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InterOffice Memo

To: Art Chmielewski 303-308

From: Cronin B. Vining

Date: March 10, 1993

Subject: "Power Stick" Concept input for MESUR Mini-Meteorological Stations

"Power Stick" Concept: Integrated miniature power source including RTG, rechargeable battery and any required load-leveling electronics.

Application: MESUR Mini-Meteorological Stations.

Features:

- ↻ Integrated power source in tube-shaped package
- ↻ Proven Radioisotope Heater Units (RHU's) with small nuclear inventory of 34 Curies
- ↻ Proven thermoelectric conversion and rechargeable battery technologies
- ↻ Multifoil thermal insulation to force heat through converter assembly
- ↻ 'Waste' heat still available for thermal control of instruments

Preliminary specifications:

- ↻ <80 grams for RTG + TBD grams for battery
- ↻ <4.6 cm diameter, TBD cm long (RTG is 5.2 cm, including insulation and converter) + battery/electronics TBD cm
- ↻ 1 W thermal power
- ↻ ≥ 30 mW continuous electrical power
- ↻ User selected output voltage (1-15 V easily accommodated)
- ↻ RHU's tested to 425 G, battery tested to TBD
- ↻ Fully charged battery delivers TBD W-hrs
- ↻ TBD hrs required to recharge battery

TATUS:

No feasibility issues, all components available

Detailed design and test of integrated unit TBD

"Power Stick" Breadboard Plan for MESUR Mini-Meteorological Stations

Objective: Build a scale model integrated power source package.

Breadboard prototype to include:

RHU (with electrically simulated nuclear heat source)

Prototype thermal vacuum jacket

Thermoelectric converter module

Rechargeable battery

Validation Criteria:

Power output demonstration

Thermal performance verification

Preliminary flight design and performance estimates

Drop tests

Radiation/magnetic environment estimates

Estimated Breadboard resource requirements: \$200K and 1 year.



POWER STICK

**A POWER SYSTEM OPTION
FOR MINI-MET STATIONS**

PRESENTATION TO CHARLES ELACHI

**CONCEPT BY
ART B. CHMIELEWSKI & CRONIN VINING 342**

3-24-93

POWER STICK



THERE ARE FOLLOWING POWER SYSTEM OPTIONS FOR MINI-DEVICES ON MARS:

- **RTGs - expensive to develop and approve for launch**
- **Solar Arrays - performance dependent on latitude, time of the day, orientation, dust storms; size and survivability issues**
- **Primary Battery - large, heavy, limited life**
- **Power Stick**

POWER STICK



ATTRIBUTES:

- USES EXISTING RHU, NO ADDITIONAL COST FOR LAUNCH APPROVAL
- PROVIDES HEAT JUST LIKE ANY OTHER RHU
- EFFICIENT BATTERY CHARGING AT LOW TEMPERATURE
- BATTERIES HEAT UP ON DISCHARGE
- 70WH/KG ENERGY DENSITY
- MANY YEARS OF OPERATION
- MANY USER VOLTAGES EASILY ACCOMMODATED
- RECURRING COST IN TENS OF \$K
- CAN BE DESIGNED TO WITHSTAND HIGH G LOADS (500G)

PERFORMANCE PARAMETERS:

- PROVIDE 30WH TO MINI-MET MARS STATION
- REPEAT A MARS ROVER CYCLE: GO 100 M, DO SCIENCE, TRANSMIT EVERY WEEK FOR YEARS
- POWER AUTONOMOUS SEISMOMETERS

