

Meeting Minutes

2009 Annual Business Meeting of the NCERA-101 USDA Committee on Controlled Environment Technology and Use

4 – 7 April, 2009, Park City, Utah

4-5-09. Call to order at 8:07 AM

Attending: Lou Albright (Cornell), Felix Arguedas (Univ. Maryland), Wade Berry (UCLA), Matt Blanchard (Mich. State Univ.), Mark Blonquist (Apogee Inst.), A.J. Both (Rutgers Univ.), Bruce Bugbee (Utah State Univ.), Brian Cook (EGC), Fred Davies (Texas A&M), David de Villiers (Cornell), Gerry Deitzer (Univ. Maryland), Tracy Dougher (Montana State Univ.), Bruno Faucher (Greenhouse Engineering), David Fleisher (USDA-ARS), Jonathan Frantz (USDA-ARS), Gary Gardner (Univ. Minn.), Richard Gladon (Iowa St. Univ.), Steven Griggs (EGC), Alec Hay (Utah State Univ.), Douglas Hopper (Achieving Solutions), Henry Imberti (Percival Scientific), Hugues Joannis (Univ. Laval), Lloyd Jones (Monsanto), Ramesh Kanwar (Iowa State Univ.), Meriam Karlsson (Univ. Alaska), Jongyun Kim (Univ. Georgia), Mark Kroggel (Univ. Arizona), Chieri Kubota (Univ. Arizona), Ron Lacey (Texas A&M), John Lea-Cox (Univ. Maryland), Mark Lefsrud (McGill Univ.), Peter Ling (Ohio State Univ.), Gioia Massa (Purdue Univ.), Vic Mirabella (Priva), Cary Mitchell (Purdue Univ.), Bob Morrow (ORBITEC), Desmond Mortley (Tuskegee Univ.), Bert Neeft (Total Energy Group, Inc.), Derrick Oosterhuis (Univ. Arkansas), Sonali Padhye (Univ. Florida), Robert Pauls (BioChambers), Reg Quiring (Convicon), Dennis Raath (Total Energy Group), Sharon Reid (Convicon), Mark Romer (McGill Univ.), A.O. Rule III (EGC), Erik Runkle (Mich. State Univ.), John Sager (NASA-Kennedy), Dan Schmoldt (USDA), Philip Sheridan (Cycloptics), Todd Smith (Duke Univ.), Ryan Stewart (Univ. Illinois – UC), Gary Stutte (NASA-Kennedy), Marc Theroux (Biochambers), Ted Tibbitts (Univ. Wisconsin), Richard Tuck (Cycloptics), Alex Turkewitsch (Greenhouse Engineering), Marc van Iersel (Univ. Georgia), Jeff Werner (Univ. Alaska), Ray Wheeler (NASA-Kennedy), Dave Wilson (NASA-Ames), Neil Yorio (NASA-Kennedy)

Chair: Gary Stutte, Chair-Elect: Alex Turkewitsch, Secretary: Jonathan Frantz, Past Chair: Erik Runkle

Gary Stutte made opening remarks.

- Thanks to all for attending
- Thanks to Bruce Bugbee, Mark Blonquist, Alec Hay, and April Hay for organization, the good program, and choosing a great venue
- Preview the agenda (Appendix 1) of the business meeting, and station reports and presentations in the afternoon.
- A request was made to place hard copies of station reports in the lobby and to send electronic copies in PDF format to Jonathan Frantz, Tracy Dougher and Gary Stutte

Welcome by Bruce Bugbee

- Many thanks and applause for Alec and April Hay
- The list of attendees is included in the handout/ registration materials (Appendix 2)
- Encouraged the attendees to visit and meet with the five graduate poster submissions throughout the event, thanked them for participating, and for the group to sponsor the competition.
- Recognized and thanked the sponsors and gave them a round of applause
- Announced a contest to guess the daily light integral (in moles of photons $\text{m}^{-2} \text{d}^{-1}$) in today's weather in Park City. The winner gets a new MQ-100 from Apogee Instruments.

Update on GreenSys 2009 was made by Chieri Kubota

- GreenSys will be held this year on June 14th through 19th, 2009 in Quebec City, Quebec, Canada. <http://www.greensys2009.com/>
- With sponsorship and planning assistance from the NCERA-101 committee, an all-day session was organized for Wednesday, June 17th. This is co-sponsored by the NE-1035 committee (Committee on Commercial Greenhouse Design and Systems).
- The title of the session is called "Novel Instrumentation, Control, and Cropping Strategies to Improve Uniformity in Controlled Environments." The keynote speaker for this session is Royal Heins; the title of his talk is "Factors Leading to Lack of Uniformity in Commercial Greenhouses – And Potential Solutions"
- The all-day session will be divided into three parts:
 - Part I: Instrumentation Technology Showcase (4 speakers: J. Lea-Cox, M. van Iersel, G. Massa, and M. Gent)
 - Part II: Issues and trends in Controlled Environments and Greenhouse Systems and Designs (2 speakers: M. Lefsrud and J. Campen)
 - Part III: Measuring and Reporting Guidelines for Environmental Parameters in Greenhouse Facilities (Discussion led by A.J. Both). This part is co-sponsored by the International Committee on Controlled Environment Guidelines (ICCEG)
- All speakers were selected based on speaker proposals

Discussion: Alex Turkewitsch pointed out that the deadline for reduced fees and registration deadline is April 15th, 2009. GreenSys 2009 will have two concurrent/overlapping events. One is designed for engineers and scientists and the other one (called the Technical Program) is for growers. GreenSys occurs every 2 years. In 2005, host was Belgium. In 2007, host was Naples. In 2009, host is Quebec City. In 2011, host is Greece. 200 to 300 participants are typically attracted to GreenSys.

Chieri Kubota also announced the Light in Horticulture conference

- The International Society for Horticultural Science (ISHS) made the 2nd announcement for the Light in Horticulture conference, to be held November 15th to 19th, 2009.
- <http://www.lightsym2009.jp/> (Conference website for more information)

- The deadline for submission of abstracts is May 31st, 2009.
- The tours for this conference should be a highlight and will include a Genetically Modified Organism “plant factory,” an LED lettuce production factory, a lettuce production factory utilizing fluorescent lamps, and a lettuce aeroponic factory.

The floor was opened for general announcements

- Dave Fleisher announced the Tri-society (Soil Science, Crop Science, Agronomy Society) deadlines for title submission is April 24th for this year’s annual meeting.

