used with a minimum of cost but with greater risk of destruction.

A few suggestions I might take are the following:

1. A water anchor may have considerable value for certain conditions. I believe it can be most effective as a separate, one-foot diameter (more or less) tube and inserted in a larger fold-back tube made from the main greenhouse sheeting and running the full length of both sides of the greenhouse.

The fold-back tube could be cut at one or two-foot intervals to facilitate inserting the smaller tube into it. The inner tube could then be fully inflated with water, making possible an intimate seal to the ground with uniform anchorage regardless of soil unevenness or level. This would still allow the strong tear-drop shape of the outer tube. Stress points would be at a minimum if an open head is maintained at the highest point of the inner tube.

2. Larger capacity low-pressure fans appear to be very satisfactory, provided their vents can be closed and higher pressures built up by higher pressure capacity fans during strong windstorms.

3. A very low-volume fan can be adequate for quiet, cool, nights although much loss of heat is by radiation.

4. Modular construction might be considered. That is, end-domed areas having framed doors and vents (instead of zippers) could be made of nylon reinforced plastic sheeting. These might be constructed to connect to the main running area of a greenhouse by use of zippers. Do not use zippers which might corrode.

5. Cheap pressure control devices are possible. They could be installed to prevent rapid collapse of a greenhouse during a power failure.

MODERATOR BODDY: Dr. Tokuji Furuta is an Extension Specialist in Ornamental Horticulture and is servicing the entire state of California, operating out of the University of California campus at Riverside. Tokuji has been with us about a year and he's certainly become one of the most widely-traveled people in the state of California. Tok —

ANATOMY OF THE PLASTIC HOUSE — The Arkansas Razorback

TOK FURUTA
University of California
Riverside, California

Dubbed the "Arkansas Razorback" by the editor of *Jed's Jottings*, this greenhouse was designed by Joseph W. Vestal and Sons, Inc. of Little Rock, Arkansas, a large producer of floricultural products. The clear span structure is simply constructed of prefabricated steel pipe arches and is covered with plastic.

The initial houses were 30 feet wide without posts or

trusses. Later models are 40 feet wide. The steel arches are made from 1¼ inch steel tubing. For the 30-foot house, 21-foot lengths of pipe were used while 26-foot pipe was used for the 40-foot model. The pipes are joined at the top of the arch.

The ends of each arch are inserted into a length of 2-inch pipe, 2 feet of which is below ground and 1 foot above. The rows of anchor pipes are 4½ feet apart and adjacent houses overlay by this distance. Thus, the arches from adjoining houses intersect approximately 6½ feet above the ground. Channel iron, or "V" shaped wooden gutters are placed in this junction.

Along the length of the house the arches are placed 8 feet apart. Steel pipe purlins are used to join the arches — 3 are used on the 30-foot house. In addition, wooden 2 x 4 inch purlins are placed on top of the arches 4 feet apart for the attachment of the corrugated panels of rigid polyvinyl chloride.

All steel members are spot welded together.

MODERATOR BODDY: Thank you, Tok. Now are there any questions? Yes —

RON HUROV: I am wondering if any people who use clear plastics here have had any experience with ultraviolet stabilized plastic? We use quite a bit of plastic in Hawaii. In fact, 70,000 acres under plastic, and we get quite a bit of variation. In the past few years some of the companies have tried various stabilizers. Some of them are pretty good; they have doubled and tripled the life of some of the clear polyethylene.

MODERATOR BODDY: Is there anyone who can comment on the question of ultraviolet stabilizers for polyethylene?

BRUCE BRIGGS: We have used UV plastic now for about four years. The only problem is the cost factor. We can go two winters and one summer with a UV plastic and with clear we can only go one year.

MODERATOR BODDY: Is your conclusion then to use the UV plastic?

BRUCE BRIGGS: Yes, I think if you figure the price of labor, it really pays to use it.

PETER VERMUELEN: Just some general observations on this subject. Gering Plastic Company in Kenilworth, New Jersey, is putting out what they call DBL-TUFF. We haven't used it because you have to buy it in 400,000 sq. ft. lots, and we haven't quite got up to that quantity yet; but some of the growers have used it with good success and it has quite a bit of longevity — beyond, I think, the UV polyethylene. Price-wise it's about the same as their light-stabilized plastic.

