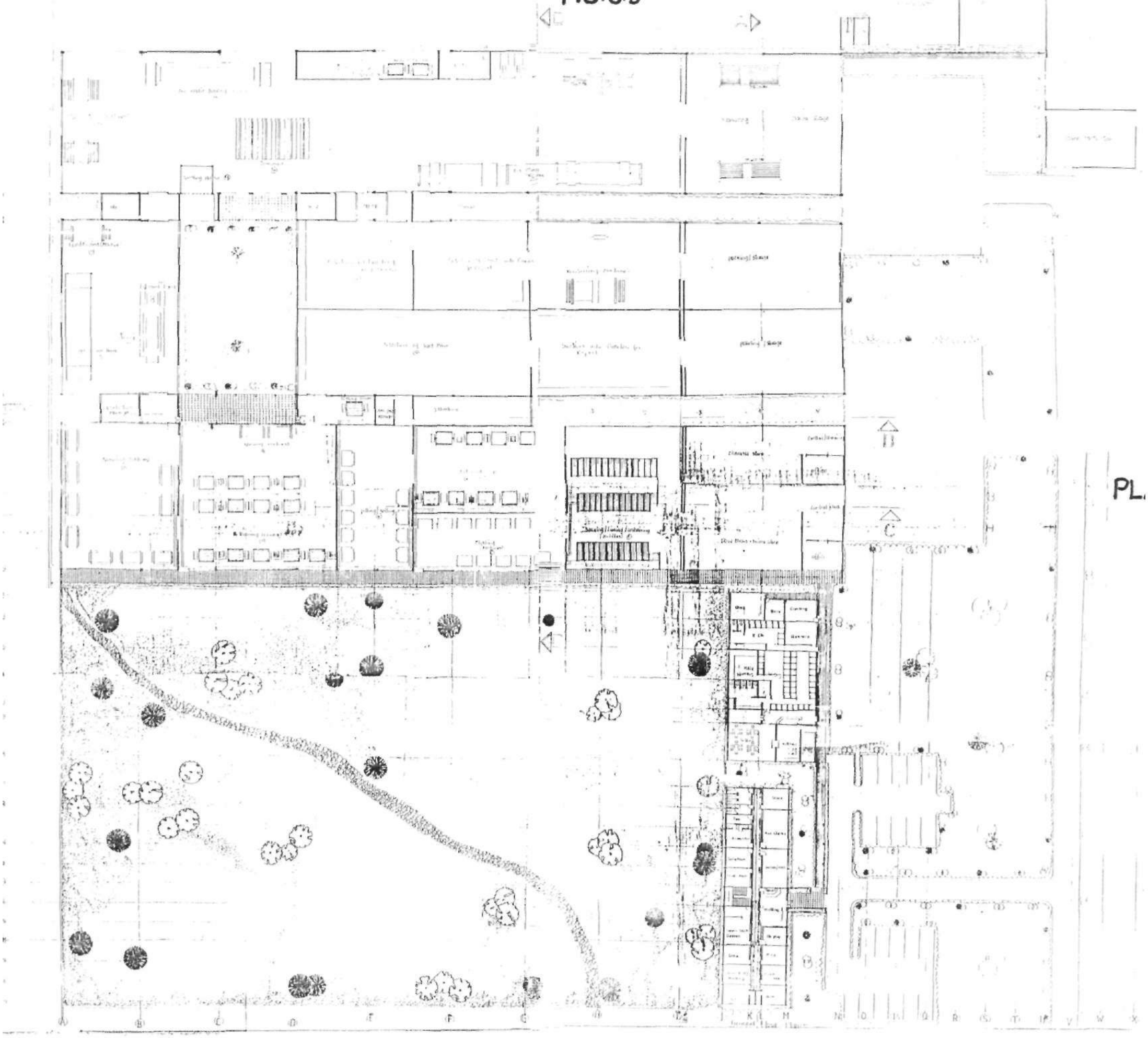
The site plan is simple, efficient and functional. All buildings on the site are well orientated either for or against solar radiation. Short sides of the administrative block and workers facilities face North-South to reduce the effect of hamattan cold wind and allow a small percentage of solar radiation indoors for warning these interiors to make

