Technical Standards for Naturally Ventilated, Fan & Pad Green House and Shade Net House

Protected Production under NHB Scheme
(Technical Standard No. NHB-PH-Type 02-2011)

राष्ट्रीय बागवानी बोर्ड
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National Horticulture Board
(Department of Agriculture & Cooperation)
Ministry of Agriculture, Govt. of India
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PREFACE

Application of green house technology for commercial production of a number of high-value horticulture crops is growing rapidly. On one hand, technology for production of hi-value horticulture crops in protected conditions in poly houses, shade nets, tunnel houses is being transferred to the producer farmers effectively by horticulture extension system; on the other, Indian industries have developed indigenous technology and built up in-house capability to design and fabricate infrastructure for protected cultivation in varying agro-climatic conditions in the country.

Department of Agriculture & Cooperation has been promoting capital investment in protected cultivation by extending capital investment subsidies extending from 25% to 50% of normative capital cost. So far as National Horticulture Board is concerned, it has been extending financial assistance for poly house and shade net construction since inception of its credit linked, back-ended subsidy schemes for promotion of commercial horticulture in the year 1999-2000 which has given impetus to the growth of protected cultivation of horticulture crops in India. Sizable financial assistance is also available under other schemes of Central Government and State Government for protected cultivation of horticulture crops.

It needs to be noted with concern that the norms for subsidy under various Government schemes vary with the type of infrastructure such as naturally ventilated and fan & pad system for cooling and heating purpose; high, medium and low cost (Bamboo) poly houses etc; however, the concerned scheme guidelines generally do not prescribe specification for construction of poly house/ shade house of specific category resulting into large scale variation and resulting into compromise in quality of various components of the infrastructure of poly houses etc under various categories. In this context it is noteworthy that a number of poly house units and shade nets have not been successful due to use of sub-standard structural design and material which has ultimately affected the techno-economic viability of the projects. Absence of technical standards and design specifications for infrastructure for protected cultivation in poly houses, shade nets etc has also been one of the reasons for insurance companies not coming forward to provide insurance coverage for such capital intensive infrastructures.

It is thus obvious that for ensuring rapid growth of quality infrastructure for protected cultivation, it is necessary to have minimum technical standards and material specifications for infrastructure components. This has necessitated prescribing technical standards / design specifications and linking the same with the normative cost in the larger interest of the industry and user farmers.

This publication entitled "Technical Standards of Naturally Ventilated, Fan and Pad Type Green Houses and Shade-nets" is intended to serve as minimum requirements and are not to be construed as limiting scientific & technological innovations and good practices.

I take this opportunity to acknowledge the valuable contribution made by experts particularly Dr. K.G. Singh, Sr, Research Engineer, PAU, Ludhiana; Sh. Ashok Girhotra, Sr. Project Officer, NCPAH; Shri Brajendra Singh, Zonal Director, NHB and Shri Anil Kumar, SHO, NHB in bringing out this publication.

Last but not the least, contributions made by fabricators of Green House, Input suppliers, growers, experts, officers of the Central and State Government by way of their active participation has been of immense value in firming up technical standards.

(Bijay Kumar)
Managing Director
National Horticulture Board

Contents

Section-1 : Introduction

1. **Introduction:** Poly-house is a framed structure made of GI pipes/MS angle with protective shade made up of polythene used for growing high value agricultural products. It is semi-circular, square or elongated in shape. Temperature, humidity, ventilation of air are controlled by the equipments fixed in the polyhouse. Crops grown in the polyhouse are protected from intense heat, bright sunlight, strong winds, hailstones and cold waves. Polyhouses are used in floriculture , vegetables and nurseries. Besides from this, polyhouses are also used for horticulture, though the primary and best is floriculture when considering the investment. Every factor influencing a crop can be controlled in a poly house. High tech poly houses even have heating systems as well as soil heating systems to purify the soil of unwanted viruses, bacteria etc.

Advantages of poly-house/green-house:-

- The yield may go up to 10-12 times higher than that of out door cultivation depending upon the type of greenhouse, type of crop, environmental control facilities.
- Reliability of crop increases under greenhouse cultivation.
- Ideally suited for vegetables and flower crops.
- Year round production of floricultural crops and off season production of vegetable & fruit crops...
- Disease-free and genetically superior transplants can be produced continuously.
- Efficient utilization of chemicals, pesticides to control pest and diseases due to precision farming..
- Water requirement of crops very limited and easy to control.
- Maintenance of stock plants, cultivating grafted plant-lets and micro propagated plant-lets.
- Hardening of tissue cultured plants
- Production of quality produce free of blemishes.
- Most useful in monitoring and controlling the instability of various ecological system.
- Modern techniques of Hydroponic (Soil less culture), Aeroponics and Nutrient film techniques are possible only under greenhouse cultivation.

Points to be considered while constructing green house

- East and south sun is excellent for the green house, which can remain open on both these sides, but it should be shaded on the north and the west to protect from winds.
- Construction: A plan should be prepared before constructing the green house together with plan of beds and paths on the ground.
- Selection of plastic film structure and roof slope
- Use of proper controlled climatic condition
- Area and Green house structure
- Plant protection measures

Types of green houses:

- Tunnel type (cold climate green house)
- Quonset (semicircular/subtropical green house)
- Gabble type (slopping roof)
- Tropical region green house
- Ridges and furrows green house
- Ground to ground green house

Design consideration of Poly-house:

Site selection:-

- While selecting the site for construction of a Poly-house, following points should be considered for the optimum growth and development of plant:
- The site should be free from shadow.
- The site should be at a higher level than the surrounding land with adequate drainage facility.
- Availability of good quality irrigation water and electricity.
- pH of irrigation water should be in the range of 5.5 to 7.0 and EC between 0.1 to 0.3 mS/cm.
- pH of soil should be in the range of 5.5 to 6.5 and EC between 0.5 to 0.7 mS/cm.