Jonathan Frantz announced the NCERA-101 2009 Graduate Student Poster competition

- Five entries this year. One first place award (\$300) and four \$250 awards to be granted. Each Student introduced themselves, their affiliation, and the title of their work
 - Curtis Adams, Utah State University (Bruce Bugbee advisor), Controlled release fertilizers: a quantitative approach to characterizing release
 - Chris Parry, Utah State University (Bruce Bugbee advisor), Iron nutrition of corn in containers: interveinal chlorosis
 - Jongyun Kim, University of Georgia (Marc van Iersel advisor), Modeling daily water use of Abutilon and Lantana based on environmental conditions
 - Jeremy Crook, Utah State University (Brent Black advisor), Chilling requirement to overcome bud dormancy in chokecherry
 - Felix Arguedas, University of Maryland (John Lea-Cox advisor), Issues and model approaches to predict real-time pore water electrical conductivity in soilless substrates
- Alex Turkewitsch, Ted Tibbitts, and Jonathan Frantz are the judges.

Post-business meeting note: the winner selected by the judges was Jongyun Kim, University of Georgia.

The Administrative Advisor’s report will be given on 4-6-09 since Ramesh Kanwar was delayed getting to Park City due to delays in other travel obligations.

Alex Turkewitsch presented the Minutes of the 2008 business meeting in Cocoa Beach, FL.

- The minutes are available on the USDA website
http://ncr101.montana.edu/minutes/2008/2008_NCERA-101_Meeting_minutes.pdf
- Mark Romer made the motion to accept the minutes. Marc van Iersel seconded. Unanimous approval by vocal vote to accept.

Mark Romer gave a Membership Report (see Appendix 3 for complete report)

- The 145 members is an all-time high and these members represent a total of 100 institutions from 8 different countries and 29 States.
- Good representation from industry, government, growth facilities.

- Of note: Hugues Joannis from Quebec, Sonali Padhye from Florida, Fred Davies from Texas A&M and Doug Hopper from Colorado are new representatives. John Lea-Cox is resuming the role of official representative of Maryland; Tracy Dougher is attending and does an outstanding job of hosting the web site; Derrick Oosterhuis from University of Arkansas is new official representative from Arkansas; Carl Sams is pursuing becoming the official representative of Tennessee; Three new industry members: Vic Mirabella from Priva, Bert Neeft and Dennis Raath from Total Energy Group in California
- Some of our past membership will be recognized at tonight's award's banquet: Gerry Dietzer (University of Maryland) and Desmond Mortley (Tuskegee University) will be recognized as 20-year members. Our Administrative Advisor Ramesh Kanwar will be awarded the Significant Contributor award. Thanks to these long-time contributors.
- This past year, Bruce Bugbee and Mark Romer worked on drafting a "Letter of Invitation" to use when recruiting new USDA representatives. Sonali Padhye, our most recent official representative from the University of Florida, assisted in identifying the process required to join the group. This procedure involves:
 - Interested party signs up or indicates an interest via email to one or more of the executive members and discusses the issue with their Experiment Station director.
 - Experiment Station director agrees to fund/support this applicant to join the group
 - Ramesh speaks with Experiment Station Director on behalf of committee

Discussion: Erik Runkle noted that the procedure was long and drawn out. We need a general letter and included in this letter should be a description of the group (who we are and what we do). Can we simplify this process? Sonali Padhye noted that the key to the process in her case was the she (the interested prospective member) needed to express interest to the right person within her institution. If there is resistance by that key person, then Ramesh Kanwar was willing to pursue it on a one-on-one basis. Mark Romer asked if there was a volunteer to write this basic letter to be used as a template to prospective members, and Ted Tibbitts volunteered to write the general letter template; John Lea-Cox and Erik Runkle also volunteered to help. Once the letter is constructed, the current NCERA-101 chair signs the letter.

- John Lea-Cox suggested the letter contain a description of what the group does, who is in it, why it is important that Experiment Station Directors support activity of their station, and a brief list of accomplishments by the group.
- Gary Gardener encouraged the authors to limit the letter to a single page so that Experiment Station directors and other institutional administrators will be more likely to read the letter of invitation.
- Marc van Iersel noted that the Maine experiment station denied an attempt at a Maine representative joining the group.
- Cary Mitchell suggested that Ramesh Kanwar be involved in the letter, but at a later, more defined stage of development.
- Bruce Bugbee noted that the key to the whole process is getting a very interested prospective member. Ramesh Kanwar can then polish the effort of this prospective member.

- Alex Turkewitsch supported this idea and said that self-selection is important – we can't prod potential members into joining.

Ray Wheeler made a motion to accept the membership report. Bruce Bugbee seconded. Unanimous passing of the motion by vocal vote.

Mark Romer gave a Website Report

- Tracy Dougher (Univ. of Montana) was introduced as the keeper of the website, and was thanked for her efforts. It was noted that she has been very quick to respond and post things when items are submitted to her.
- John Lea-Cox reported that the 2001 Proceedings disappeared from their posted website. He will be working with Tracy Dougher to post them again on our site.
- Mark Romer reported that each member institution is required to have a contact person listed on their webpage. Over 95% of members have provided contact information.
- Ray Wheeler noted that last year's proceedings are posted and are able to be adjusted (example was a request from Joey Norikane). However, the adjustments and new postings take time. This is because in the case of international meetings, the meeting host has hosted/posted the proceedings on their own server, but in other, non-international annual meetings, the reports are hosted by Montana State University and managed by Tracy Dougher. Also noted was that membership requests have gone to Mark Romer in the past, yet web-posted information gets sent to Tracy Dougher. In other words, there is a potential difficult web to navigate from year to year and information nugget to nugget. Gary Stutte asked if Tracy Dougher could host all of the meetings on the Univ. of Montana server and Tracy said yes.
- Gary Stutte encouraged the membership to use the website – it is loaded with useful information.
- Thanks were given to Ted Tibbitts and Tracy Dougher for their work on improving the website.

Peter Ling moved to accept the website report, AJ Both seconded the motion, and there was unanimous acceptance by vocal vote.

Mark Romer reported on the Email/Electronic Discussion Group

- In 2007, the group brought up a need for email discussion group for NCERA-101 business. A Google group site (NCERA-101) was set up and tested, but not launched to the membership. This would be good to discuss things like International Meetings, exchange ideas (rather than just report them as through an email process), suggestions of speakers, etc. Email relays are cumbersome to manage.
- The topic was raised last year, but not discussed due to lack of time.
- The current version of the site is a "moderated site", which means all emails are screened by the moderators. Should we keep the current site or disband it?
- Currently, Tim Mies is the only volunteer to administer this group; the discussion group currently has only three members (Ryan Stewart, Mark Romer, and Tim Mies).

- The site has a file area to post topics, tailor preferences for individual members (email preferences – all posts, daily digest or web only access), rules of participation.
- Do we want to have the site?

