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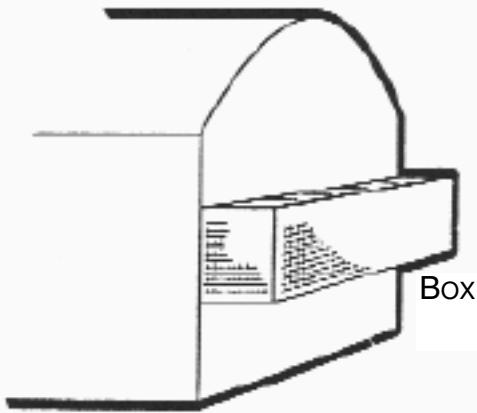
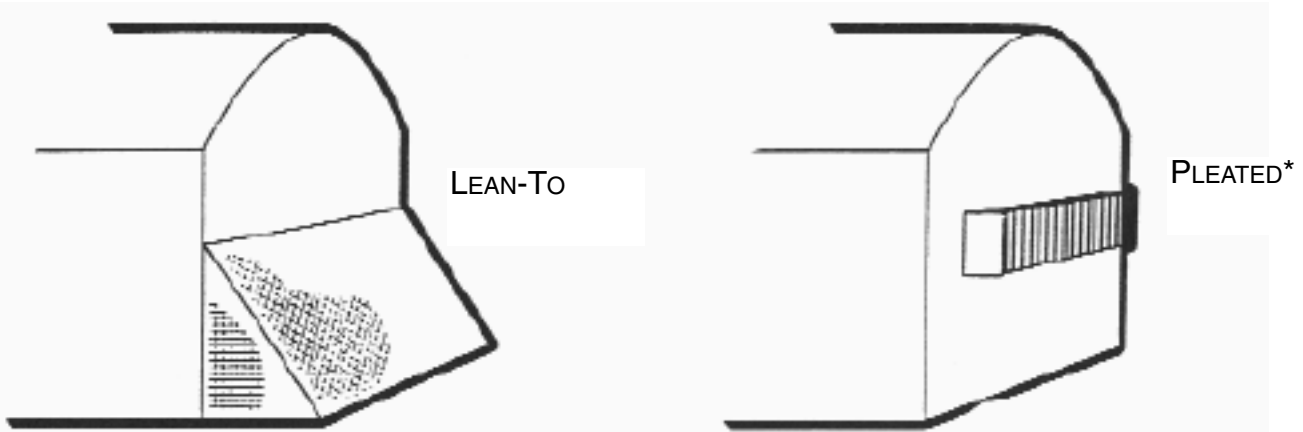
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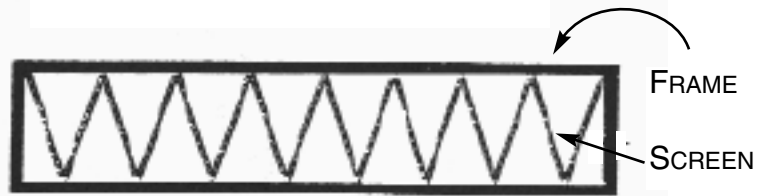
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**COMMON INSECT SCREEN INSTALLATION**