FIG. 6.4



SITE PLAN

FIG.6.5



PL

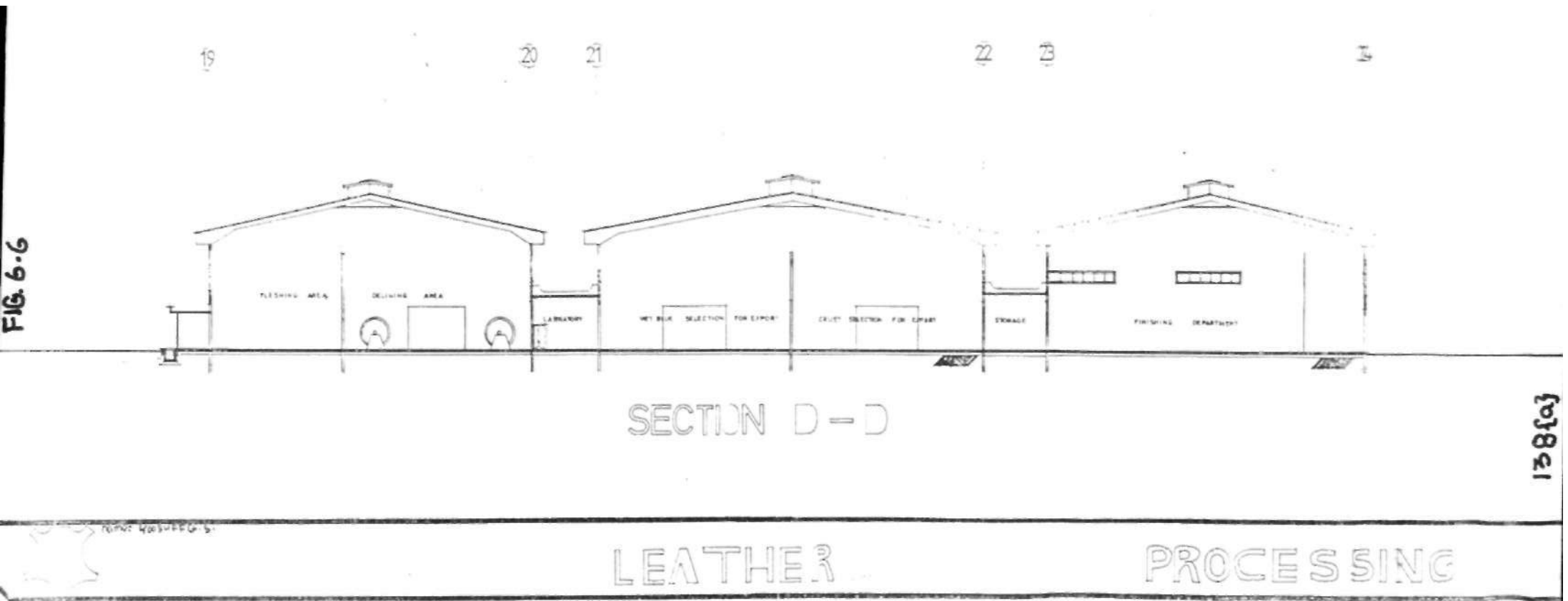
137(b)

conducing for the long stay during office hours; while in the production hall, and auxiliary, the short sides of them face East-West to reduce the effect of the solar radiation on the interiors. The longer sides of such buildings as such face the South-North, as such they are about 45^0 to the prevailing winds. Thus, good cross ventilation to reduce the huge amount of heat produce by machines to the interiors.

Access to the site is by two sets of gates for good, effective an simple circulation. The gate to the west is used for maintenance waste disposal and for fire, while the trucks, customers and staff uses the southern one customers and members of staff who do not have vehicles after being drop of by taxis or motorcycle uses the pedestrian entrance to get into the industry.