Discussion: Alex Turkewitsch reported that discussion at past meetings centered on using the Association for Education Research Greenhouse Curators group model, which is an unmoderated site. This is a fairly open membership, but has vetted applications, and any attachments are moderated. The idea is to have short and concise entries. One of the big benefits of the AERGC having this site is in recruiting. Gerry Dietzer asked if a discussion site is necessary at all and what the value is for such a site. Mark answered that a site like this makes it more convenient than email communications to discuss topics, and used Chieri Kubota's GreenSys organization as an example of how communication could be improved.

Mark Romer motions that we launch the site in the NCERA-101 name through Google Group sites. Gioia Massa 2nd. Unanimous passing by vocal vote.

Mark Romer motions that the NCERA-101 Google Discussion Group site be non-moderated in posting, but the membership is vetted (invited) by NCERA-101 membership. Application process is needed and needs to be approved by the moderator for prospective users. John Lea-Cox seconded the motion.

Discussion: Gary Gardener stated that there is a need to condition its use (i.e. no advertisements on the postings) and asked if there was a screen for figuring out what the discussion topic is. Mark Romer replied that all of that is handled within the group site, and the site can be expanded to include other existing group discussions (for example, other international groups). John Lea-Cox pointed out that the user controls their involvement through the personal settings on the Group Site. Desmond Mortley asked if it would be open to people from outside of our immediate group – can we invite specific people into the group. Mark Romer answered that involvement is all handled by membership approval process. Alex noted that the AERGC website has 500 members and gets good discussion going to posted questions. Discussion closed. Motion passed unanimously by vocal vote.

Mark Romer asked the group about the criteria to use in order to admit people to the site. Ted Tibbitts recommended we set it up initially with all current NCERA-101 members and re-evaluate next year. All agreed with this approach. Dan Schmoldt recommended we make this the first discussion topic on the Group Site. John Lea-Cox asked if we can limit participation to only certain discussion topics and members. The answer is to set those restrictions in the Google Discussion Group topic areas.

Dan Schmoldt presented the Cooperative State Research, Education, and Extension Service (CSREES) Representative Report.

- Dan announced that this would be the last CSREES report due to the transition of CSREES to the National Institute of Food and Agriculture (NIFA). The transition must be done by October 1, 2009.
- Funding update: FY '09 appropriation was about 3.3% higher than FY '08

- Agriculture and Food Research Initiative (AFRI) was about 5.6% higher over FY '08
- Earmarks continued, but some small across the board reductions from Stimulus Bill
- Mandatory programs were left alone at the Farm Bill funding level.
- AFRI was authorized for \$700 million, but less than that was appropriated.
- Farm Bill specified that at least 30% of AFRI projects must be integrated with research, extension, and education.
- The research component must be 60% basic and 40% applied.
- The 6 program areas were the same this year (and the same as the last 40 years).
- The types of proposals that can receive funding now are “Single function” (just research, just extension, just education) or integrated/multifunctional, conferences, or coordinated agricultural projects.
- Mandatory programs grew significantly due to the '08 Farm Bill.
- The transition from CSREES to NIFA was stimulated by the 2008 Farm Bill.
 - The user will not see much/many changes.
 - The goal of the transition is to raise the profile of Agricultural Research to that of the National Science Foundation, The National Institute of Health, and other similar programs.
 - There will be a presidential appointment to head NIFA.
 - Most of the transition is re-organization done internally.
 - The new Office of REE Undersecretary created one director for each of the 6 research areas. This should help coordinate national initiatives in agriculture research. The REE Undersecretary is also titled the “Chief Scientist”
 - Key points to remember:
 - Transition should not affect users.
 - Volunteer for review panels – this will provide direct input to what gets funded/should get funded.
 - When responding to a Request For Application (RFA), respond directly to application criteria.
 - Grants.gov is NOT your friend this year. It was underestimated last year how many simultaneous users there would be and the system is very slow now.

Erik Runkle asked if Dan Schmoldt could share overall outlook on the Specialty Crop Research Initiative (SCRI). Dan Schmoldt responded that they are expecting more proposals than last year (about 300 are expected). Based on last year's proposal evaluations, there is an emphasis on engaging stakeholders and a need to be truly interdisciplinary. Chieri Kubota asked whether next year's time line would be the same as this year's. Dan Schmoldt answered that they are trying to move it towards the beginning of the fiscal year (FY '10), so the RFA would be in the Fall of 2009. The project types will be the same as before. Chieri noted a need to bring the NCERA group together to submit a proposal, specifically regarding getting LED research and use/commercialization improved. Peter Ling asked if international matching dollars

would be acceptable under the SCRI requirements. Dan Schmoldt answered that at this point, there is not a concern (not viewed as a negative or positive). Peter Ling asked if there was a verification or auditing process to ensure the matching support is true. Dan Schmoldt answered that upon an award, an evaluation takes place to ensure the accuracy of the matching claims. Peter Ling noted that there is a difficulty in documenting the long-term commitment of some matching dollars, especially from commercial cooperators. Dan Schmoldt responded that there is some latitude in awarding projects one year at a time (a continuation award), subject to annual review, to accommodate those issues.

Bruce Bugbee presented the Instrument Package Report.

- There were three users this year (spectroradiometer, one quantum sensor, one net radiometer), which generated \$900 in income.
- The expenses amounted to some shipping, which was minimal (about \$300).
- The final account balance is about \$1,000.
- He brought the package to Park City, UT meeting to view along with a poster to explain what is in the package.
- He noted that each time a user receives the quantum sensor package, the user finds a problem with their own instruments that they didn't realize they had and an opportunity to fix it. The value is in doing in situ calibration
- The Spectroradiometer package is good for material characterizations, filters, and glazings.
- The Net Radiometer package is good for thermal quantification / characterization.
- The Humidity package has not seen much use.
- Sign up sheet was displayed with the instrument package.
- It was pointed out that when meeting surpluses occur, the balance could be transferred to the instrumentation account. Last year's surplus had a large surplus. Now, that balance (held by Utah State Ag Experiment Station) is about \$12,000. This is because the committee does not have an account for itself. This issue will be raised later in the meeting under new business for more complete discussion.

Discussion: Ted Tibbitts pointed out that the inclusion of the instrument package poster on the website was made, which has good descriptions of the packages. Bruce wondered if the package would get more use if the cost was cheaper. The group showed little interest in this. Utah State is now set up to take credit cards, but the cost to the instrument package is \$25/month plus 3% of the transaction fee. The bill-to is "Utah State University" and additional notes can be added (instrument package, for example) to the invoice. Mark Romer asked if there were any international shipping issues. Bruce Bugbee and Alec Hay replied that it looks like it may not be a problem anymore. Alex Turkewitsch says that there is some verbiage to use (replacement part, trade show, calibration package, temporary export) that will enable the sensor package to pass through customs. Mark Romer will attempt to ship the package to McGill this year and test this idea, and will discuss this with Bruce Bugbee and Alex Turkewitsch. Colleagues in England have also expressed an interest in utilizing the package.