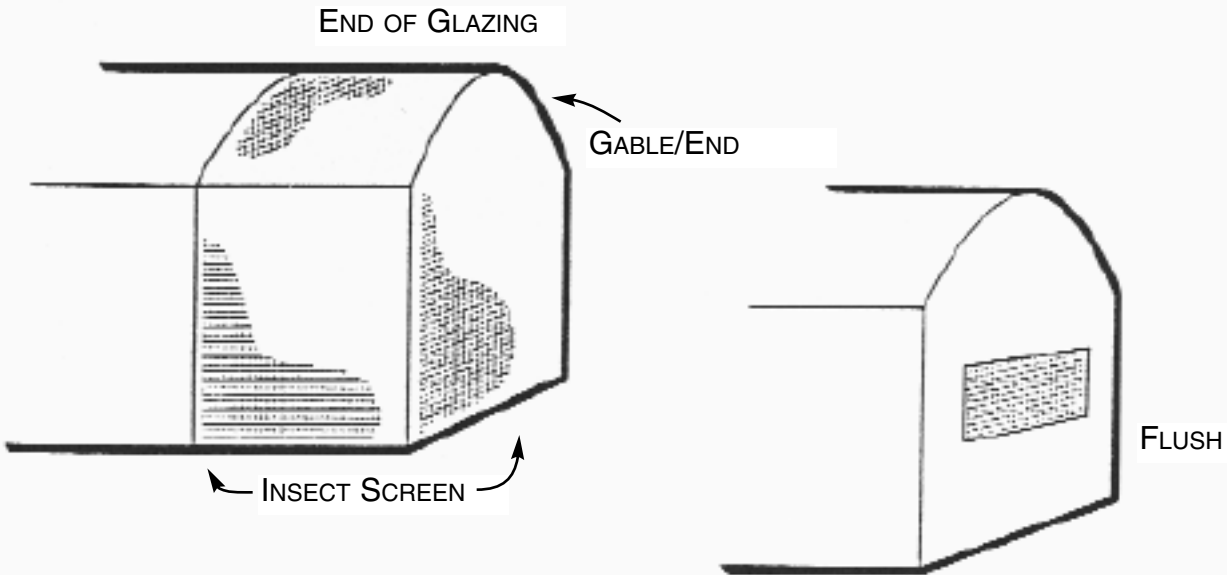
Shown on Intake Vent End of Greenhouse



Top view 'cut away' of a typical frame holding pleated screen



\*Pleated insect screen installations with the same total surface area as an unpleated piece generate the same airflow characteristics, but take up less space.



### FOREWORD

The NGMA has been requested by its members to develop a succinct, up to date document outlining the use, and application of insect screens on greenhouses. The following has been compiled by a team of greenhouse manufacturers, screen supply companies and universities. For more technical information please refer to the NGMA Cooling and Ventilation Standards. **Please be aware that this document has been produced as a service to the industry in order to acquaint growers with the use, types and construction of insect screen. It is not intended as a publication of standards nor is it an endorsement of any particular brand or type of insect screen.**

### BACKGROUND

These factors are creating fundamental change in the way greenhouse managers approach the problem of crop damage from insects:

- A. Increasingly strict and costly government regulation of traditional chemical pesticides, particularly with regard to worker protection and disposal.
- B. Growing consumer preferences for “naturally grown” or “chemical free” plants and vegetables.
- C. The ongoing battle between chemical pesticides and insect resistance.
- D. Some Cooperative Extension Agents are recommending insect screen as a first line of defense, before insecticides are recommended.

Screening for the exclusion of insect pests is an integrated pest management technique that does not depend upon pesticide application. Advantages to screening include reduced introduction of insects and pests, reduced need to spray and reduced exposure to pesticides. Disadvantages include difficulties in how to size and fasten to structure, reduced ventilation, reduced access to the greenhouse structure, screen maintenance, and pests can be screened in as well as screened out. Pest exclusion will be much more effective if greenhouse workers can be trained to keep the door closed as much as practical especially during ventilation. Screening is likely to work better for growers that are careful about all aspects of crop management.

There is a basic problem with the exclusion of insect pests; screens with small hole sizes exclude more pests than screens with larger hole sizes but are usually more resistant to airflow. A screen with inadequate area of material may cause higher static pressure drops, inadequate air exchange, higher energy consumption by the fans, excessive wear on the fan motors, and higher greenhouse temperatures. However, screens properly chosen for new construction or retrofitted to existing greenhouses can exclude pests and still allow adequate ventilation.

### SELECTING INSECT SCREEN

The grower must consider several factors occurring in the greenhouse in order to match the right type of screen to his or hers operation. Presently, there are almost as many insect screen varieties as there are greenhouse pests, and each may have its merits depending on the application. The challenge for the grower is to match the proper type of insect screen to his needs. The following points must be considered:

1. The nature of the insect attack:
  - A. Does the crop suffer from pests during the entire growing season or just a limited portion? If the attack is only during a limited part of the growing season, lighter duty, less expensive screens may be called for.
  - B. Does the crop suffer from different pests, perhaps at different times during the season? For example, aphids in spring, thrips in summer, and whiteflies in the fall. In this case the grower must select a screen tight enough to reduce or completely exclude as many of these pests as possible. (Refer to point #3)

2. Type of insect(s) to be screened. Compare insect size to hole size of the screen to be sure of exclusion. One must target a screen according to the smallest greenhouse insect (usually thrips or whiteflies). Once this is done the larger ones will be blocked as well. (Refer To Chart)
3. It has been shown in many cases thrips can be dramatically reduced by screens designed for whiteflies, even though technically they are small enough to fit through. This may be because thrips do not recognize screen material as something to feed on, or it may be that they are not attracted to the white color of most screens.

When faced with the choice of exclusion versus airflow, most growers who want to stop thrips will settle on a whitefly screen to maximize ventilation; a big plus for naturally ventilated greenhouses.