Another observation. White plastic — has anybody here used white plastic? We're using it quite extensively on the East Coast. This is valuable where you might have a shading problem; you can also reduce your heat considerably by using the white plastic. You don't have this large heat build-up that you do with clear plastic.

In making temporary structures we're now using electric conduit; it's a steel conduit put out by Republic. We were formerly using the 21-foot lengths of half-inch galvanized pipe, which cost us 12.6c a foot. This electric conduit is 9.6c a foot, and we're using the ¾ inch size. The people at Republic say it has a higher tensil strength than ½ inch galvanized pipe, and you're cutting your cost by a considerable amount. It only comes in 10 foot lengths, however; you have to use a connector in the middle.

MODERATOR BODDY: Does the white plastic last as long as the ultraviolet resistant type?

PETER VERMUELEN: No, it doesn't last as long as the ultraviolet resistant poly — it lasts as long as ordinary poly. The cost is about the same as the UV-resistant polyethylene.

MODERATOR BODDY: How about the transmission of light? Is it still pretty good?

PETER VERMUELEN: Good enough, I would say, for storing. For growing, probably not sufficient. For propagating it may not be sufficient on a dark day, but for propagating sometimes you want a lower light intensity.

RON HUROV: There's one point that I'd like to bring up. There is a considerable variation in polyethylene. Probably just as much variation as in various grades of paper. I think both the manufacturers and the users have a lot to learn about it. We had some black polyethylene this year; it broke up in two months. In another case, we had polyethylene that was supposed to be the same but it lasted two to three years.

GEORGE OKI: In buildings with wooden trusses, we found that by painting the surface upon which the polyethylene will rest, the polyethylene life will usually lengthen by a slight bit. Now, I've also noticed that many of the cut-flower growers are using a wider slat — wider than the two by four — it seems that the polyethylene will usually fracture right on the edge of the two by four area.

JOE KLUPENGER: Fiber glass has been the most talked about material, I believe, in the last ten years for covering greenhouse structures. There has been lots of discussion of fiber glass but not too much has been done about it. I think it's because of the high cost. Now we have about 35,000 sq. ft. under fiber glass — both a 20-year guarantee material and a competitive material that's not guaranteed. It's a 4½ ounce grade. We're building another structure now for pot plants — 65,000 sq. ft.; about 30,000 sq. ft. is going to be fiber glass at a 20-year guarantee. We were asked why didn't we go ahead and build the entire structure of fiber glass. Well, although it's got a 20-year guarantee, there's a lot to learn about fiber glass as far as the lasting qualities, although they do have 18 and 20 year guarantees on it; but if you run for 18 or 20 years and have to recover 65,000 sq. ft. all at one time, it would be quite a chore. We are going in smaller portions at a time, so if we do have to recover we wouldn't have to do too

much area at once. What I'm getting at is this, that in the next ten years where you want a permanent structure, you're going to find that in 80 to 90 per cent of the cases, fiber glass will be replacing glass and that the structural costs will come far below that for glass structures. We will be able to build a less expensive structure that will be permanent. Now polyethylene makes a good temporary building but for something permanent that has good growing qualities it seems like we're farther ahead with fiber glass than we are with glass. With the new acrylics that they have now perhaps in the near future, on the less expensive material, we can go up there in the summer months and spray this acrylic resin or coating right on the fiber glass — which would give perhaps, another 18 or 20 years life, if you catch it in time. I was talking recently to a manufacturer of fiber glass. He said that once our industry develops some figures on approximately what they could use of a guaranteed material, so that they could have something to shoot for, they would be able to put on the market in the very near future an 18-or 20-year guaranteed material at the price of around 18c per sq. ft. Now it is hard to find anything under 24c. I think that we're heading in the right direction but we should be doing a little of our own research, gathering this information that would be a great help to the manufacturers to let them know what our thinking is for the future.