6.6.2 Buildings

All industrial buildings designed, have portal frames. These portal frames span 30m and 35m respectively and are spaced at 8m center to center. All the enclosure walls are non-load bearing made of sandcrete blocks. All the East and West walls are also solid but non-loadbearing, where openings are, used to enhance ventilation and lighting of the interiors. While the south and north walls, metal grills and windows are used to provide cross ventilation. At certain portions of the wall, the metal grills are demountable, as such they allow for ease of installing or removing drums and



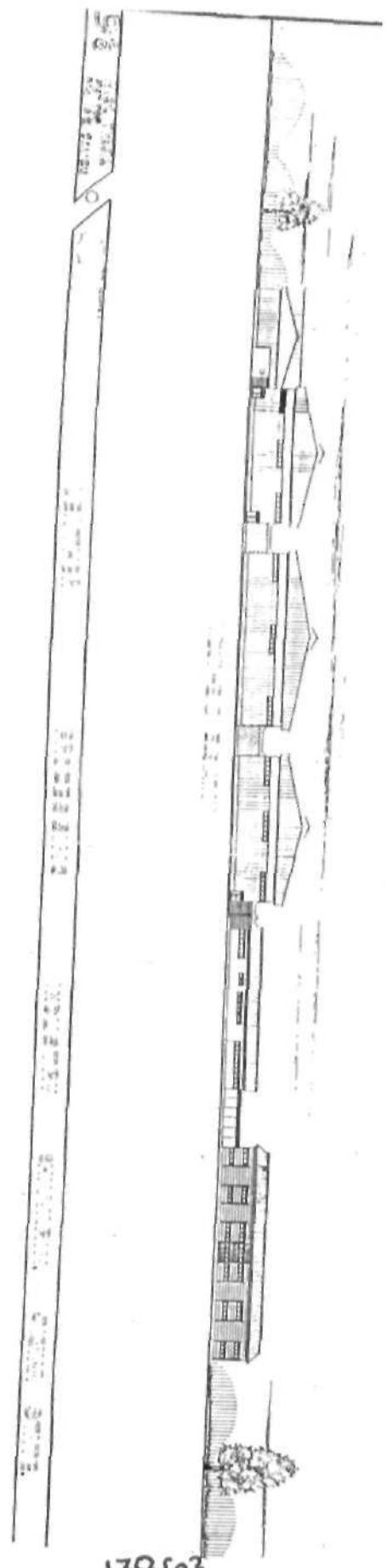
SECTION D–D

FIG. 6.6

138(a)

