**NCERA-101 Station Report**
**Orbital Technologies Corporation, Madison WI**

**July 01, 2015-August 31, 2016**

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**1. Impact Nugget:**

ORBITEC continues to develop environmental control technologies for space based biological and physical-chemical life support systems, technologies that may have applications for terrestrial environmental control systems.

**2. New Facilities and Equipment.**

ORBITEC fabricated a prototype "Greenwall" plant growth system to test hybrid life support system concepts.

*Greenwall prototype designed for fresh food production in space habitats.*

**3. Unique Plant Responses.**

Nothing to report.

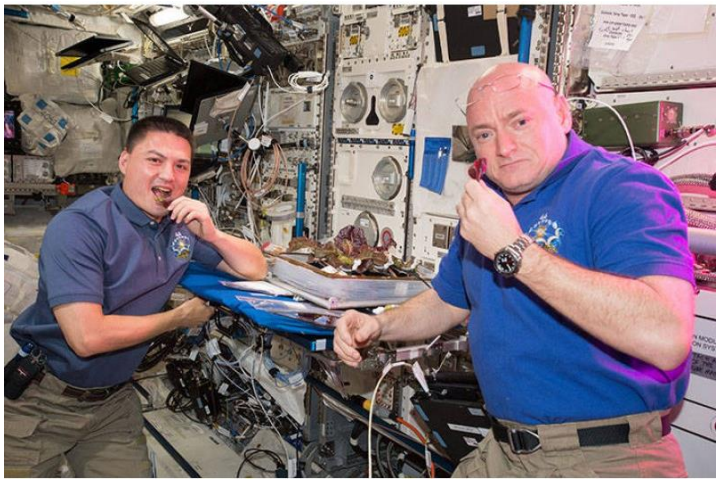
**4. Accomplishment Summaries.**

***Life Support Systems***

ORBITEC is working toward the development of Exploration Life Support Salad Crop production as an early stage implementation of hybrid life support systems (combination of bioregenerative and physical-chemical life support technologies).

***Space Plant Biology***

ORBITEC continues to work with the Kennedy Space Center (KSC) to support the Veggie plant growth system hardware that is on-board the ISS. Currently, Veggie has been used to grow two crops of lettuce and one crop of Zinnias, and to conduct multiple experiments such as APEX-3. The Veggie team was able to obtain clearance from NASA to allow ISS crews to consume lettuce produced in the Veggie hardware. A second Veggie unit is planned for the ISS later this year.



***NASA astronauts Kjell Lindgren and Scott Kelly on the International Space Station eating lettuce plants grown in the Veggie plant growth system.***

ORBITEC also continues to support KSC in the development of the Plant Habitat system that will be used for plant research aboard the International Space Station. When flown, this system will be the largest plant growth system put in space to date. It is expected to fly in 2017. The Plant Habitat flight units are currently undergoing testing.

***Plant testing in NASA Plant Habitat Engineering Development Unit.***

***Aerospace Environmental Control***

ORBITEC continues to work with Commercial Crew Integration Capabilities partners for development of human Life Support and Thermal Control systems.

**5. Impact Statements**

- ORBITEC is advancing the technology of controlled environment systems to meet the performance and quality needs of long duration space applications. Some of this technology may be transferable and scalable to protected agriculture systems.

- ORBITEC is developing LED lighting configurations and control strategies for plant and human lighting applications to provide increased lighting system utility in addition to increased operating efficiency.
- ORBITEC is using its space biology controlled environment work and human life support work to spark interest in high school and college students in controlled environment technology and STEM.

**6. Published Written Works.**

Massa, G.D.,R.M. Wheeler, R.C. Morrow and H.G. Levine. 2016. Growth chambers on the International Space Station for large plants. Acta Hortic. 1134. ISHS 2016. DOI 10.17660/ActaHortic.2016.1134.29 Proc. VIII Int. Symp. on Light in Horticulture Eds.: C.J. Currey et al.

*Submitted*: Kopsell, D.A., C.E. Sams, and R.C. Morrow. 2016**.** Interaction of light quality and fertility on biomass, shoot pigmentation and xanthophyll cycle flux in Chinese kale. Journal of the Science of Food and Agriculture. Journal of the Science of Food and Agriculture (Accepted for publication).

Mitchell, C. A., M. P. Dzakovich, C. Gomez, J..F Burr, R. Hernandez, C. Kubota, C. J. Curry, Q. Meng, E.S. Runkle, C. M. Bourget, R. C. Morrow, and A.J. Both. 2015. Light-emitting diodes in horticulture. In: Janick, J. (ed). Horticulture Reviews 43:1-87.

**7. Scientific and Outreach Oral Presentations.**

*2016 American Society of Horticultural Science Annual Meeting (presentation only)*

Non-Thermal Fresh Food Sanitation by Atmospheric Pressure Plasma. R.C. Morrow, R. J. Surdyk, and R.W. Remiker. Orbital Technologies Corporation, Madison, WI, USA.

*2016 International Conference on Environmental Systems Annual meeting (presentations & papers)*

Morrow, R. C, R. C. Richter, G. Tellez, O. Monje, R. Wheeler, G. Massa, N. Dufour, and B. Onate. 2016. A New Plant Habitat Facility for the ISS. 46th International Conference on Environmental Systems ICES-2016-320.

Remiker, R.W., R. J. Surdyk, R.C. Morrow, and M. Thiyagajaran. 2016. Non-Thermal Fresh Food Sanitation by Atmospheric Pressure Plasma. 46th International Conference on Environmental Systems ICES-2016-430.

Richter, R., B. Onate, R. C. Morrow, G. D. Massa. Advanced Plant Habitat Capabilities. ISS R&D Conference, 12 July 2016

Treichel, T.H. 2016. Human Factor Analysis of Light Emitting Diode Technologies for Aerospace Suitability in Human Space Flight Applications. 46th International Conference on Environmental Systems ICES-2016-95.

Wetzel, J.P., R. C. Morrow, D.A. Wyman3, R.R. Wallace, G. J. Ladwig, R. J. Surdyk6, D.A. Barkow, and Robert C. Richter. 2016. Mass Measurement Capability for Small Masses in a Microgravity. Environment46th International Conference on Environmental Systems ICES-2016-32.

*2016 ISS R&D Conference (presentation only)*

Richter, R., B. Onate, R. C. Morrow, G. D. Massa. Advanced Plant Habitat Capabilities. ISS R&D Conference, 12 July 2016

*2015 American Society for Gravitational and Space Research Annual Meeting (presentation only)*

Mass Measurement Device for Small Masses in Microgravity Environment. John P. Wetzel[1], Robert C. Morrow[1], Daniel A. Wyman[1], Russell R. Wallace[1], Greg J. Ladwig[1], Robert J. Surdyk[1], David A. Barkow[1], and Robert C. Richter[1]. [1]ORBITEC, Madison, WI, USA.

Non-Thermal Fresh Food Sanitation by Atmospheric Pressure Plasma. R.C. Morrow, R. J. Surdyk, and R.W. Remiker. Orbital Technologies Corporation, Madison, WI, USA.

**Other relevant accomplishments, news and activities.**

- ORBITEC provided tours of our facilities and projects, including those related to controlled environments, to several student groups during the last year. We continue to hire several interns each year, primarily engineering students but also an occasional biology student.
- ORBITEC continues to be a vendor for Space Gardens (an outreach/education plant growth system) and mars regolith simulant materials.

**8. Websites:**

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| ORBITEC | http://www.orbitec.com/ |
| Sierra Nevada Corporation | http://www.sncorp.com/ |