Orientation:-

Correct orientation can provide good environmental conditions inside the poly-house.

Size:-

The size of poly-house needs to be selected based on availability of the land.

Cost:-

The cost may vary depending upon the types of poly-house and many other reasons.

Height:-

Height is one of the most important aspects of poly-house design. The height of structure directly impacts natural ventilation, stability of the internal environment and crop management. The ideal height of Naturally Ventilated small green house (up to 250 sqm) should be in the range of 3.5 m to 4.5 m and 5.5 m to 6.5 m in case of large size poly-houses.

Maintenance of favorable environment in naturally ventilated green house

a) Ventilation in green house:-

A greenhouse is ventilated for either reducing the very high greenhouse air temperature or for replenishing carbon dioxide supply or for moderating the relative humidity in the greenhouse. Air temperatures above 35° C are generally not suited to greenhouse crops. It is a quite possible to bring greenhouse air temperature below this upper limit during spring and autumn seasons by providing adequate ventilation for the greenhouse.

The ventilation in a greenhouse could either be natural or forced. In natural ventilation, air becomes less dense as it gets heated and, thus, rises. This chimney effect could be used to move the warm air out and cool air in. Winds also permit creation of additional natural ventilation could be quite effective during spring and autumn seasons. The total minimum ventilation area should be around 10% of ground area.

The optimum height of the poly house should be 6-6.5 m at the centre. The lesser height will result in higher inside air temperature and the greater height will result in material wastage and risk of damage from wind thrusts.

b) Control of temperature in green house

In a composite type of climate like in Punjab, the ambient air temperature rises above 30° C in the month of March due to which inside air temperature of a closed polyhouse exceeds 38° C and becomes detrimental to the inside plants. In order to remove the inside hot air, the poly house should have continuous side ventilators along the south and north wall. In a 100 m^2 area poly house, the size of these ventilators should be equal to the length (16m) and height (2m) of these walls. With the start of March month, the polyethylene (PE) sheet over these ventilators should be rolled up to allow the entry of outside cool air. By doing so, inside air temperature of the poly house drops significantly.

However, in the month of April, when the outside air temperature exceeds 33-35° C, natural ventilation through the side ventilators only becomes less effective. From this month onwards, roof top ventilation (window type) provided at sufficient distance on the centre of the poly house roof should also be

opened. The optimum size of the ventilator should be 1m x 1m on each side of the roof at the centre. The smaller size ventilator would hamper the flow of hot air from inside and the larger size ventilator would face greater pressure against wind. The optimum distance (gap) between the two ventilators should be 3m for a 3m high greenhouse at the centre. Greater distance would form hot air pockets inside the poly house and the proper removal of inside air would not take place. If both the side as well as top ventilators is opened, then this type of ventilation replaces the internal hot air by external cooler one during the hot sunny days with weak wind. The external cool air enters the greenhouse through the lower side openings while the hot internal air exits through the roof openings due to density difference between air masses of different temperature causing the lowering of temperature in the greenhouse significantly.

In the months of May and June when the outside air temperature exceeds 38-40^{o}C, natural ventilation does not work well. During this period the peak solar radiation on the floor of the greenhouse and light intensity also becomes very high due to which the plant growth is adversely affected. The entry of this unwanted high radiation (or light) can be controlled by the use of shading. A 50% shade net should be used at 2m height (if used inside) or at the outside roof the poly house (if used outside). For smaller size poly houses not exceeding 250 m^2 area, 50% shade net can be fixed over the roof of the poly house from outside. By doing so, the plant temperature inside the poly house drops significantly. The use of shade net works very well if evaporative cooling method using foggers is also used during these hot and dry months of May and June. This arrangement can lower the inside air temperature by 5-6^{o}C below the ambient air temperature. However, care should be taken to avoid high humidity insides the poly house above 70%.

c) Control of humidity in greenhouse

For most crops the acceptable range of relative humidity is between 50%-80%. However, for plant propagation work, relative humilities upto 90% may be desirable. Humidification in summers can be achieved in conjunction with greenhouse cooling by employing appropriate evaporative cooling methods such as fan & pad and fogging systems. Sometimes during winters when sensible heat is being added to raise the greenhouse air temperature during nights the relative humidity level might fall below the acceptable limit. In that situation, humidifiers might need to be operated to circumvent the problem.

Dehumidification is often a problem not amenable to simple solutions. During rainy seasons the ambient relative humidity is high along with that of the greenhouse. In this situation the ventilation can not lower the humidity of greenhouse air. But, when the ambient relative humidity is lower then ventilation could be practiced to reduce the greenhouse relative humidity. Chemical dehumidification systems are technically feasible but expensive at present.

Section-2 : Components of Green House and General Specifications

In case of permanent poly-house structure steel and fiber made glass are galvanized hallow pipe-having glass or transparent polythene sheet structure is needed. Major Components are listed here below:

Roof: transparent cover of a green house.

Gable: transparent wall of a green house

Cladding material: transparent material mounted on the walls and roof of a green house.

Rigid cladding material: cladding material with such a degree of rigidity that any deformation of the structure may result in damage to it. Ex. Glass

Flexible cladding material: cladding material with such a degree of flexibility that any deformation of the structure will not result in damage to it. Ex. Plastic film

Gutter: collects and drains rain water and snow which is place at an elevated level between two spans.