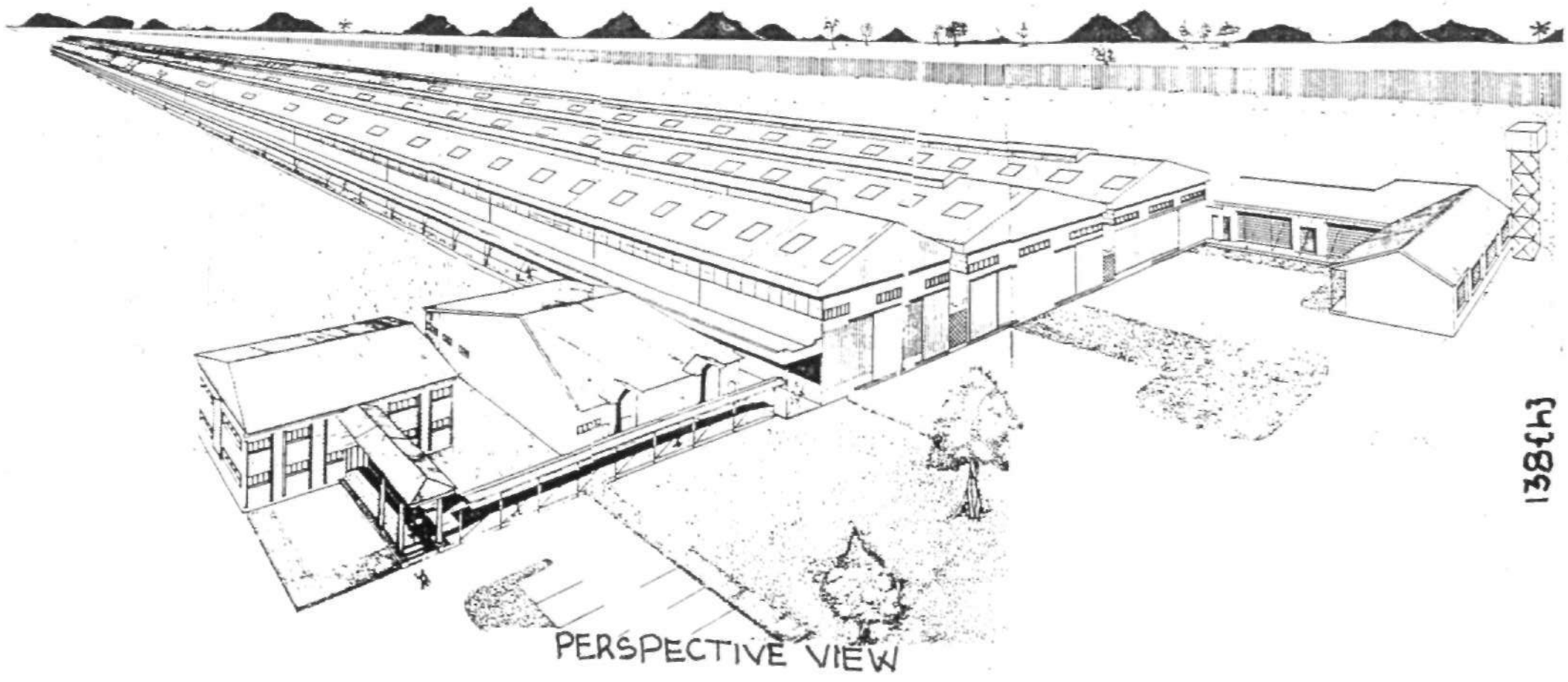
LEATHER PROCESSING

FIG. 6·9[a]



138[e]

FIG. 6.4125



PERSPECTIVE VIEW

1384(4)

peddles or pigmenting machines as well as milling drums and Buffing machines.

Roof vents are also provided to help in exchange of heated air with fresh one and in the venting off fires in case of any outbreak.

The administrative block is a sandcrete framed multi-storey building with sandcrete block-infills. Occieces in administrative building are doubled banked aimed at conserving energy indoors due to harsh weather condition during hamattan. The structure housing the workers facilities and gate house are made of simple load-bearing concrete blocks.

6.6.3 Expansion

Due to the nature of products produced in leather processing industry which amount to at least three-wet blue, crust leather and finished leather products, the very import point of attention in the design is that of future expansion: Because most of the existing leather processing industries had to start with structures to produce only wt-blue, while crust leather and finished leather normally come as expansion. But, this expansions usually result i a complex scattered and unsystematic production flow. For this reason, we proposed that all that is needed interms of structure will be provided in this proposal but can be erected in phase. So, that If there will be a need to increase production, only certain

machines can be added to in increase this production to about half.

Thus, it is economical to provide enough space for machinery for phases one, two, that is the initial production and immediate expansion to produce crust and finished leather products.

6.6.4 Integrated Services

The character of leather processing industries is that of solid waste, air and water pollution. The essential facilities provided are:

1. Waste water treatment plant where all the polluted water will recycled back into the factory while the solid waste will collected and used as fertilizer in the farm harmless.
2. Maintenance services of the machineries. An access way has been provided for maintenance to all parts within the industry, including wall mounted equipment, production machineries, fire alarms, and indicators.
3. Adequate electricity due to the nature of the machinery involved. The electrical mains supply to this industry is a 3-phase alternating current with the mains transformer located, externally on a fenced-off part of the site. This is to minimize the likelihood of fire outbreak from the transformer spreading to the entire complex.