Marc van Iersel motioned to accept the instrument package report. Ron Lacy seconded motion. Motion passes unanimously by vocal vote.

9:53 AM BREAK

10:15 RESUME

AJ Both update on ICCEG.

- The tissue culture brochure was handed out at Cocoa Beach, and more copies were distributed to member stations.
- Thanks to Chieri Kubota and other Arizona members for sending them out.
- There was difficulty in producing the posters. The printing was done in England and shipped to Rutgers, then sent to the member stations (61 addresses) in February, 2009.
- AJ has a large poster that is available for meetings. This poster has been used twice: once in Arizona and once in UK. If interested in using it, contact AJ for the poster and the abstract.
- The tissue culture brochure will be posted on the website shortly after this meeting.
- There was a paper that was produced from this work; colleagues in England led this effort to publish it.
- 2,000 copies of the minimum guidelines were printed. If interested, contact AJ for 50 to 100 copies at a time.
- Thanks were given to the executive committee for funding the printing and shipping of this document to member stations.
- Now there is a list of potential guidelines/discussion items for monitoring and reporting environmental parameters for experiments in greenhouses (see Appendix 4; this was a handout to the attendees). This list will be discussed at GreenSys 2009 in Part III of NCERA-101 sponsored session. The goal is to complete the guidelines by the 2012 Annual meeting, which will be the international gathering in Cambridge, England. AJ Both is also looking for any volunteers to work on the guidelines. The volunteers will develop a subcommittee on these guideline developments.

Discussion: Gary Gardener asked when pdfs of the tissue culture guidelines would be available. AJ Both stated that he would email the pdfs to the NCERA-101 membership in the next couple of weeks. Ted Tibbitts asked if it would be possible to get refereed publications for these guidelines. AJ Both answered that if people are interested in this, please see him and participate in the GreenSys session to begin those discussions on how to best pursue the idea. AJ Both asked the group for suggestions on how the ICCEG can publicize the guidelines and how they might provide instructions for their use. Gioia Massa asked if the guidelines could be published in HortScience. AJ Both answered yes, and he encouraged her and/or others to do so. Dick Gladon stated that he uses the guidelines in his classes and introductory/orientation classes. Alex Turkewitsch suggested submitting the guidelines to Science for their news section. Gary Stutte suggested using the list serve from our member societies (ASHS, Tri societies, etc.). Chieri Kubota suggested contacting the Society for In vitro Biology about this effort and

the general availability of the guidelines, and wondered if ASHS could do the same for all the guidelines this committee has developed. Marc van Iersel answered that the proper way of doing it would be to make an official request to the ASHS board to consider using these guidelines as standards in publications. Gerry Dietzer pointed out that the American Society for Plant Biology should also be notified for their journals. Gary Gardener suggested that the meeting sponsors could also have a link on their sites to educate the customers about what they need. AJ will contact the sponsor companies about doing this.

Erik Runkle reported on translating the handbook into Spanish.

- Nothing has happened in the last 12 months. There were issues about copyright and expense of this translation, but due to time constraints, the issue was postponed.
- Mark Romer stated that the request is two years old and there was no follow up from the original requestor since the original.
- Dick Gladon stated that the handbook was published through Iowa State Univ.; he can track down copyright issues.
- Alex Turkewitsch read the minutes from last year's meeting, which spelled out the action that the committee proposed to take; therefore, it is not possible to kill this motion at this time.
- The committee needs to draft a letter to Miguel Gimenez Moolhuijzen, a member of the UK CEUG from Spain (the original requestor) allowing translation, request specifics of what he wants from us. The letter needs to state that NCERA-101 is not an active participant in the translation, but will allow it to occur.
- Alex Turkewitsch stated that we need to be clear that the permission is just to translate, not to update the edition.
- Ted Tibbitts asked if they intended to translate and sell, so we need to condition them to make the translation available for free.
- Henri Imberti volunteered to verify the accuracy of the translation.

Discussion: Ray Wheeler asked what the publication date was. Dick Gladon answered that 1997 was the copyright. Gary Gardener stated that posting the pdf of the document doesn't violate the copyright – we just need to document the original copyright holder is Iowa State. John Lea-Cox recommended that the next version's copyright should reside with the NCERA-101 group. A letter will be drafted and sent to Miguel Gimenez Moolhuijzen with these specifics included in our response.

New Business

Erik Runkle reported on the selection of 2009-2010 incoming secretary

- The nominating committee recommended the appointment of Marc van Iersel.

Erik motioned we accept this nomination. Cary Mitchell seconded. No other nominations. Unanimously passed by vocal vote.

Gary Stutte began and led discussion on surplus meeting funds.

- For the past several years, the meeting has grown in sophistication, energy required to host, sponsorship/funding involvement, which has led to surpluses.

- 2008 international meeting, several things occurred: sponsorships were up, attendance grew more than expected, and they received some unexpected price breaks on hosting.
- The result was that they ended with ~\$14,000 surplus.
- This surplus has so far gone to fund some printing and distribution of the tissue culture guidelines and Gary's travel to NCERA-101 in 2009.
- Still have between \$11,000 and \$11,300 in a corporate account at Dynamac, which is a for-profit company.
- Accounting issues, taxes, appearances, raise the need to transfer this to the NCERA 101 instrumentation account at Utah State University.
- What do we do with future surpluses? Instrumentation? Buffer future meetings? Outreach Efforts?

Discussion: Ray Wheeler asked how previous meetings have fared with regards to surplus/meeting goals. (The past several hosts answered) Desmond Mortley replied that the meeting in Tuskegee had a few thousand dollars in surplus. Peter Ling had a few thousand dollars and that was used for student travel support. Chieri Kubota had a few thousand dollars and that too was used for student travel support. Gary Gardner shared his past experiences with another group (Plant Growth Substance) when he hosted. His conclusion was that it is better to transfer all surpluses into a single account held by a single member institution than having the committee hold an account in their own names, as long as the host allows expenditures for the group. Alternative is to partner with an existing non-profit as a sub-account, which allows sponsorships/donations to be tax deductible. As a point of information, Mark Romer presented what the UK CEUG group had done a few years ago. The UK-CEUG is not a non-profit group with 3 principal operating activities:

- Annual group operationing costs (Executive committee meetings; mailings, accounting and reporting costs) are funded by sponsorship from industry members.
- Invited speakers for the annual meeting are funded by the industry trade exhibition at the annual meeting.
- Annual meeting costs are completely covered by participating members.
- Excess funds generated by any of these activities is returned to a central account and is used for travel bursaries for International meetings and costs associated with the newly developed instrument package.

