RESEARCH REPORT

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PROJECT STATUS REPORT #2 : Test Building Instrumentation
Cooperative Agreement # DE-FC02-80CS30367.A003
BUTLER MANUFACTURING COMPANY
HEATING/DAYLIGHTING PROTOTYPE DEVELOPMENT, Phase II
Passive and Hybrid Solar Manufactured Building Project

covering research conducted during the period 16 Apr 80 - 16 Mar 81

23 March 1981

by Lawrence L. Lindsey
Princeton Energy Group

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Test Building instrumentation is nearly complete, following delays resulting from several causes: sensor failure due to unexpected moisture problems; slow delivery of critical electronic parts for the data acquisition system (DAS); unexpected technical problems in fabrication of solar components.

Thermistors and fan-bladed flow meters were installed during rockbed and slab installation. Flow meters were subsequently performance tested and determined to have failed due to water damage, requiring redesign for an alternate means of measuring air flow in below-slab locations. Hot wire anemometers (of a type not available at reasonable cost when the DAS was originally designed) were selected for this purpose.

Project subcontractor Princeton Energy Group began design and prefabrication of DAS components at project inception, and has only recently achieved substantial completion of the hardware and monitoring software. The attached trip report by Jack Cooper of PEG documents DAS delivery, bench test and initial system instruction with Butler Research Center staff. The delay in DAS fabrication has resulted primarily from slow delivery of required electronics. The system also involves some techniques not previously tried at this scale using the Commodore PET/CBM™ microprocessor control. Several unexpected and time-consuming hardware problems had to be solved during the course of system fabrication.

The test building itself is not yet complete, due to delays in construction of prototype solar components, particularly the insulating/reflecting shutters designed for use in the roof aperture. The operating mechanism originally conceived was abandoned due to excessive cost; redesign ultimately involved changes in shutter operating modes, and additional calculations were required to assure that these changes would not harm system performance. Several other detailing problems involving resilient seals, fans and ductwork, lighting and mechanical controls, were encountered during test building erection, requiring additional design and trial fabrication time. Due to the necessity of occupying the building at an early date, the installation of solar components has been slower than expected. Solar building elements are now 95% complete, and should be fully operational by mid-April.

Sensor connections and final DAS tests are underway, and will be completed as soon as solar components are functioning. Performance monitoring will begin immediately thereafter.

10 March 1981

Bill Sanders and Larry Krueger
Butler Manufacturing Company Research Center
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INSTRUMENTATION TRIP REPORT

Trip to: Butler Research Center, Grandview, MO

Date: 25 - 27 February 1981

Purpose: installation of Data Acquisition System, Roof and Roll Runner Building

25 February 81

DAS and Commodore PET™ microcomputer controller were shipped from Princeton via Airborne on 24 Feb 81. Larry Lindsey and Jack Cooper of PEG arrived at Butler Research Center on the morning of 25 February. DAS and PET™ were delivered in the early afternoon; visual inspection revealed no apparent damage during shipment.

During the morning Cooper and Lindsey conferred with Bill Sanders and Larry Krueger, Butler technical personnel in charge of project instrumentation and data collection at the Research Center. Topics discussed were:

- 1) general status of completion: DAS hardware and software, test building construction;
- 2) distribution of labor and responsibility, key tasks, anticipated levels of effort, schedule constraints;
- 3) specific technical issues: monitoring of electrical and gas consumption, monitoring door and shutter position, and current status of sensor installation in the test building.

The following decisions and conclusions were reached:

ELECTRICAL CONSUMPTION will be monitored in three functional categories: lighting, air conditioning, and total. Meters will be GE model IW-70-S (mechanical switch type). Bill Sanders will purchase and install meters; Jack Cooper will adjust meters on a subsequent trip. The difference in power consumption of the blower between air conditioning and heating modes will be handled by recording lapsed time of blower motor operation at the air conditioning speed.

GAS CONSUMPTION will be monitored with optical coupler output equipment to be purchased and installed by Bill Sanders.

DOOR POSITION will be monitored with magnetic switches such that the circuit will close when a door is open. The personnel door between Warehouse and main building will be monitored, rather than that between Office and Maintenance spaces. Bill Sanders is handling procurement and installation.

Sanders and Krueger, Butler Research Center
10 March 1981, page 2

SHUTTER POSITION will be monitored using switches, by recording time spent in Full North and Full South positions. In the event of later desire for performance tests in intermediate positions, or if shutter operating system tests require intermediate travel data, linear pots may be added. They would be connected to spare Hi-Level Analog channels in the DAS. Switch procurement and installation is being handled by Bill Sanders.

SENSOR INSTALLATION including connection of underground thermistors, placement and connection of above-ground thermistors, and fabrication of a stand for the PET/DAS equipment, are to proceed as quickly as feasible within schedule constraints of Bill Sanders' and Larry Krueger's other test responsibilities. Items ordered by Butler but not yet received are: weather instrument shelter and mast; Watt-hour meters; gas meter. Cooper, Lindsey and other PEG staff are available on call for any assistance needed by Sanders/Krueger, including actual labor on electronics installation, if required for reasons of time conflict with other ongoing work at the Center.

26 February 81

Cooper reviewed DAS literature and draft documentation with Sanders and Krueger. A complete package of current written material was transmitted, including program listings, manufacturer data sheets and instruction manuals, design notes, tables and wiring schedules, and schematic diagrams (itemization attached). Some items were in preliminary form, transmitted at this time only to provide basis for project communications pending the completion of better quality presentations. Cooper is to continue revising, expanding and clarifying these materials, forwarding all updated versions to Sanders immediately upon completion.