4. How will the screen be used?
  - A. Lighter duty shorter term use considerations:
    1. Interior use creating different zones in the greenhouses.
    2. "Periodic" use: Some applications may only call for screen during certain times or seasons. For example, thrips may appear in large numbers primarily in late spring. Their numbers may be relatively low in July and August.
  - B. Heavy duty long term use considerations may demand stronger, more rigid screens.
    1. Heavy exposure to elements, including sun, wind, hail, rain, snow.
    2. Wear and tear from use as a roll up curtain (if applicable).
    3. Wear and tear from workers and equipment brushing by.
    4. Wear due to weights (some applications call for weights to anchor the screen and keep it from interfering with closing vents as well as to maintain correct surface area.)
    5. All screens are prone to premature deterioration due to any type of abrasion.

INSECT SIZING CHART -Table provided by Jim Bethke

INSECT PEST (common name)	SIZE micrometers/inches Width of thorax	SIZE micrometers/inches Width of Abdomen
Western Flower Thrips	215/0.0085	265/0.0104
Silverleaf Whitefly	239/0.0094	565/0.0222
Greenhouse Whitefly	288/0.0113	708/0.0279
Melon Aphid	355/0.0140	2394/0.0549
Green Peach Aphid	434/0.0171	2295/0.0904
Citrus Leafminer	435/0.0171	810/0.0319
Serpentine Leafminer	608/0.0239	850/0.0335

## SCREEN TYPES

### MATERIALS:

1. Stainless Steel and Brass - Longest lasting but expensive in most cases.
2. Polyethylene
  - A. Monofilament - Typically polyethylene screens are woven of monofilament threads, meaning each thread is a solid strand, instead of strands made of many fibers, "multifilament." This type of thread, similar in appearance to fishing line, makes for a very rigid and strong screen.
  - B. Film - Some of the first screens were polyethylene film that was punched full of "micro holes" and used as a crude, but low priced insect barrier. Drawbacks included weak construction and low UV protection, as well as very restricted airflow.
3. Polyethylene/Acrylic - The acrylic yarns are multifilament and cause resistance to smooth yarns sliding together therefore maintaining the hole integrity.
4. Nylon -An option where shorter term/low cost/light duty exclusion is called for. Drawbacks include durability and relatively more restrictive air flow.

### TYPES OF SCREEN CONSTRUCTION

1. Weave -The most common screen construction done today, provides a trade off between exclusionary hole sizes and air flow. Always check the tightness of the weave. If the holes distort when lateral tension is applied, airflow and exclusion may be affected negatively.
2. Knit - Each thread is tied around the next, forming a durable network of knots that resist tearing and raveling. The extra loops and knots may also cause greater air restriction.
3. Film - As mentioned previously, polyethylene film can be punched full of micro holes creating an insect barrier.  
Note: These products are very restrictive to air flow and must be applied with the correct side out.

## ENGINEERING & STRUCTURE

### FAN COOLED GREENHOUSES:

*Static Pressure* - When exhaust fans are running, air pressure drops inside the greenhouse. If a manometer is used for determining static pressure drop, the flexible tubes must be free of any drops of liquid, the tubes cannot be kinked, the tube-to-manometer connections must be tight, and the manometer must be level for accurate readings. Static pressure is usually measured in inches of water. If static pressure drop is too great, the fans will not be able to move enough air to properly ventilate the greenhouse, the fans will use excessive power, the fans may overheat, and the greenhouse will overheat during hot, bright summer days. For more technical information please refer to the *NGMA Cooling and Venting Standards*. (Call the NGMA at 1-800-792-NGMA(6462) for a copy)

*Adequate Ventilation - New Construction* -Willits (1993) recommends an air exchange of 11 to 17 cubic feet per minute per square foot. This recommendation is higher than the earlier recommendation of 8 cubic feet per square foot (Nelson 1985) which is based on a greenhouse using standard cooling methods. Willits' flow rates are higher due to the fact that the study was done to determine the ideal flow rates for greenhouses with no alternate cooling devices employed, ie. cooling pads, shade cloth, whitewash, etc..

*Adequate Ventilation - Retrofitting* - To fit screening to an existing greenhouse, first check if it is presently adequately ventilated. Measure the difference in static pressure in the structure (close all doors and windows that will not be screened first) with all the fans off, with the fans running. Use that pressure drop when consulting the fan manufacturer's specification chart to estimate the total amount of air moving through the greenhouse. Interpolate between the 0.0", 0.05" and 0.1" volumes given for the various fans and motors. (For example, 0.025" pressure drop is half way between 0" and 0.05". Thus the volume of air moved would be about half way between the volumes given for 0" and 0.05"). Then add all the volumes of the fans together. By dividing this total volume by the number of square feet of the greenhouse, the quotient should equal an air exchange of 11 to 17 cubic feet per minute per square foot. Certainly if the volume of air exchange is below 8 cubic feet per minute, the structure is likely to overheat during hot, bright weather. If the total volume of air exchange is well above 17 cubic feet per minute per square foot, the selection of screening fabrics may be limited and transpiration and evaporation will be excessive.