Gary Stutte asked Dan Schmoldt if as a USDA-regional committee, can we even set up this non-profit? Dan Stutte answered that we probably could not. Gary Stutte pointed out that we needed to get Ramesh Kanwar involved in this discussion, and suggested tabling the discussion until Ramesh can get involved tomorrow.

The second issue is what to use the surplus for. Suggestions were sought.

- Gioia Massa suggested using it to buffer future meetings (domestic meetings).
- Marc van Iersel suggested travel grants for graduate students.
- Dave Fleisher agrees with its use as a buffer and also to provide some travel grants for international meetings of NCERA participants.

- Peter Ling recommended we have a comprehensive budget plan rather than piece-by-piece votes.
- Ted Tibbitts suggested making the instrument package free for 1 year and revisit the requesting the experiment stations to pay for it. Peter Ling asked Bruce Bugbee what the costs of maintaining the instrument package was and Bruce said that there were some recalibration and time costs that are not always reflected in the annual accounting, making a free use probably not ideal.
- Ted motioned that we make the instrument package available for free. Dave de Villiers seconded. Audible vote not conclusive. By show of hands, Yes (15) No (18), motion failed.
- Alex Turkewitsch asked if we could reflect the total cost in the instrument package as well as all other expenses (calibration, time, etc.).
- Gary Stutte said there is Executive Committee discussion each year on all expenses for the meeting and how the surplus should be used.
- Gary Gardner said that the local institution must have financial obligation as a host to prevent irresponsible management.
- Erik Runkle noted that the surplus only amounted to about \$100 per member, and recommends leaving how the surplus is spent up to the executive committee.
- Jonathan Frantz suggested we use Erik Runkles model with an annual financial report by the executive committee with Bruce Bugbee's input and accounting.
- Mark Romer asked if there would be a perception by station directors that they are funding a surplus. Gary Gardener answered that if the fees/costs are marketed as registration for the meeting, there shouldn't be such a perception.
- John Lea-Cox supported this observation and pointed out that there is a big difference between an Experiment Station's support and an Experiment Station's financial support. If an experiment station contributes to the meeting, it's really only part of the cost of attending the meeting.
- Ray Wheeler pointed out that our current situation is really the result of one isolated exception (Cocoa Beach).
- Mark Romer suggested that industry could alter their upfront meeting support and offer "credits" for future support as required.
- Bruce Bugbee stated that there really wasn't an issue of USU concern over an account with money in it for long periods of time.
- AO Rule suggested the money flow from host institute to host institute, year by year.
- Gary Stutte said that they will transfer the surplus money to USU, invest in international travel support for 2012 and buffer future meetings.
- Table remaining discussions for tomorrow when Ramesh Kanwar arrives.

Future meetings:

2010 – Bob Morrow of ORBITEC and Peter Vanderveer of Univ of Wisconsin to host. Meeting will be March 20 to 23 on Univ of Wisconsin, Madison, WI campus which has good housing and conference facilities. Cost should be in the \$85 to 90/night range for rooms. No other offers to host. Unanimous passed by vocal vote. Tours will preliminarily include UW Biotron, Orbitec, University greenhouses, Monsanto, Omega, Milwaukee manufacturing.

2011- Iowa State will not be ready to host, but maybe in 2013. Michigan State is a possibility (Erik Runkle as host).

Mark Romer reported on the idea of having industry host the meeting.

- Everyone he polled informally agreed that it was a great idea.
- This year, Apogee is a partial host, as was 2008 when Dynamac helped host.
- There is a fear of a perception that the USDA/supporting agency is getting influenced by host or that competition among hosts might be present to out-do or show one host up over another.
- There was no concern with visitations or tours within industry factories.
- The current interest is to co-host as a partner with University/host institute. Next year, ORBITEC will extend this model.

Discussion: Gary Gardner proposed we document, perhaps with Ramesh Kanwar's help, how this group is unique with industry involvement and the scope of the coverage.

2012: Mark Romer updated the group on his discussions with the UK-CEUG who have offered to host the next international meeting in Cambridge, England .

- There is an organizing committee established for planning this event.
- The meeting is scheduled for Sept 9 to 12, 2012 with post conference tours in East Anglia and Cambridge University.
- The meeting will follow the format of 2001 with a proposal to hold 8 sessions with 20 invited speakers, individual poster contributions, and trade exhibitions.
- An email from Lynton Incoll has been circulated to the NCERA-101 membership soliciting feedback on potential session themes. Briefly, these suggestions could include:
 - Revisiting topics covered during the 2001 sessions,
 - Updating relevant topics using a review format (changes since 2001)
 - Updating the growth chamber handbook
 - Selecting new topics and suggestions
- members are urged to communicate their suggestions and preferences to Mark Romer for forwarding to the UK group!

Discussion: John Lea-Cox suggested food safety as a possible topic to include with the technology behind detection and monitoring. Gary Gardener asked if there was precedence/or a historical reason behind hosting the annual meeting in March/April. Bruce Bugbee answered that historically, it was during Spring Break, but no technical reason behind having it at a certain time of the year. The only timing that is critical is to have the annual report submitted 60 days or less after the annual meeting.

A poll was taken to see how many station reports would be given and a sign up list was posted. Meeting adjourned for the day at noon. Station reports were given in the afternoon.

4-6-09 Call to order by Gary Stutte at 8:12 AM

Todd Smith from Duke Univ. made a meeting announcement.

- The Association of Educators and Research Greenhouse Curators (AERGC) conference on July, 20 to 23, 2009.
- NC State and Duke will co-host the meeting with workshops at both locations on nutrition, soils, transgenics, and plant database management.
- The tours will include research triangle facilities, Duke's new facilities, as well as NC State's new greenhouses, but details of those tours will be finalized in about a week.
- Duke will host the accommodations.

Gary Stutte stated that there was some confusion about bringing hard copies of station reports this year; only five groups brought them. Station reports are on the web, but the key is to submit them (all experiment stations are supposed to submit a report) and for the membership to read them. Station reports are not limited to experiment stations.

Ramesh Kanwar presented the Administrative Advisor's Report.

- Apologized for his late arrival and offered thanks to the organizers.
- He was impressed with the afternoon workshops and the industry participation in those workshops, which reminded him of the 2050 challenge. The 2050 Challenge is an Iowa State University College of Engineering program briefly (from the website <http://www.engineering.iastate.edu/the-2050-challenge.html>)

Look ahead to the year 2050, to a world of 9 billion people, and ask yourself what critical challenges must be met over the next four decades to ensure the expectation of a high-quality life. These include: Renewable nonpolluting energy, Abundant clean water, Access to modern healthcare, Sustainable agriculture and manufacturing, Safe roads and bridges, Adequate preparation for, and protection from, natural and man-made disasters.