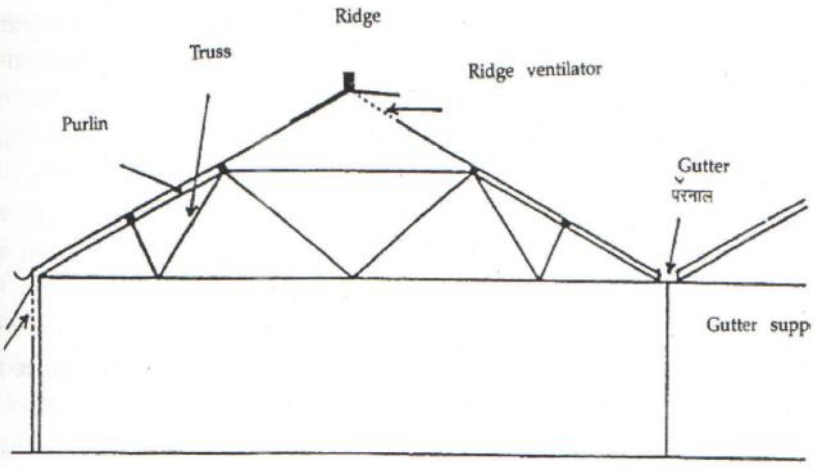
Column: vertical structure member carrying the green house structure

Purlin: a member who connects cladding supporting bars to the columns

Ridge: highest horizontal section in top of the roof

Girder: horizontal structure member, connecting columns on gutter height

Bracings: To support the structure against wind



Arches: Member supporting covering materials

Foundation pipe: Connection between the structure and ground

Span width: Center to center distance of the gutters in multispan houses

Green house length: dimension of the green house in the direction of gable

Green house width: dimension of the green house in the direction of the gutter

NEED FOR FIRMING UP TECHNICAL STANDARDS OF GREEN HOUSE:- Depending upon various factors viz. Location, crop, budget, size, requirement etc, variable specifications of various components involved in construction of Green House/ Net House are being used. A large number of such Green Houses/ Net Houses have come up with heavy subsidies from Government, Both Central and State including NHB, and loans from Financial Institutions. There are numerous cases of failure of Poly House/ Net House Structures due to use of sub-standard material or non- compliance of Minimum Technical requirement needed for setting up such structure resulting into heavy loss to the beneficiary and also defeating the purpose of providing assistance. This necessitates the need of firming up of Minimum Technical Standards for various types of Poly House / Net Houses with the help of various Stake Holders.

Technical Standards in vogue : Some of the standards being followed for construction of Green Houses are as under :

Indian Standard:- The Bureau of Indian Standards (BIS) has formulated following standards with respect to Poly-House/Green Houses:-

1. IS 14462:1997 - Recommendation for layout, design and construction of green house.
2. IS 14485:1998 – Recommendations for heating, ventilating and cooling of green-house.
3. IS 15827: 2009 – Plastics films for Green house

Section-3: Technical Standards of Naturally Ventilated Polyhouse/Greenhouse

<table>
<tr><th>Sr.No</th><th>Item</th><th>General Specifications</th></tr>
<tr><td>1</td><td>Type</td><td>• Minimum top ventilation should be 10% of total Polyhouse/Greenhouse area and side ventilation depends on requirement of the climatic conditions.
• Preferably Saw tooth design or Even Span, Ridge & Furrow depending upon suitability for naturally ventilated polyhouse/greenhouse</td></tr>
<tr><td>2</td><td>Size</td><td>Area = As per the requirement.
Length = Multiples of 8 Meter + 4 Meter. Ex. 8x2+4 or 8x3+4. (Length is side along the gable or side along the truss lines)
Width = Multiples of 4 Meter. Ex. 4x2 or 4x3. (Width is side along the gutter or side along the Purlin lines)</td></tr>
<tr><td>3</td><td>Grid</td><td>8M x 4M. 2 Meter corridors/balcony along all four sides.
If the area is ≤250 Sq m then it is better to go for single span green house</td></tr>
<tr><td>4</td><td>Shape</td><td>To reduce the impact of wind and consequent damage to greenhouse structure; Green house will be aero dynamic along all four sides with curvature shaped balcony pipes of 48 mm OD/2 mm thick G I pipes</td></tr>
<tr><td>5</td><td>Structure</td><td>Hot Dip Galvanized Tubular Structure. Galvanization of the structural members of BIS standards should not be less than 300 GSM (grams per square meter).</td></tr>
<tr><td>6</td><td>Stability of Structure</td><td>Structure should withstand to minimum wind velocity of 80.6 miles per/hr or 130 Km/hr or 36 Meter per second.
Note:- In case of high wind velocity zones, structure should withstand wind velocity upto 94 miles per/hr or 150 Km/hr or 42 Meter per second.</td></tr>
<tr><td>7</td><td>Sizes of the structural members</td><td>Refer sequence as =
<table>
<tr><th>Members Name</th><th>Outside Diameter (mm)</th><th>Thickness (mm)</th><th>Wt. per meter length (kg)</th></tr>
<tr><td>Columns</td><td>76</td><td>2</td><td>3.75</td></tr>
<tr><td>Top Purlins</td><td>48</td><td>2</td><td>2.30</td></tr>
<tr><td>Gutter Purlins</td><td>42</td><td>2</td><td>2.10</td></tr>
<tr><td>Top Arches of the truss</td><td>42</td><td>2</td><td>2.10</td></tr>
<tr><td>Bottom Chord of the truss</td><td>60</td><td>2</td><td>2.85</td></tr>
<tr><td>Internal Bracings of the truss</td><td>33</td><td>2</td><td>1.60</td></tr>
<tr><td>Coridors/Balconies</td><td>60</td><td>2</td><td>2.85</td></tr>
<tr><td>Curtain Runner</td><td>42</td><td>2</td><td>2.10</td></tr>
<tr><td>Flap control pipe</td><td>21</td><td>2</td><td>1.08</td></tr>
<tr><td>Curtain Shaft</td><td>27</td><td>2</td><td>1.30</td></tr>
<tr><td>Cross Bracing</td><td>33</td><td>2</td><td>1.60</td></tr>
<tr><td colspan="4">Not:- Welded pipes should not be used for structure erection except bottom pipe of 8 m length.</td></tr>
</table></td></tr>
</table>