AL HOLLAND: The other day a fiber glass fabricator called at my office and made the comment that duPont has a material they can incorporate into fiber glass now and keep it clear.

VOICE: I'd like to ask these gentlemen if they have any condensation problem with any of these polyethylene, fiber glass, or PVC structures.

JOE KLUPENGER: This is a question that I've heard lots about over the past five years, especially up in the Northwest where we have a high moisture condition; people have said we would have condensation dripping on plants. If you have too flat a roof you'll have trouble, but with a standard greenhouse pitch — which I think is about a quarter pitch — and with fan-driven heaters and air-conditioning fans I think this will eliminite a lot of the problem. The worst problem with condensate drip in our area would come about March and April. We noticed this year, with the standard greenhouse pitch, that there were drips on the ground in the trails, but you could walk through the house and brush the plants anywhere and you wouldn't get your hand wet. Most of it is going down to the drip gutters. From what I viewed this year I wouldn't hesitate to grow any pot plants, such as pot mums or poinsettias, under that type of fiber glass with ordinary greenhouse pitch roof.

VOICE: How much air "leakage" do you have with glass, vs. polyvinyl chloride vs. fiberglass covered houses?

JOE KLUPENGER: I would say that there is less leakage, either on a good tight polyethylene or fiber glass house, than with glass. Now on glass, of course, it depends on what you're talking about. With new glass, properly constructed, there is very little leakage, but more leakage than with fiber glass. Fiber glass seems to be a little easier to heat, or takes less BTU's to heat a given area, than does glass. Polyethylene, I would say, takes double the heat — BTU's per square foot — since it is such a thin film.

VOICE: I'd like to know how Joe fastens the seams on his fiber glass construction.

JOE KLUPENGER: Well, first of all, we have the fiber glass sheets manufactured in 54-inch widths rather than two feet. Then we get it cut to specified lengths — so we have to do no cutting for the roof at all. We have a little — what we call — lap nut. There's a little piece of angle iron about ¾ by ½ inch, bent into the shape of an L with a hole in it; just at the laps between the purlins we have about 4½ feet. We use one or two of the these and run a metal screw right through them — no sealer or anything; use about two of them between the 4½ foot purlin spaces. On these inexpensive fiber glass houses which we've just built, we used a plain galvanized pipe strap, one inch pipe cap over one-inch purlin and then run our metal screws right down from the outside, the hex nuts, the neoprene head metal screw, right into the pipe strap. That holds it onto the purlin; spaced at about 14 inches.

VOICE: I'd like to ask Mr. Holland how he held the plastic airhouses down.

AL HOLLAND: We had a water-filled ring. It was a ten-mil clear, polyvinylchloride ring in a loop around the house. We never did fill it full. It was 18 inches in diameter, engineered to stand an 80-mile wind, and it withstood 60-mile winds, not completely filled.

BOB BODDY: I just want to comment further on condensation drip. In a small propagating quonset-type house that formerly was covered just with polyethylene, we had a lot of drip. We use a chicken-wire-like material, to frame the house and we found that if we put saran cloth under the polyethylene that we didn't get any drip. The only places that dripped was where the saran had a seam. We used scrap saran and where the seam was, the water collected and it dripped in that place, but the saran seemed to eliminate the bad drip problem.

BILL CURTIS: I have a quonset type plastic house, 17 x 98 feet. On either end I have a 4 by 8 foot door and a window above the door, and when we cover it in the fall we cover the whole thing up, but I do have a V-opening right at the peak. The first year we took a knife and opened this V for ventiliation so that we wouldn't have a problem when we had our

High-Low heater burning. The second year, for some unknown reason, we didn't cut out this V. I never thought anything about it. We closed the house up. The weather got cold and we lit the High-Low heater. I went in in the morning and the place was full of smoke. I figured that something was wrong with the heater. Another one had worked well in a shed-type plastic house that I have, so I changed heaters. The next night the same thing happened again. Then it dawned on me that I had the house so tight that it had cut off all the air and there wasn't sufficient oxygen for the heater to operate; so I went up there with my knife, cut in the holes, and I've never had any trouble since where I have this little V in the top. The plastic house is real tight.