Meeting these challenges requires the technical expertise and social ingenuity to collaborate locally and globally, with a full appreciation of cultural values and priorities. The work will take determination and vision. Who has the capability and commitment to lead us to solutions, and to implement those solutions?

- Ask where the technology is going and globally, where is the NCERA-101 group going?
- He complimented us on getting graduate student involvement at this meeting.
- There is stimulus money going to NSF, NIH, and DOE. All of last year's proposals that were turned down due to lack of funds stand a good chance of funding this year. Short (2-3 years) time frame for projects is encouraged. Technology/sensor development is an area of emphasis for these projects.
- Some stimulus money is being given to the states for shovel-ready projects (about \$100 to \$150 million). Talk to your deans, department chairs, heads, and get involved. New greenhouse projects that have been delayed are possible with this money.

- Challenge: how to move forward? Where should science and technologies go? Form a small group within this NCERA-101 group to meet with NSF heads. (USDA can come up with travel money to DC) to guide direction of national programs.
- Heads up: European Union and NSF are developing a program on how to fund joint projects between US and European groups. Can 2012 meeting identify/solidify these partnerships? Ramesh Kanwar can help connect NSF, EU collaborators. A 2012 session can perhaps be set aside to identify these linkages. Similar programs are being developed in Australia, India, China, and Japan. These projects lead (should) to new projects/products/technologies (deliverables). Ramesh Kanwar can give us this information.
- Many countries are developing a vision for developing infrastructure and expertise to train people. For example, in Thailand, their 2020 program plans to train 20,000 PhDs by 2020. This program plans to give the equivalent of \$150,000 for training and overseas training (2 years each). They need a foreign mentor. \$7,000 is given to that mentor for two trips to mentor and work in Thailand. Every student is expected to write 3 to 4 refereed publications during their program.
- In terms of administrative advising, Good job, keep it up. This group has done a good job in the past.
- Minutes are due 60 days from today (4-6-09, which puts the due date at June 5th, 2009). The minutes should be posted on the website and he can help clarify the minutes.
- Statements of accomplishments and impact statements are expected. The two handouts that he provided are instructions on writing impact statements; ask who cares, so what, what is new, and how does this impact the broader society? When impact statements are written, include a contact person or people. Several emails are okay to list on this statement. Be inclusive with your cooperators. The project is easier to sell when there are outcomes.
- Glad we are still thinking internationally with the next international meeting to be hosted in England. NSF has a program for 10 travel grants (\$2500 each) for a meeting (international). This group certainly should try to get this award. USDA has been able to co-sponsor up to \$10,000 for graduate student travel grants (\$500 each). Can we get industry sponsored travel grants for students?
- View budget cuts as “how can we get better?”

Discussion: Ray Wheeler asked if the NRI or AFRI can have a topic of controlled environment agriculture as a topic. Dan Schmoldt responded that his agency is not getting any funding for any new projects; NSF is getting the lion's share of stimulus money. ARS getting lots, but predominantly for deferred maintenance of buildings. Ramesh said that new faculty and new laboratories can get support from NSF – NSF is looking to support these efforts. He recommended that interested parties get in touch with NSF Program directors – they have flexibility (more than other agencies). NSF Directors can fund up to 10 projects, even if they did not get highly scored, but only for the next 3 to 6 months (due to stimulus funding and time restraints). Alex Turkewitsch asked what the timeframe for the climate change conference was. Ramesh Kanwar

responded that March to May time frames are typical. Alex Turkewitsch followed up wondering how NCERA 101 members can get involved. Ramesh Kanwar suggested that in UK in 2012, we should figure out how to do it through inviting NSF panel members and EU participants to help us.

Gary Stutte addressed deferred items from yesterday.

Mark Romer summarized discussion yesterday.

- Ramesh Kanwar responded: Extension/Education and Research Activity is in the name. This is to reflect the industry as a stakeholder, so no problem from that perspective. From the experiment station perspective, we are told to involve the industry, so no problem from that perspective. Do what is best for the group. Keep partners informed, but no problem in how it looked.
- Mark Romer explained that the concern is trying to include, not peddle influence or have the perception of doing that. Ramesh Kanwar recommended we not worry about that.
- Ramesh Kanwar also recommended that we get the USDA and Experiment Station websites to post information about the meeting so that we encourage communication.

Gary Stutte reviewed the history of surpluses from previous meetings.

- Need to move last year's meeting surplus to USU instrumentation account. The questions we have for Ramesh Kanwar are 1) How do we manage this? 2) How might an account be set up through NCERA-101 committee? 3) How would it look?
- Ramesh Kanwar replied that it is simple to handle, and outlined his experience to set up accounting at experiment stations. He recommends we set up guidelines on how it will be used for professional activities to support the group. We need to be upfront about the "hands off" by host institute.
- Gary Gardner asked if there is precedence in NCERA groups to set up non-profit groups. Ramesh Kanwar could not identify other examples of committee accounts in committee's name.
- If meetings run a deficit, host sends an invoice to Bruce Bugbee or Utah State spelling out expenses, so no "transfer" questions arise from moving money from one institution to another. Alex Turkewitsch pointed out that all of this is predicated on Bruce Bugbee's willingness to do this.
- Gary Stutte summarized that the action to take is put together guiding principals of how to spend the money, transfer money, and account for money next year.
- Alex Turkewitsch recommended that the executive committee will decide on the expenditures and reflect the accounting in the budget at the annual meeting.
- Bruce Bugbee reiterated that he doesn't anticipate problems from USU.
- Bruce Bugbee also reported that he will offer the instrument package for \$100 instead of \$300 as a trial basis to be reviewed in one year.

A.J. Both asked the group if we could decide on written reports. He motioned that we have written reports at all annual meetings. Peter Ling seconded. Voice vote

inconclusive. Yes (10) No (17). Motion defeated. Gary Stutte summarized that as of next year, electronic station reports are only required, not written reports.

Alex Turkewitsch motioned for the meeting to end. Jonathan Frantz seconded. The motion passes unanimously. Meeting adjourned at 9:12 AM.

The gavel was passed that evening from Gary Stutte to Alex Turkewitsch.

Appendix 1: 2009 Annual Meeting Agenda.

USDA NCERA-101
NCR-101
Committee on Controlled Environment Technology and Use

Saturday April 4:

3 to 5p.m. ASHS Growth Chamber and CE Working Group Meeting
6 to 10p.m. Reception with heavy hors d'oeuvres and complimentary drinks.