8	Fixtures to join structural Members	Different type of fixtures are used to join structural members of poly-house like brackets, cleats, clamps, nut & bolts, washers, self tapping & drilling screw etc. The entire iron fixture should be galvanized and strong enough.
	a) Brackets and cleats	Made from the section like angle, channel, I beams and should be cold galvanized with minimum coat of 120 GSM
	b) Clamps	Different type of clamps like 76/60/48/42/33 mm OD full, 76/60/48/42/33 mm OD half are used which should be made from min. 42 mm wide and 2.1 mm thick GP Coil having minimum 120 GSM Galvanization. Curtain clamp should be made from high carbon steel strips of min.30mmwide and 0.8mm thick. Such clamp should have proper spring action so that after fixing at the place they should not change the location.
	c) Nut, bolt and Washers	From M12 to M6 Bolts, Nuts, washers should be used and they should be cold galvanized with min. 120 GSM Coat.
	d) Self tapping and drilling Screw	These screws should be used to assure extra safety. They prevent dislocation of clamps from its place. Distance between tapping screw specially for fixing profile to gutter should be 30-40 cm.
9	Gutter	Gutter should be made of Galvanized sheet of 2 mm thickness in trapezoidal shape having 500 mm wide perimeter (Preferably of single length without joint) Coil having 120 GSM Galvanization. It should be leak proof. Min. 1% slope required for the gutter. Assure uniform slope to gutter to avoid stagnant water in gutter to achieve maximum life of gutter. Gutter Orientation – North- south and may change according to wind direction.
	(a) Gutter Height	Gutter height should be 4 to 4.5 meter from foundation formation level
10	Ridge Height	Ridge height should be 6 to 6.5 meter from foundation formation level.
12	Arches Overlap	Minimum overlap of top arch over second (small) arch should be 600mm to avoid direct rain entrance into the greenhouse from the vent.
13	Foundations	Pit size should be min.450mm dia. Depth 750 to 900mm or suitably altered depending upon Ground strata / level so as to ensure safety and stability of the structure even under extreme wind conditions. Columns are fitted over ground "Inserts" and bolted to Insert pipe of 60 mm OD/2mm thick G I Pipe. Length of Insert 1200 to 1300 mm. & filling the pit with 1:2:4 concrete hand mixed with appropriate Grade cement.

		Before doing the line out for the foundation, ensure that slope of greenhouse ground along the gable should be 0% to 1% and along gutter min. 1% and max. 3%. If slope of ground exceeds this limit then ask grower to do the land development and maintain the slopes of the ground within the limits. Slope along the gable and gutter should be uniform. If developed ground has filling depth more than 200 mm then ask grower to do the flooding of water over the ground so that it should settle down. If the flooding is not done then there are chances of foundation piercing into the ground after application of structural load even foundation may dislocate.
14	Civil Works	Cement concrete 1:2:4 blocks of size 30 cm x 30 cm x 80 cm for embedding vertical pipe/poll in brick work for wall around poly house will be 23 cm thick, 0.5 meter high (0.3 m below GL and 0.2 m above GL) in cm 1:6 with 10 cm thick with PCC 1:4:8 in foundation of wall. Wall will be plastered in cm 1:4 on top and sides. 80 cm to 1m wide and 10cm thick footpaths made of cement concrete ratio of 1:2:4 should be provided
15	Curtain opening	In general temperature inside the poly-house is more than ambient. To reduce the inside poly-house temperature increase, side ventilation, minimum 20% of floor area is necessary. Minimum 1.5m clear side curtain opening is required. Side curtain should have min. 200mm overlap to the bottom apron. This overlap is necessary to avoid direct entrance of rain into the greenhouse and also to stop direct air entry in the nights.
16	Bottom Apron	To tap the CO_2 inside the greenhouse, bottom apron is necessary. It should have min.0.6m height from the ground and max 1.5 meter depending upon the crop and climatic conditions.
17	Doors	Double door entry, Doors should be made of form FRP Sheets or polycarbonate sheets. Opening and closing is either hinged or sliding. Min. width of door should be 1M and min height 2M.The door area should have 50 mm PCC Flooring over 75 mm thick sub base.
18	Top Shading and Side shading	Top shading can be done by using following material: a) Shading net: Shading net made from HDPE should be used. The selection of shade net depends upon the selection of crops grown and the light spectrum. It should not be more than 50% shade factor. It should be UV stabilized so that it should last long for min. three years. GSM should be minimum 100. Opening and closing arrangement either manual or auto should be provided to the shading net to increase its utility.