#### **NATURAL OR PASSIVE VENTILATION:**

When a greenhouse is cooled by fans, the action of the fans create a constant velocity of air coming through the intake vents. As shown previously, we can account for velocity and accurately predict the resistance that the screen will create, and thereby determine the amount of surface area required.

When a greenhouse is naturally ventilated, however, the velocities of the air moving through the greenhouse are not nearly as rapid, nor for that matter do they remain constant. Therefore, there remains no formula for determining how one of these greenhouses will behave when screened. This does not mean that passively ventilated greenhouses cannot be successfully screened. However, when screening such a structure, it would be wise to consider the following questions and guidelines:

1. When does the crop suffer from insect damage? Is it at a time when heat loads are critically high for the crop? If not, you may consider screening all vents and monitoring temperatures closely, and removing the screen when the threat of pests is past and the weather grows warmer.
2. If the greenhouse is already at its upper limit for temperature, consider these options:
  - A. Increase the surface or open area of your vents and walls to increase ventilation. It may help to replace solid poly walls with walls made of insect screen, covered by roll-up poly film when necessary.
  - B. Go easy. If you are unsure of heat gain, experiment with one range, bay etc. and monitor its temperatures closely, as you grow comfortable with the application, expand its use.
  - C. Screen only the side that faces the prevailing wind. Remember that the fewer insects in your house, the fewer sprays you will need to control them. Since many insects are carried by the wind, it has been shown that insect populations can be reduced by screening the sides of the greenhouse that face the wind.
  - D. Consider alternative methods of shading your greenhouse. Black has been the traditional color of shade cloth because of its long UV life. However, black also absorbs the sun's rays, creating excessive heat transfer through the greenhouse covering and radiates into your house. Many growers have achieved significant temperature reductions by switching to more reflective types of shade cloth, particularly Aluminized Shade Cloth. These products will reduce and possibly negate the additional heat gain associated with the insect screen.

#### **MAINTENANCE**

When designing an exclusion structure, incorporate easy access to the inside of the screen to facilitate cleaning of the screening material. Clean fabrics have less resistance to air flow. The grower should install a manometer to check static pressure in each screened greenhouse on a regular basis especially in hot, dusty weather when screening is likely to be fouled by dust. We suggest you check with your screen manufacturer for proper guidelines for cleaning. However, the

following may be used for most screens. You should be able to clean screens by using hose and nozzle pressure from the inside out. High pressure cleaners and brushes should not be used; these can alter hole sizes. Screening should not be cleaned during ventilation! Water can fill the openings in the material by capillary action and completely stop air flow. Unscreened windows and doorways would have to be opened to prevent heat damage to plants before the water in the screen evaporates, defeating the exclusion effort. The best time to clean screens is in the evening when ventilation is usually over.

### **HARDWARE TO ATTACH SCREEN**

How will this insect screen be fastened?- “Poly Fastener,” “Spring Lock” or “Lath.” All means that can seal the screen to the structure, keeping the screen snug and not allow abrasion. Contact your greenhouse manufacturer for recommendations. They may have ready-made solutions available.

### **GROWER CATEGORIES “REFERENCES TO FORCED VENTILATION”**

1. The “average grower” is one that grows and sells to market or end user. This grower usually wants good control of insects and will be very content with 70 to 90% decrease. This grower can simply achieve this by screening their air inlet only.

2. “Primary Propagator”: This grower has high demand from his grower customers to provide insect free plants. This grower needs to consider the following:

- A. Air inlets
- B. Vents
- C. Fans
- D. Air locks on doors
- E. Seal all leaks or gaps in house

3. Research Facilities: Any research greenhouses needing full control of the environment follow all recommendations from section 2.

Any of the above questions regarding natural ventilation houses please refer to the section previously regarding Natural or Passive Ventilation.

### **INSTALLATION “HOW TO”**

The ways of installing insect screens are too numerous to mention and changing daily with new ideas. Our best advice is to consult your greenhouse manufacturer for specific ideas on how to apply insect screen.

### **CONCLUSION**

We have discussed the pros and cons of insect screens, the background and how to select screens, the screen types, engineering, maintenance, hardware and grower categories. Insect screens are here and now. The technology and application are here. The need will only increase due to reduced availability of insecticides and the need for high quality insect free plants. The NGMA would like to do all it can to encourage the successful use of insect screens. Please contact your greenhouse manufacturer immediately to get started or the NGMA for a list of NGMA members.

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