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/3mm 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

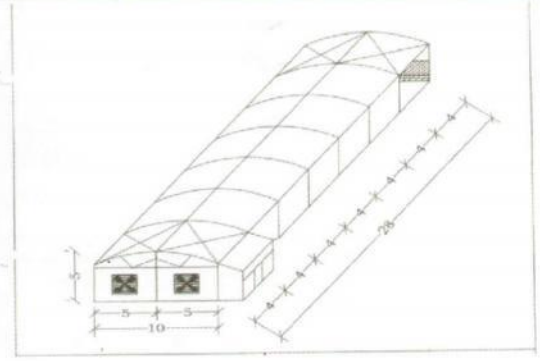
19.	Polythene	*Anti Drip *Anti Mist *Anti Dust Manufacturing Process: Three Layer/Five layer NHB also recommends (not mandatory) polythene with gas bubbles inside because in India high temperature is the problem in front of maximum growers. Our crop wise recommendation of minimum properties of polythene 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>
<tr><td></td><td>Withstand to Wind Velocity</td><td>Structure should withstand to minimum wind velocity of 80.6 miles per/hr or 130 Km/hr or 36 Meter per second.
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<tr><td></td><td>Sizes of the structural members</td><td>
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<tr><td>Top Purlins</td><td>48(Ridge)</td><td>2</td><td>2.30</td></tr>
<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>
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	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.