DEVELOPMENT OF THE COMMERCIAL PLANT BIOTECHNOLOGY FACILITY FOR THE INTERNATIONAL SPACE STATION

W. Zhou

Wisconsin Center for Space Automation & Robotics, University of Wisconsin Madison, 1415 University Drive, Madison, WI 53706 USA (Email: wzhou@facstaff.wisc.edu)

A Commercial Plant Biotechnology Facility (CPBF) has been developed by the Wisconsin Center of Space Automation and Robotics (WCSAR) at the University of Wisconsin-Madison. The purpose of the CPBF is to support long-term commercial and scientific plant research in a microgravity environment on board the International Space Station (ISS). CPBF provides an enclosed, environmentally controlled plant growth chamber with controlled parameters of temperature, humidity, light intensity, and atmospheric composition, and with fluid nutrient delivery.

CPBF is configured as a quad single Middeck Locker payload to be mounted in an EXPRESS rack that will be installed in the U.S. Lab Module. Since the CPBF is envisaged to remain on board ISS for extended periods of time, its design is based on an open-architecture concept i.e. the subsystems are removable and replaceable on board ISS. CPBF consists of seven major subsystems: a rack interface structure; an environmental chamber; a light module; an ASTROPORE^{TM} unit; active fluid and nutrient delivery; atmosphere composition control; and computer control and data management.

The rack interface structure serves as a chassis to house the CPBF payload and is attached to the Payload Mounting Panel of the EXPRESS Rack. The environmental chamber provides an airtight volume to prevent the chamber air from being contaminated by the ISS cabin atmosphere, which usually contains high levels of CO_2 and trace organic compounds that may affect plant growth. The ASTROPORE^{TM} unit provides the features of self-priming, humidification, dehumidification, and recovery of condensate from the dehumidification process. The light module offers a choice of two configurations, an LED light module using high-efficiency, low-heat red and blue light emitting diodes at wavelengths of 670 nm and 450 nm, respectively, and a fluorescent light module using high output bi-axial tubes. Fluids and nutrients are delivered to the plants through porous tubes buried in the rooting material. The nutrient solution is confined within the porous tubes with a slightly negative pressure so that it is supplied to plants by capillary transfer through the pores into the rooting material. The atmosphere composition control system maintains chamber CO_2 concentration at a desired level and continuously removes the ethylene released by the plants. The computer control and data management system integrates the advanced control, fault detection, and telescience technologies together to increase overall system robustness and user friendliness.