Sunday April 5:

7 to 8a.m. Continental Breakfast – meeting room.
8 to 11:30a.m. Business Meeting

- Opening remarks (Gary Stutte)
- Welcome to Park City (Bruce Bugbee)
- General announcements (conference/events)
 - Participation in GreenSys (Cheiri Kubota)
 - Other announcements
- Administrative Advisor's Report (Ramesh Kanwar will arrive in the afternoon and present his report).
- Minutes from 2008 meeting in Florida (Alex Turkewitsch)
- Membership and website report (Mark Romer)
- E-mail discussion group update (Mark Romer)
- CSREES Representative Report (Dan Schmoldt)
- Instrument package report (Bruce Bugbee)
- Other Committee Reports/Old Business
 - Update from ICCEG (A.J. Booth)
 - Translation of Plant Growth Chamber Handbook into Spanish (Eric Runkle)
- New Business
 - Selection of 2008-2009 Incoming Secretary
 - Nominating Committee: Erik Runkle, Gary Stutte, Alex Turkewitsch, Jonathan Frantz.
 - Use of surplus funds from meetings.
 - Surplus funds from 2008 International meeting (Gary Stutte)
 - Self-funding by UK CEUG (Mark Romer)
 - Future Meetings (Gary Stutte/Mark Romer)
 - 2010 (Wisconsin, Robert Morrow/Peter Vanderveer)
 - 2011 open
 - 2012 International Meeting, Cambridge, UK (Mark Romer)
 - 2013 open

11:30 to 12:30 Group Lunch – meeting room
12:30 to 5p.m. Informal Exchange

6p.m. Awards Banquet at The Yarrow
After Dinner Talk by Frank Salisbury – **“Life Support and the Biosphere: From Vernadsky to Averner”**. Frank recently completed

editing a book titled: “*Geochemistry and the Biosphere: Essays by Vladimir Vernadsky*”. He will talk about his experiences with this book and share his thoughts on the early days (1970’s and 1980’s) of the NASA Controlled Environment Life Support Systems Program. Frank retired from Utah State University in 1997.

Monday April 6

7 to 8a.m. Continental Breakfast
 8 to Noon Information Exchange
 Noon to 1p.m. Group Lunch – meeting room
 1 to 5p.m. Instrumentation Workshop

We will divide into 5 groups and rotate among 5 stations at 45-minute intervals. Each station will provide a hands-on opportunity to use new instruments. These stations are:

1. Principles of measurement of stomatal conductance using leaf porometers: Gaylong Campbell, Decagon Devices.
2. Measurement and control of substrate water content in Containers: Marc van Iersel, UGA and John Lea-Cox, UMD.
3. Measurement of temperature using thermocouples and thermistors and programming dataloggers in CR Basic: Dave Meek, Campbell Scientific.
4. Measurement of spectral transmission and reflectance using the NCERA spectroradiometer: Mark Blonquist, Apogee Instruments.
5. Principles of measurement of surface temperature by infa-red thermometry: Bruce Bugbee, USU.

5 to 7p.m. Free time to tour historic Park City Main Street
 7p.m. Group Dinner at Squatter Pub and Brewery (across from The Yarrow).

Tuesday April 7

Tour 8a.m. to 6:30p.m. Tour of instrumentation companies and mountain lakes.

7 to 8a.m. Continental Breakfast
 8a.m. Tour bus leaves from the Yarrow and travels to Logan.
 10 to 11:30a.m. Campbell Scientific, Inc. automated manufacturing of printed circuit boards and sensors.
 11:30 to 1p.m. Lunch hosted by Apogee Instruments. Tour of the new passive solar Apogee Instruments building, including unique monitoring and control instrumentation.
 1 to 2p.m. Caisson Laboratories (Dr. John Carman) Tissue culture and genetics.
 2 to 3p.m. Utah State University Space Dynamics Laboratory (Dr. Gail Bingham).
 3 to 4p.m. USU Research Greenhouse Complex. View Bruce’s low tech control center.
 4 to 5p.m. Drive to the Bear Lake Summit at 2370 meters to look out over Idaho and Wyoming (weather permitting).
 5 to 6:30p.m. Complete the tour loop by driving past Bear Lake and back to the Yarrow.
 7p.m. Group Dinner at Robert Redford’s restaurant (Zoom).

Appendix 2: List of Attendees NCERA-101 April 4-8, 2009

Curtis Adams	<i>Utah State Univ.</i>	Vic Mirabella	<i>Priva</i>
Lou Albright	<i>Cornell</i>	Cary Mitchell	<i>Purdue Univ.</i>
Felix Arguedas	<i>Univ. Maryland</i>	Robert Morrow	<i>ORBITEC</i>
Wade & Betsy Berry	<i>UCLA</i>	Desmond Mortley	<i>Tuskegee Univ.</i>
Matt Blanchard	<i>Mich. State Univ.</i>	Bert Neeft	<i>Total Energy Group, Inc.</i>
Mark Blonquist	<i>Apogee Inst.</i>	Sonali Padhye	<i>Univ. Florida</i>
A.J. Both	<i>Rutgers Univ.</i>	Chris Parry	<i>Utah State Univ.</i>
Bruce Bugbee	<i>Utah State Univ.</i>	Robert Pauls	<i>BioChambers</i>
Gaylon Campbell	<i>Decagon Devices</i>	Reg Quiring	<i>Conviron</i>
Rob Campbell	<i>Juniper Systems</i>	Dennis Raath	<i>Total Energy Group, Inc.</i>
Brian Cook	<i>EGC</i>	Sharon Reid	<i>Conviron</i>
Jeremy Crook	<i>Utah State Univ.</i>	Mark Romer & Bonnie Soutar	<i>McGill Univ.</i>
Fred Davies	<i>Texas A&M</i>	A.O. Rule, III	<i>EGC</i>
David de Villiers	<i>Cornell</i>	Erik Runkle	<i>Mich. State Univ.</i>
Gerry & Barbara Deitzer	<i>Univ. Maryland</i>	John & Barbara Sager	<i>NASA-Kennedy</i>
Tracy Dougher	<i>Montana State Univ.</i>	Daniel Schmoldt	<i>USDA</i>
Bruno Faucher & Guylaine Pruneau	<i>Greenhouse Engineering</i>	Philip Sheridan	<i>Cycloptics</i>
David Fleisher	<i>USDA-ARS</i>	Todd Smith	<i>Duke Univ.</i>
Jonathan & Susan Frantz	<i>USDA-ARS</i>	Ryan Stewart	<i>Univ. Illinois – UC</i>
Gary Gardner	<i>Univ. Minn.</i>	Gary Stutte	<i>NASA-Kennedy</i>
Richard Gladon	<i>Iowa St. Univ.</i>	Marc Theroux	<i>Biochambers</i>
Steven Griggs	<i>EGC</i>	Ted Tibbitts	<i>Univ. Wisconsin</i>
Alec & April Hay	<i>Utah State Univ.</i>	Richard Tuck	<i>Cycloptics</i>
Douglas Hopper	<i>Achieving Solutions</i>	Alex & Eva Turkewitsch	<i>Greenhouse Engineering</i>
Henri & Robin Imberti	<i>Percival Scientific</i>	Marc van Iersel	<i>Univ. Georgia</i>
Hugues Joannis	<i>Univ. Laval</i>	Jeff Werner	<i>Univ. Alaska</i>
Lloyd Jones	<i>Monsanto</i>	Ray Wheeler	<i>NASA-Kennedy</i>
Ramesh Kanwar	<i>Iowa State Univ.</i>	Garret Wheeler	<i>Apogee Instruments</i>
Meriam Karlsson	<i>Univ. Alaska</i>	Dave Wilson	<i>NASA-Ames</i>
Jongyun Kim	<i>Univ. Georgia</i>	Neil Yorio	<i>NASA-Kennedy</i>
Mark Kroggel	<i>Univ. Arizona</i>		
Chieri Kubota	<i>Univ. Arizona</i>		
Ron Lacey	<i>Texas A&M</i>		
John Lea-Cox	<i>Univ. Maryland</i>		
Mark Lefsrud	<i>McGill Univ.</i>		
Peter Ling	<i>Ohio State Univ.</i>		
Gioia Massa	<i>Purdue Univ.</i>		
Dave Meek	<i>Campbell Scientific</i>		