POWER STICK

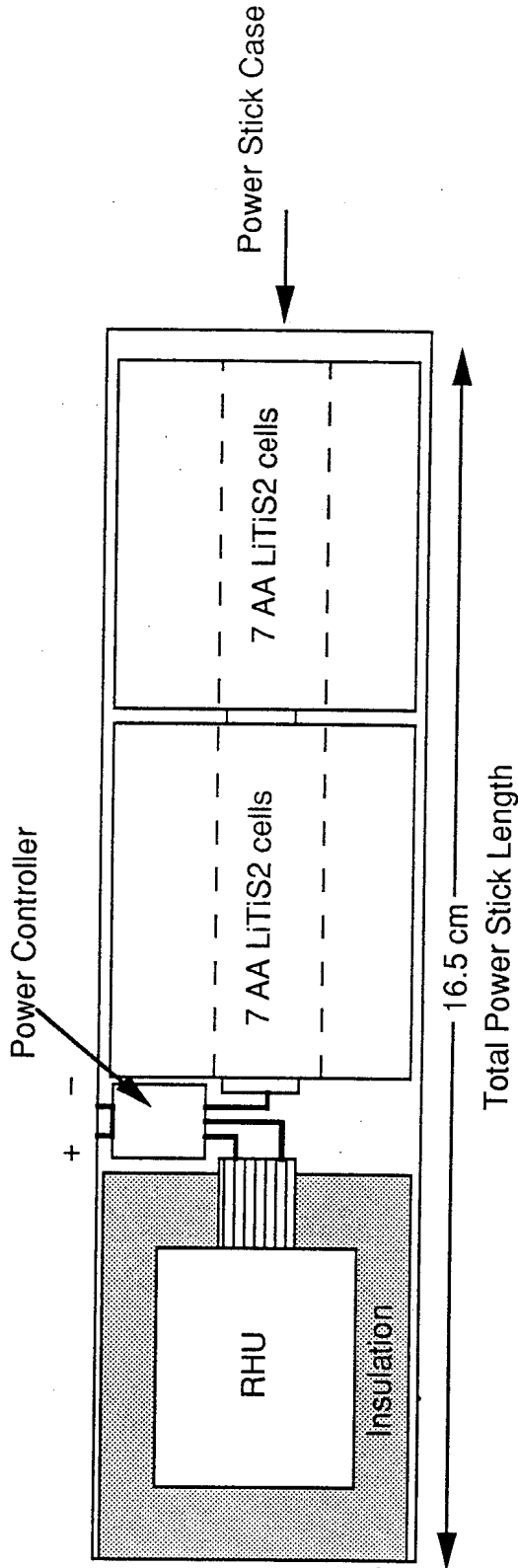
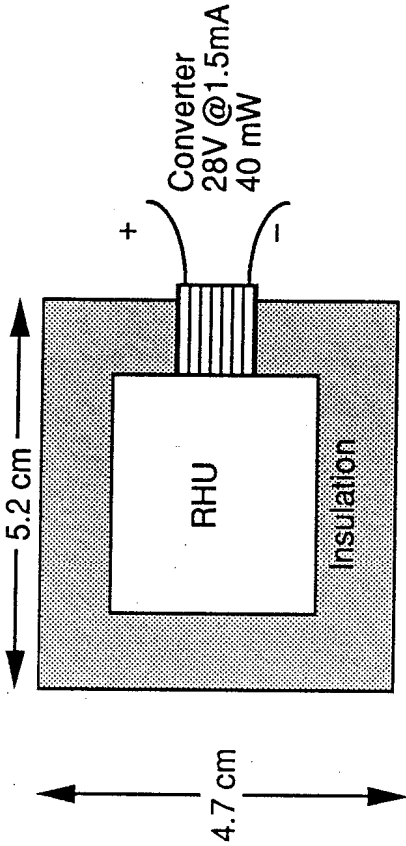


Radioisotope Heater Unit (RHU)+converter provide power to recharge the battery. The battery provides power for intermittent operation.

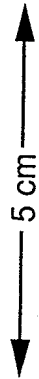
Battery recharge time is about a month.

14 AA cells provide 28 V and 1Ah for a total of 28Wh

| | |
|---------------|-------------|
| Mass: Battery | 220 g |
| RHU+converter | 80 g |
| Other | 80 g |
| Total | 380g |



1:1 SCALE



Battery Details:
14 LiTiS2 cells from EIC

Cell Characteristics:
1 Ah 2V AA size 16 g
achieved 350 cycles @ 100% DOD



WILSON BREADBOARD PLAN

OBJECTIVE: BUILD A PROTOTYPE OF A POWER STICK

- RHU with electrically simulated radioisotope heat source
- prototype thermal vacuum jacket
- thermoelectric converter module
- rechargeable LiTiS2 AA batteries
- microchip DC-DC converter