		b) Thermal screen/Aluminate: This is better option to create the shading. It reflects the light back and by the means controls the temperature also. This defuses the light also. This is made from HDPE with hot dip aluminium coating. Minimum GSM should be 100 and minimum aluminium coating should 25 micron. Opening and closing arrangement either manual or auto should be provided to the thermal screen to increase its utility. Side Shading: Shade net of 35% should be used to create side shading. This is useful to avoid direct entry of sunlight into the polyhouse/greenhouse when curtain is open. Minimum GSM should be 75. or Use of 40mesh UV stabilized insect proof net is also recommended to protect direct entry of insects into the polyhouse/greenhouse. This should have minimum 100 GSM weight. The shade factor (opening) in colour shadenet depends on the spectrum of light through which light is passing through. So right kind of shadenet is major challenge that depends on grower's choice as well to take advice from the experts. The manually operated crank mechanism should be provided for expending and retracting the shadenet.
19	Polythene	Technical Specifications of polythene should be as per Indian standard (IS 15827: 2009) To select the proper film for poly-house is very important and which have direct relation with quality of the crop as well quantity of the produce. Polythene should be properly UV stabilized and pro rated warranted for at least three years. Thickness of polythene should be minimum 200 micron (0.2mm). Polythene quantity accommodate maximum 5.4 sq. meter area in its 1 Kilogram weight. (For example, 5.5m x 100 m polythene roll should have minimum weight of 5.5x100/5.4 = 101.85 Kg or 4.5m x 100m one roll should have minimum weight of 4.5x100/5.4= 83.33 Kg.). **Options in green house film:** Compulsory Properties: *UV stabilization *Diffusion/Clear (Light Transmission) Optional Properties: *UV Blocking /Antivirus *Sulphur Resistant *Thermic

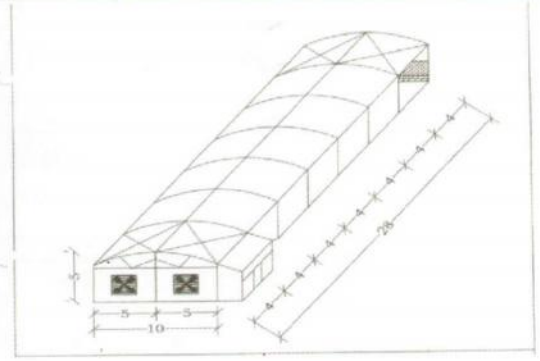
19.	Polythene	*Anti Drip *Anti Mist *Anti Dust Manufacturing Process: Three Layer/Five layer NHB also recommends (not mandatory) polythene with gas bubbles inside because in India high temperature is the problem in front of maximum growers. Our crop wise recommendation of minimum properties of polythene is: 1. Dutch Roses: 200 micron thick, UV Stabilized, UV Blocking (Not for bi color roses), anti dust, anti sulpher, with cooling effect. Light diffusion should be maximum (upto 75%) but it should not be less than 50%. 2. Gerbera, Coloured Capsicum, Anthurium and orchids: 200 micron thick, UV Stabilized, anti dust, with cooling effect. Light diffusion should be maximum (upto 75%) but it should not be less than 50%. 3. Carnation: 200 micron thick, UV Stabilized, anti dust, with cooling effect. Where altitude is high polythene should be with IR protection.
20	Aluminum Profile/ Poly fixing	C type profile made from Alloy Aluminum should have - high strength with light weight – (approx 220-250 gm/rmtrs), smooth edges, curve bottom proper for 1.25" to 3" pipes, Proper Channel for spring and suitable for double spring locking 0.9mm thick. Self Drilling Screw should be fixed on profile every 40 cm along the full length of the profile.
21	Spring Insert	A plastic coated GI wire spring of 2.2mm diameter, having good elasticity should be used for longer life that transferring less heat to the cladding materials as plastic films or shade net. If we are using GI spring it is better to use a two inch strip of new poly film to be placed over the main plastic in the profile and then lock it with GI profile. This will help in longer life of the plastic as the rusted spring will not directly come in contact with the main plastic. All spring must end inside the profile. Any spring outside profile must be either fixed inside or should be cut so that it does not damage the plastic in strong wind as it will initiate all the plastic being pulled out of profile.

22	Air circulation by 'air circulating fans':	In hot and humid climate, when ambient temperature and humidity are in higher side, it is very natural that both these factors have a tendency to increase further inside a greenhouse. Under such condition 'air-circulating fans' inside the greenhouse will do a good job to reduce the harmful effect of high humidity and temperature on plant. The increased airflow inside the plant canopy reduces the leaf temperature and disperses the high humidity around leaves, which maintain the transpiration pull of crop. This will work best when coupled with exhaust fans that will throw out the accumulated hot and humid air. In cool climate, during winter when the greenhouse is heated, you need to maintain air circulation in such a way that temperature remains uniform throughout the greenhouse. Without air mixing fans, the warm air rises to top and cool air settles around the plants on the floor. During rainy season, when humidity is high and high ambient temperature cools down due to rain, this air circulating fans may be used judicially to disperse the higher humidity around plant canopy. Small fans with a cubic-foot-per-minute (ft3/min) air-moving capacity of one quarter of the air volume of greenhouse are sufficient. Place the fans in diagonally opposite corners but out from ends and sides. The goal is to develop circular (oval) pattern of air movement. Operate fans continuously during required period of a day.

General Conditions:

1. Green house structural design should be sound enough to withstand wind speed of 130 km/hr.
2. The companies should be asked to get their structural design verified from the structural engineer because the proposed design is based on the functional requirements and field experience.
3. The firm should guarantee for free maintenance/damage to the structural material for ONE year.
4. The firm should be able to construct the entire green house within eight weeks of the issue of work order.

Section-4 : Fan & Pad Controlled Poly-houses



Fan and pad

Selection of fan

The fans should deliver the required air at 15mm static pressure. The maximum center to center spacing between the two fans should be of 7.5m. The height of the fans is to be determined based on the plant height which is proposed to be grown in the greenhouse. The fan blades and frame are to be made of non-corrosive materials like aluminum/stainless steel.