Set-up of the DAS for bench checkout was completed, and Cooper began detailed review of system design and operating principles with Bill Sanders and Larry Krueger.

27 February 81

Bench checkout using program "Diag-3.5-PEG" was completed. Three component failures were noted:

1. Card #8, upper rack (Thermistor MUX Card)
2. Card #14, upper rack (Hi-Level A-D Converter Card)
3. Card #20, upper rack (Hotwire Anemometer Card)

Sanders and Krueger, Butler Research Center
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Spares were substituted for Card #8 and #14. Krueger and Cooper diagnosed Card #20 as a failure of the transistor controlling the probe switching relay. Krueger is to obtain and substitute a spare, and report to Cooper.

With the exception of switching of hotwire anemometer probes, the PET/DAS were left up and operating in bench test condition as in Princeton before shipping. Cards #8 and #14 were brought back to Princeton for service and failure analysis by Cooper.

A subsequent instrumentation trip involving Cooper and other PEG staff will be scheduled when sufficient progress has been made on sensor installation and receipt of outstanding items of equipment, to allow enough final hookup and testing to warrant the expense of a trip. Additional trips by PEG staff prior to final hookup will be made if required to assist installation, upon request by Bill Sanders. Meanwhile, any problems which may arise will be communicated by phone.

Respectfully submitted,

A handwritten signature in cursive script that reads "Jack B. Cooper". The signature is written in dark ink and is positioned above the typed name and address.

Jack B. Cooper
Princeton Energy Group
cc: M.Snyder, L.Lindsey

PROGRAM LISTINGS

DRAFT COPIES TRANSMITTED 26 FEB 81

DAS-3.1-PEG	current running program
DIAG-3.8-PEG	various system diagnostic routines
DIAG-3.7-PEG	
DIAG-3.6-PEG	
DIAG-3.5-PEG	
#11 - DIAG	program to check A-D converter w/ & w/o analog multiplex

MFR SPEC DATA

TRANSMITTED 26 FEB 81

SCIENCE ASSOCIATES, INC.	666A Solar Radiation Integrator	9pp
TELEDYNE HASTINGS-RADIST	Hastings Air Meter Instruction Manual	12pp
CONNECTICUT MICROCOMPUTER	ADA 1200 RS-232 interface	7 items incl. warranty card
SEMICONDUCTOR CIRCUITS	UPS cut sheet (cat. pg. 24)	1p
NATIONAL SEMICONDUCTOR	Adjustable Current Sources	8pp
COMMODORE	Your Model C2N Cassette Operating Instructions	11-page booklet
INTERIL	ICL 7109 12 Bit Binary A/D Converter	16pp

JBL NOTES, TABLES, DIAGRAMS

TRANSMITTED 26 FEB 81

CARD SLOT ASSIGNMENTS	1p
THERMISTOR WIRING - BACK PANEL TO UPPER RACK	5pp
COUNTER-TIMER CARD WIRING (BACK PANEL TO LOWER RACK)	4pp
BUTLER BUFFER ASSIGNMENTS	1p
C/T CARD SWITCH POSITION TEST	1p
BUTLER HI-LEVEL CHANNEL ASSIGNMENTS	1p
BUTLER COUNTER-TIMERS CHANNEL ASSIGNMENTS	1p
COUNTER-TIMER CARD SCHEMATIC	1 blueprint
DAS. PWR (terminal strip on back panel)	1p
UPPER RACK BUSSING (CARD TO CARD BUSSING) & LOWER RACK BUSSING	4pp
BOTTOM RACK WIRING - BUS TO BUS	1p
TOP RACK WIRING - CARD TO CARD	4pp
RACK TO RACK WIRING (TOP & BOTTOM)	2pp
MISC. 12-TERM STRIPS - BACK PANEL TO BOTTOM RACK	1p
PET TO DAS CABLE (2/81)	1p
BUTLER EQUIV ADDRESSES	1p
BACK PANEL POWER MONITORING	1p

JBL NOTES, TABLES, DIAGRAMS (cont'd)

BUTLER WIND DIRECTION & HUMIDITY TO BACK PANEL

BUTLER BACK PANEL

9200175

COLOR CODING FOR ALL MICRO RIBBON CONN. (EXCEPT *PET*)
36-pin connectors 57-30360, 57-40360

COLOR CODING FOR ALL MICRO RIBBON CONN. (EXCEPT *PET*)
57-30240, 57-40140

COLOR CODING FOR ALL MICRO RIBBON CONN. (EXCEPT *PET*)
24-pin connectors 57-30240, 57-40240

PET BUFFER CARD

RS-232 TO 20 mA Current Loop Converter 11/80

THERMISTOR MULTIPLEXER DECODER CARD 9/80

PET BATTERY CABLE CONNECTIONS

PHOTO-TRANSISTOR LIGHT CHOPPER CIRCUIT

15 V. PRECISION SUPPLY WITH 67.2 mA "I" SUPPLY 8/80

CTC MULTIPLEXER

SOLAR RADIATION INTEGRATOR CARD 11/80

THERMISTOR ANALOG MULTIPLEXER CARD

A/D CONVERTER CARD (HI LEVEL ANALOG)

A/D CONVERTER CARD

CONTROL PANEL WIRING 1/15/81

ANEMOMETER CIRCUIT CARD (REV. 2, 1/15/81)

SOLAR RADIATION INTEGRATOR CARD (REV. 11/80)

1p

1p

1p

1p

1p

1p

2pp

1p

1p

1p

1p

1p

2pp

1p

1p

1p

1p

1p

1p

1p