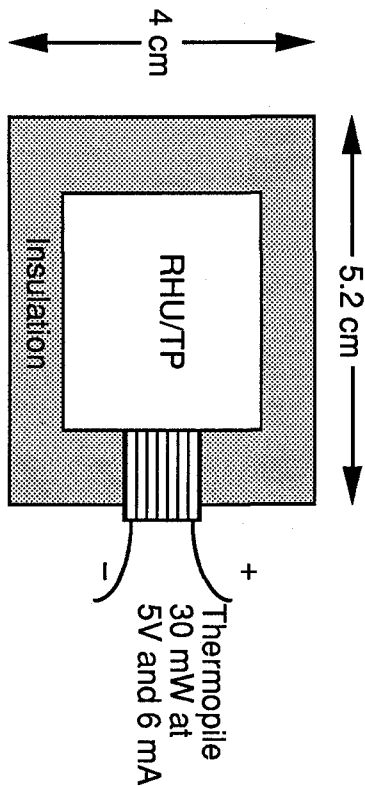
DEVELOPMENT PLAN:

- perform preliminary design, radiation, magnetic estimates
- fabricate case, insulation, support system; procure batteries, RHU, TE converter, microchip DC-DC converter
- vacuum test to verify power and thermal performance

RESOURCES NEEDED:

| | | | |
|-------------------------|------|---------------------|-------|
| design engineer | 0.25 | battery procurement | \$2k |
| structural engineer | 0.1 | RHU and heater | \$3k |
| thermal engineer | 0.1 | TE converter | \$30k |
| battery consultation | 0.05 | case fabrication | \$4k |
| launch approval consul. | 0.05 | insulation package | \$10k |
| power distribution | 0.05 | instrumentation | \$2k |
| test engineer | 0.1 | support structure | \$15k |

POWER STICK CONCEPT



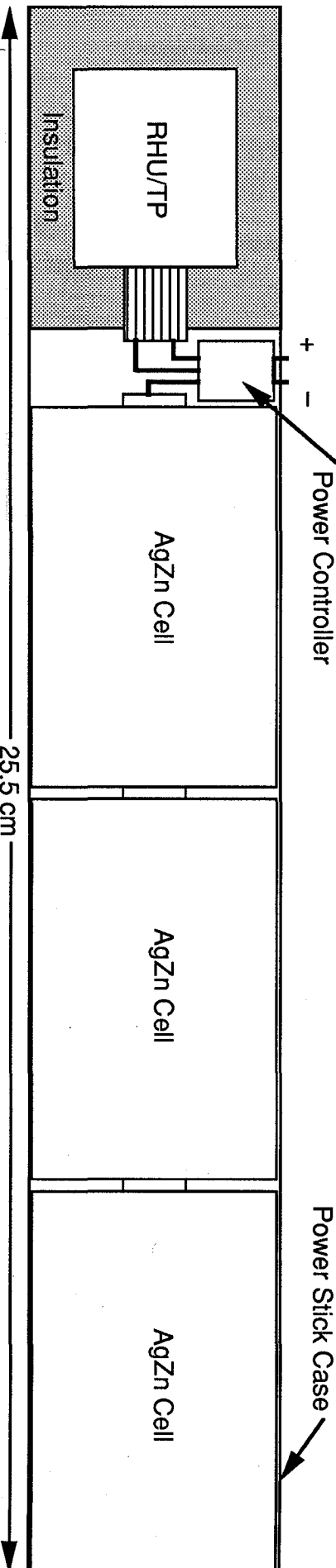
Radioisotope Heater Unit/Thermopile (RHU/TP) provides power to recharge the battery. The battery provides power for intermittent operation of a transmitter.

Battery recharge time is 15.3 days for every hour of battery discharge.

The three cell AgZn battery will provide 10W at 4.5V and 2.22A for up to 3 hours.

Mass:

| | |
|--------------|-------------|
| Battery | 240 g |
| RHU/TP | 80 |
| Other | 80 |
| Total | 400g |



Growin,

Here is a concept

For the "Power Stick". Just don't tell our Li-Battery people that it uses AgZn batteries (they are required since they allow very slow charge rates)

-Mark

Battery Details:
Three AgZn cells from Yardney

Cell Characteristics:
6A-h nominal capacity
Discharge: 2.2 A and 1.5 V
Dimensions: 6.45x4.01x1.63 cm
Mass: 79.4 g