Design

The cross fluted cellulose pad is preferred. These are available mostly in 100mm thickness. One meter of pad height is given for every 20m of pad to fan distance. However, the fan to pad distance should not exceed 60m. The air flow rate should be of 75 cubic meter/minute/sq.m of pad. The water flow rate should be of 9 litres per minute/linear meter pad. The uniform distribution of water on pad is to be maintained.

Type 2:- Technical Standard of Fan and Pad cooling system Green House: With Fan Pad / Fogging System:

<table>
<tr><th>Sr.No.</th><th>Item</th><th>Departmental Description</th></tr>
<tr><td>01</td><td>Size ;</td><td>According to requirement (As given in page no. 13)</td></tr>
<tr><td>02</td><td>Shape</td><td>- Aero Dynamic along all four sides with curvature shaped hockey pipes of 48.0 mm OD G.I. Pipes with a view to reduce the impact of wind and consequent damage of Poly House Structure.
- Gutter Orientation – North South and may change according to wind direction.
- PAD should be in Wind direction and must have covered elevated balcony for shade.</td></tr>
<tr><td>3.</td><td>Structure</td><td>Hot Dip Galvanized Tubular Structure of BIS standards. Galvanization of the structural members should not be less than 300 GSM (grams per square meter).</td></tr>
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<tr><td>Gutter Purlins</td><td>42/43 (Centre)</td><td>2</td><td>2.10</td></tr>
<tr><td>Top Arches of the truss</td><td>42</td><td>2</td><td>2.10</td></tr>
<tr><td>Bottom Chord of the truss Horizontal (G I pipe)</td><td>60</td><td>2</td><td>2.85</td></tr>
<tr><td>Top chords and trusses member</td><td>48/43</td><td>2</td><td>2.30/2.10</td></tr>
<tr><td>Internal Bracings of the truss – Pipe structural members to be fitted in plated nuts, bolts and washers without welding</td><td>33</td><td>2</td><td>1.60</td></tr>
<tr><td>Coridors/Balconies</td><td>60</td><td>2</td><td>2.85</td></tr>
<tr><td>Curtain Runner</td><td>42</td><td>2</td><td>2.10</td></tr>
<tr><td>Flap control pipe</td><td>21</td><td>2</td><td>1</td></tr>
<tr><td>Curtain Shaft</td><td>27</td><td>2</td><td>1.30</td></tr>
<tr><td>Cross Bracing</td><td>33</td><td>2</td><td>1.60</td></tr>
<tr><td colspan="4">Not:- Welded pipes should not be used for structure erection except bottom pipe of 8 m length.</td></tr>
</table>
</td></tr>
</table>

	Columns	76 OD, 2mm thick
	Purlin	48 mm OD/2.0 mm thick at ridge and 42/43 mm OD/2 mm thick for centre
	Trusses	Bottom horizontal 60 mm OD/2 mm thick G.I. Pipe, top chords and truss members 48 mm OD/ and 43 mm OD 2.0 mm thick Bracing 32 mm OD/1.8 mm thick G.I. Pipe structural members to be fitted in plated nuts, bolts and washers without welding.
	Clamps and Nut Bolts	Well Compatible GI Clamps < 120 GSM, 2 mm thickness.
4.	Grid Size	- 8 m x 4 m (Ideal size), - Size can be less depending upon space availability but not more 8m x4m grid size.
5.	Balcony and Corridor	2 meter wide, vertical/curved pipe-60 mm OD/2 mm thick G.I Pipe with 32 mm OD/1.8mm thick horizontal GI pipe as supporting pipe. Area covered by corridors should not be included while calculating the area under poly house.
6.	Foundation	Pit size should be min.450mm dia. Depth 750 to 900mm or suitably altered depending upon Ground strata / level so as to ensure safety and stability of the structure even under extreme wind conditions. Columns are fitted over ground "Inserts" and bolted to Insert pipe of 60 mm OD/2mm thick G I Pipe. Length of Insert 1200 to 1300 mm. & filling the pit with 1:2:4 concrete hand mixed with appropriate Grade cement. Before doing the line out for the foundation, ensure that slope of greenhouse ground along the gable should be 0% to 1% and along gutter min. 1% and max. 3%. If slope of ground exceeds this limit then ask grower to do the land development and maintain the slopes of the ground within the limits. Slope along the gable and gutter should be uniform. If developed ground has filling depth more than 200 mm then ask grower to do the flooding of water over the ground so that it should settle down. If the flooding is not done then there are chances of foundation piercing into the ground after application of structural load even foundation may dislocate.
7.	Gutter	should be made of Galvanized sheet of 2 mm thickness in trapezoidal shape having 500 mm wide perimeter (Preferably of single length without joint) Coil having 120 GSM Galvanization. It should be leak proof. Min. 1% slope required for the gutter. Assure uniform slope to gutter to avoid stagnant water in gutter to achieve maximum life of gutter.