4. Boiler house for heating the water, because water of different temperature are used a different section of the factory.

5. Water storage, Distribution and pressure

As the industry depends largely on a large quantity of water for its production, enough water equal to at least all the daily requirement, is stored in underground tanks number upto 5 in number while the main complex is linked with a nearby Shiwarin water works. Over tanks are in addition provided for storage of water.

Also adequate provision is made for all pumping drainage and repairs. The pipe network for cold water for drinking, washing in the processing units; cold water supply to water closet flushing values and wash hand basin taps, cold and hot water distribution to various production units, as well as supplies for fire fighting purposes, e.g. hydrants and sprinklers are provided in this factory. Hose reels and stand pipes placed outside at 25 metres. Fire hydrants are placed at 60m intervals, while sprinklers with automatic opening at a set temperature at intervals of 3.5m in all rooms.

6. Standby generators house is provided, as National Electric Power Authority of Nigeria is very unreliable.

7. Communication and control Equipments

Equipments for external communications are separated and

distinct from those used only for internal communication within the factory complex.

Fire alarm bells are located at strategic points on each of the units within the factory premises.

8. Laboratory is also provided to test the quality of samples as well as products.
9. Storages for Wet-blue for export, crust and finished items.

6.6.5 Finishes of the industry

The climatic factor of Jigawa State has made it possible to use good finishes for both the interior as well as the exterior without much hazard.

Production hall: There is a need for spatial demand of the production process as well as the requirement for a forklift moving through the length of the hall and other handling equipments like horse back, jacks, pallets, are reinforced concrete floor with cement screed on top is recommended; in say dirty production unit, while in clean production unit, precast terrazzo tiles are recommended.

Social facilities: In the workers facilities units, a cement screed floor finishes is ideal and recommended.

Administrative block: Here due to importance attached to administration, ceramic tiles are recommended as floor finish.

For wall of the complex, cement blocks are recommended as partition walls acting as dividers, except on special cases like in the compartment where bricks are used to check and minimize the risk of fire.

The floor material for the production hall is long-span aluminum due to the nature of the span and space to be covered.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATION

The potentials for a fast Leather Industrial Development are present in Jigawa State because of the abundance of raw materials. Yet efficient exploitation and utilization of such potentials are never backed up with any attempt of investment and enterpreneurship since the creation of the State in 1994 by defunct Babangida administration.

Nevertheless, being a new State, it needs to diversify its economy so as to be self relient in the exectuiont of projects in and around the State. This can only be realised through idustrializtion drive. Industrialization can only be achieved by starting with industries that can source their raw materials locally (that is Hides and skins in this case). Since, the raw materials for this proposed Leather processing industry are available in the State; this industry should be realised at whatever cost.

I therefore, recommend for the establishment of this proposal, to enhance the economy base on Jigawa State Government in particular, and the nation in general.

This proposal can be practicalised through finances from both the Jigawa State Government, on one hand and loans from Nigerian Industrial Development Bank Northern Nigeria Development Company as well as shares from businessmen of Jigawa State, in this percentage. Jigawa State Government 45% shares, Nigerian Industrial Development Bank Northern

Nigeria Development Company share 45% shares between them, while the remaining 10% shares goes to the indegene of the State.

In case of fire outbreak, the factory has been divided into compartments to check its spread; with each compartment having a fire resisting walls of brick. Fire hydrants are also located at strategic locations, as well as sprinklers, extinguisher of various sizes, and sophistication are also provided. The site planning is done in such a way to allow for turning to fire fighting facilities and parking. These factors coupled with lectures or drills on fire detection evacuation and suppression procedures and in handling fire equipment, to all employees, as well as good management will go a long way towards minimizing the risk of fire.

This pleasing architectural consideration is aimed at ensuring safety for workers and efficiency of production.

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