## REVIEW ABSTRACT

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Preferred Category: 3.C.

Presentation Mode: Oral

Title: THERMOPHOTOVOLTAIC SYSTEM PARAMETRIC MODELLING

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Objective: Use design equations and parametric modelling to define ranges of thermal, optical, and electrical system parameters in a small spacecraft thermophotovoltaic power system.

Scope: A small radioisotope power source is assumed to obtain an optimum design for small spacecraft. Equations are easily extended to larger systems and, with more difficulty, to variable heat sources.

Introduction: Three recent papers on thermophotovoltaic (TPV) power systems for small spacecraft have each presented a set of design equations. This set of equations has been used to develop the design equations for parametric analyses of system components. The equations are used to define the required range of the various properties of interest.

Component Descriptions: The TPV system components of interest are: emitter, filter, cell, and heat sink. A change made in any one component will generally place different requirements on all other components. This interdependence led to the parametric: modelling requirement.

Emitter - the emitter is located between the heat source and the filter and is viewed as a form of a filter which modifies the photon spectrum. A emitter figure of merit is developed which allows comparison of different designs for each cell type.

Filter - the filter is located between the emitter and the cell and also modifies the photon spectrum. A filter figure of merit is defined which allows comparison of different'designs for each cell type.

Cell - the cell is located between the filter and the heat sink and is viewed as a transducer with a spectral response for conversion of photons of various energy levels to electricity. A transducer figure of merit is developed for comparison purposes.

- Heat Sink - the heat sink is located between the cell and outer space and is sized to handle all heat energy not converted to electricity. The heat sink is dependent upon view factors and orientation as well as material properties so a generic heat pipe design is used with scaling factors.

Design Requirements: Emitter basic design requirements are the ability to absorb and emit the necessary heat flux and to shape the emitted photon spectrum. Other design considerations are adequate mechanical properties, retention of optical properties with time, and low volatility at operating temperature.

Filter basic design requirements are the ability to reflect photons with unwanted energy levels and transmit the remaining photons with low absorbance. Other design considerations are adequate mechanical properties and retention of optical properties with time.

Cell basic design requirements are bandgap matched to emitter spectrum, good spectral response, low series resistance, and low dark current. Other design considerations are interconnection, cell size, and thermal grounding.

Heat sink design requirement is ability to dissipate heat at a given design temperature. Other design considerations are low mass, high heat transfer rate, and spacecraft storage. These other requirements are not covered.

Results: Four basic design equations were developed to handle the energy flow for heat source to emitter, emitter to filter, cell to heat sink, and heat sink to space. A fifth equation was developed for thermal to electric conversion including resistive losses. Sensitivity analyses showed the expected high dependence between optical cavity parameters and system performance. Design tradeoffs are used to reduce demanding component parameters.