		Gutter Orientation – North- south and may change according to wind direction.
	(a) Gutter Height	4 m to 4.5 m
	(b) Gutter Slope	1 to 1.5% to be provided in civil structural work
	Ridge Height/Centre Height	Minimum 5 to 6.5 meter.
8.	Fasteners	Cold Galvanized well compatible M6 to M10 bolts & nuts, 50 to 150 mm long with plain washers as per requirement and with the best quality plating to have good anti-corrosiveness.
9	Poly film	Technical Specifications of polythene should be as per Indian standard (IS 15827: 2009) To select the proper film for poly-house is very important and which have direct relation with quality of the crop as well quantity of the produce. Polythene should be properly UV stabilized at least three years. Thickness of polythene should be minimum 200 micron (0.2mm). **Options in green house film** Compulsory Properties: *UV stabilization *Diffusion/Clear (Light Transmission) Optional Properties: *UV Blocking /Antivirus *Sulphur Resistant *Thermic *Anti Drip *Anti Mist *Anti Dust Manufacturing Process: Three Layer/Five layer Our crop wise recommendation of minimum properties of polythene is: 1. Dutch Roses: 200 micron thick, UV Stabilized, UV Blocking (Not for bi color roses), anti dust, anti sulpher, with cooling effect. Light diffusion should be maximum (upto 75%) but it should not be less than 50%.

		2. Gerbera, Coloured Capsicum, Anthurium and orchids: 200 micron thick, UV Stabilized, anti dust, with cooling effect. Light diffusion should be maximum (upto 75%) but it should not be less than 50%. 3. Carnation: 200 micron thick, UV Stabilized, anti dust, with cooling effect. Where altitude is high polythene should be with IR protection.
10	Thermal Net	30 to 50%, alluminate/thermal net as per requirement - Minimum 100 GSM - Power operated crank mechanism should be provided for expanding and retracting the shade net.
11	Poly fixing	C type profile made from Alloy Aluminum should have - high strength with light weight – (approx 220-250 gm/rmtrs), smooth edges, curve bottom proper for 1.25" to 3" pipes, Proper Channel for spring and suitable for double spring locking 0.9mm thick. Self Drilling Screw should be fixed on profile every 40 cm along the full length of the profile.
12	Spring Insert	A plastic coated GI wire spring of 2.2mm diameter, having good elasticity should be used for longer life that transferring less heat to the cladding materials as plastic films or shade net. If we are using GI spring it is better to use a two inch strip of new poly film to be placed over the main plastic in the profile and then lock it with GI profile. This will help in longer life of the plastic as the rusted spring will not directly come in contact with the main plastic. All spring must end inside the profile. Any spring outside profile must be either fixed inside or should be cut so that it does not damage the plastic in strong wind as it will initiate all the plastic being pulled out of profile
13	Entrance	Double door entry, Doors should be made of form FRP Sheets or polycarbonate sheets. Opening and closing is either hinged or sliding. Min. width of door should be 1M and min height 2M.The door area should have 50 mm PCC Flooring over 75 mm thick sub base.
14	Civil work	Wall on fan side will be 35 mm thick and 80 cm high and wall on pad side will be 23 cm thick & 100 cm high from ground level in cm 1:6 with required foundation. All the walls will be plastered in cm 1:4 on top and sides. 80cm to 1m wide and 10 cm thick footpaths made of cement concrete ratio of 1:2:4 should be provided as per the requirements.
15	Electrical fittings:	Conduit and wiring as required for connecting light, fan .motor and pumping to main electrical supplies.

		Preferably use copper wire to withstand the load of the electrical appliances of Indian standards.
16	Climate Control System	
A	Fan-Pad System	- Numbers of Fan depends upon size of Fan-fad house and it should be capable of exhausting air volume in one minutes. - Exhaust Fans- 50" however it depends upon size of fan-pad house with louvers, 1.5 HP – 3 phase ISI standard electric motor. - Cellulose cooling pads of 1.8 meter height with 100mm /150 mm thickness covering the area properly, PVC water distribution system, screen/disc filter, valve and pumps etc. - Control panel with manual operation, temp. and humidity sensors. - The necessary digital controller with sensory device & accessories of standard quality as per requirement should be provided to operate the fan & pad system for controlling temperature & humidity inside the Greenhouse.
B	Fogging System	- In consist of four way anti leak fogger 28 lph flow rate (working pressure should be mentioned at which we will be able to get required particle size, fogger spacing along the lateral and lateral spacing) and particle size 80-100 micron, 16 mm lateral class-3, PVC pipe 6kg/cm2, valves, filter, pump, panel with volt meter, MCB, relay, temp and humidity sensor etc. complete application rate 3 mm/hr.

Section-5 : SHADE / NET HOUSE

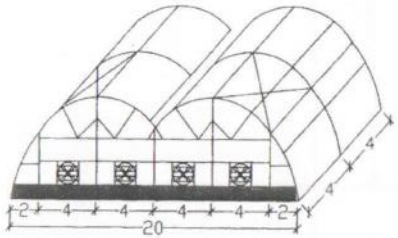
SPECIFICATION FOR SHADE HOUSE

Sr. No.	ITEM	SPECIFICATION
01	STRUCTURE	
	Size	According to requirement
	Shape	As per design
	Withstand to wind velocity	- Structure may be design to withstand wind velocity up to 104 Km/ hr.
		- 120 Km/ Hour per hrs in high wind velocity zone.
	Foundation	2mm thickness GI Pipes compatible with columns, length 1.2m.
	Main Column	Size 60 OD ,Thickness 2 mm, Wt. per length 2.85 kg , length- 4 m,
	Purlins	Purlin GI pipes- size 42/43 OD/ thickness 2 mm, Wt. per length 2.00/2.10kg length- 4 m. Purlin members-33/32 mm OD/2mm thickness, Wt. per length 1.60 kg.
	Corner	Size 48 OD ,Thickness 2 mm, Wt. per length 2.30 kg, length- 0.15 m,
	Four Way Pipe Couplers	Size 48 OD ,Thickness 2 mm, Wt. per length 2.30 kg, length- 0.15 m,
	Five Way Pipe Couplers	Size 48 OD , Wt. per length 2.30 kg, Thickness 2 mm, length-0.15 m,
	Nut Bolts	Size 3/8"
	Grid Size	4x4, 8x4, 4x6 (m)
	Gable length	4.0 m,
	Centre Height	• Flat Structure – 4 m
		• Hut/dome type structure – Centre height - 4m, Side height - 2.5m.