Appendix 3

NCERA-101 Membership Summary April 2009

Mark Romer, *List Curator*

Membership Number April 2008 137

April 2009 145

- Additions 10
- Deletions.....2
- Net Gain(Loss)8

Membership Composition

Institutions

Members

- Phytotrons & Controlled Environment Facilities 11..... 15
- University Departments, Agr. Exp. Stations..... 53..... 78
- Government Organizations & Contractors 13..... 15
- Industry Representatives 23..... 36
- Independent 1

Total Number of Institutions 100

Total Number of Members 145

New Institutions

Canada

- National Research Council of Canada – Plant Biotechnology Institute
- Envirotron - Université Laval - Faculté des sciences de l'agriculture et de l'alimentation

USA

- University of Florida – West Florida Research and Education Center
- Texas A&M – Department of Horticulture
- Colorado State University – Mechanical Engineering Department
- Great Veggies LLC
- Rough Brothers Inc.

Appendix 4: Suggested discussion points for inclusion in developing minimum guidelines for greenhouse experiments.

Guidelines for Monitoring and Reporting Environmental Parameters for Experiments in Greenhouses

Greenhouse structure

- Type
freestanding, gutter-connected, peaked roof, arched roof, open roof, hoop house, gothic, special design
- Size
footprint, gutter height, ridge height, usable growing area
- Location
city, country, latitude, longitude
- Elevation
distance above sea level
- Orientation
compass orientation of the ridge
- Glazing material (side walls and roof)
rigid, film, single layer, multiple layer, glass, plastic, sealed (e.g., containment buildings)
- Foundation and floor
concrete, soil, gravel, sand, cover material, sealed (e.g., containment buildings)
- Porosity of the building
active or passive ventilation, infiltration rate, positive or negative pressure, sealed and air conditioned
- Surroundings
wind-break, shading, common walls with adjacent buildings (e.g., headhouse)

Growing system

- Crop
(Latin) plant name, variety, developmental stage, age
- Size of the experiment
dimensions (including height), number of plants, plant density
- Growing container
material, volume
- Rooting medium
volume, material or mix, additives
- Irrigation
water source, delivery system, water use, operating strategy
- Fertigation
liquid or solid, source of fertilizers, composition of nutrient solution, operating strategy
- Nutrient solution treatment
treatment process, capacity, operating strategy
- Benching
movable, fixed, multilayer (roll-out), height, materials used, solid or open-bottom
- Growing on the floor (if applicable)
design of the floor (see above under 'Foundation and floor')
- Hanging
movable, fixed, resulting shading for crop below

Environmental parameters (inside and outside where applicable)

- Temperature
air temperature near top of the canopy, leaf temperature, root zone temperature, temperature of growing point, supply and return temperature (heating systems), irrigation water temperature, glazing temperature, temperature distribution
- Radiation
PAR, (visible), 300-800 nm (action spectrum), solar (short wave) radiation, long wave radiation, net radiation, wavelength specific (R:Fr), narrow waveband (LED), integral, uniformity

Humidity
relative humidity, absolute humidity, vapor pressure deficit, evapotranspiration

Carbon dioxide concentration
around the canopy, inside the canopy

Air velocity
through ventilation openings, around and/or through the plant canopy

Time of year and/or photoperiod
duration of the light/dark period

Dissolved oxygen concentration
in nutrient solution, in root zone

pH and EC
in nutrient solution, in root zone

Specific ion concentration
in nutrient solution, in root zone

Environmental control systems

Heating
hot air, hot water, steam, fuel source, design capacity, operating strategy

Ventilation
natural, mechanical, location and size of the inlet and outlet openings, design capacity, operating strategy

Cooling
evaporative (crop, pad and fan, fogging), mechanical (AC), design capacity, water use, operating strategy

Internal air circulation
number of fans, location, orientation, design airflow capacity, operating strategy

Humidity control
equipment, (de)humidification capacity, operating strategy

Supplemental lighting
light source specifications, (spectrum), design intensity at specified distance, (uniformity), mounting grid, mounting height, luminaire type, operating strategy

Insect screening
material, opening size, effective covering area, pressure drop, installation

Shading
inside or outside, material, design shading specifications, (design energy savings specifications), operating strategy

Photoperiod control
light source specifications, (spectrum), design intensity at specified distance, (uniformity), mounting grid, mounting height, luminaire type, black-out material, operating strategy

Carbon dioxide enrichment (of the air)
carbon dioxide source, distribution system, design gas flow, operating strategy

Oxygen enrichment (in the nutrient solution)
oxygen source, distribution system, design gas flow, operating strategy

Environmental control hardware and software
manual or computerized, make and model, operating strategy

Environmental control algorithm
measurement and recording intervals, algorithm (e.g., PI, PID, etc.), operating strategy

Sensors

Make and model, principle of operation

Precision and accuracy

Calibration
procedure, frequency, quality control

A.J. Both

March 27, 2009

File: <Draft discussion items greenhouse guidelines.doc>