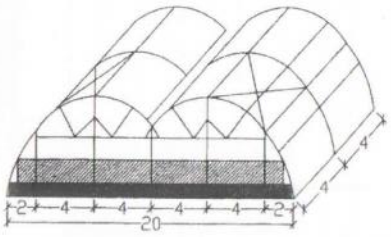
2.	Aluminum Profile	C type Aluminum profile to fix shade net to the structure by means of self tapping screws. Weight of aluminum profile is 200-220 gm/ meter. Self Drilling Screw should be fixed on profile every 40 cm along the full length of the profile
3.	Spring Insert	A coated spring is preferable compared to cold galvanized spring as a coated spring transfer less heat to the plastic and thus enhances the life of the plastic If we are using GI spring it is better to use a two inch strip of new poly film to be placed over the main plastic in the profile and then lock it with GI profile. This will help in longer life of the plastic as the rusted spring will not directly come in contact with the main plastic. Wire material should be high carbon spring steel with spring action
4.	Shade Net	UV stabilized, ranging from 30% to maximum 75% GSM shade depending upon the crop, made up of ISI/ applicable national standard, white / green/black/suitable colour.
5.	Door	Polycarbonate/polythene sheet door with 1 m widths and 2 m height and another door of 1 .m x 2 m Box section frame is embedded inside for the strength.
6.	Anti Room	Anti room of size 4 m x 3 m attached to net house
7.	Civil work/foundation	Cement concrete 1:2:4 block of size 40 cm x 40 cm x 90 cm for embedding vertical poll/pipe of shade net, subject to revision as per requirement of site.
8.	Overall slop	1 to 1.5%
	APRON	Use of APRON in shade net

Section-6 : Design

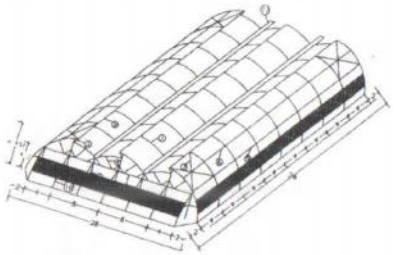
Fan Side Elevation



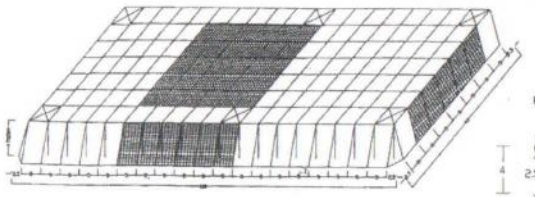
Pad Side Elevation



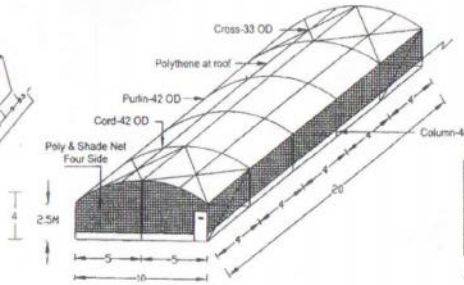
Naturally Ventilated



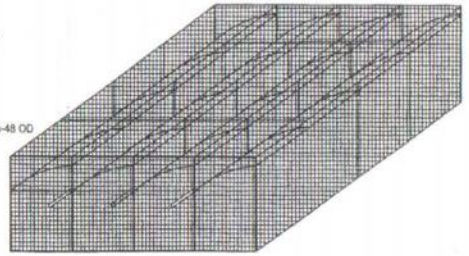
Shade House



Poly Tunnel Type



Shadow Hall



Annexure-1

List of Experts contributed/consulted for firming up of Technical Standards for Poly-house/Net House

S.N.	Department & Organization
1	Mr. L.S. Brar, Director of Horticulture-cum Mission Director, SHM Punjab, Chandigarh.
2	Anand Zambre, Joint Director - Tech. International Horticulture Innovation and Training Centre (IHITC), Jaipur
3	Mr. Ashok Girhotra, Sr. Project Officer, NCPAH, New Delhi,
4	Dr. K.G. Singh, Sr. Research Engineer, Deppt. Of soil & Water Engineering, PAU, Ludhiana
5	Mr. Ram Lai Meena, Dy. Director of Horticulture, Govt. Of Rajasthan, Jaipur
6	Mr. S.K. Kaul, Astt. Director, NHM, DAC, New Delhi
7	Mr. Ravindra Deshmukh, HTC, Pune
8	Dr. S. K. Malhotra, Principal Scientist (Hort), ICAR, New Delhi
9	Dr. D.L. Maheshwar, ADH, SHM, Lalbag, Bangaluru
10	Mr. Unnikrishnan V, Green Field Industries, Bangaluru
11	Mr. Ramesh Kumar, ZOPAR Export Pvt. Ltd.,
12	Mr. S. Chandrababu, Agri Matrix & Co., Bangaluru
13	Mr. Nagraj Bhat, Yojna Agro Services, Bangaluru
14	Mr. Jogdand Vishwas S., Indian Green House, Pune
15	Mr. Arvind Kumar Roy, M/s Saveer Biotech Ltd.,
16	Mr. Manoj Gupta, M/s Rajdeep Agri Products Pvt. Ltd., New Delhi
17	Dr. Ranbir Singh, Plasticulture Specialist

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