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## FSA's FUTURE ROLE

JET PROPULSION LABORATORY

W.T. Callaghan ✓

Future Role

### • OBJECTIVES

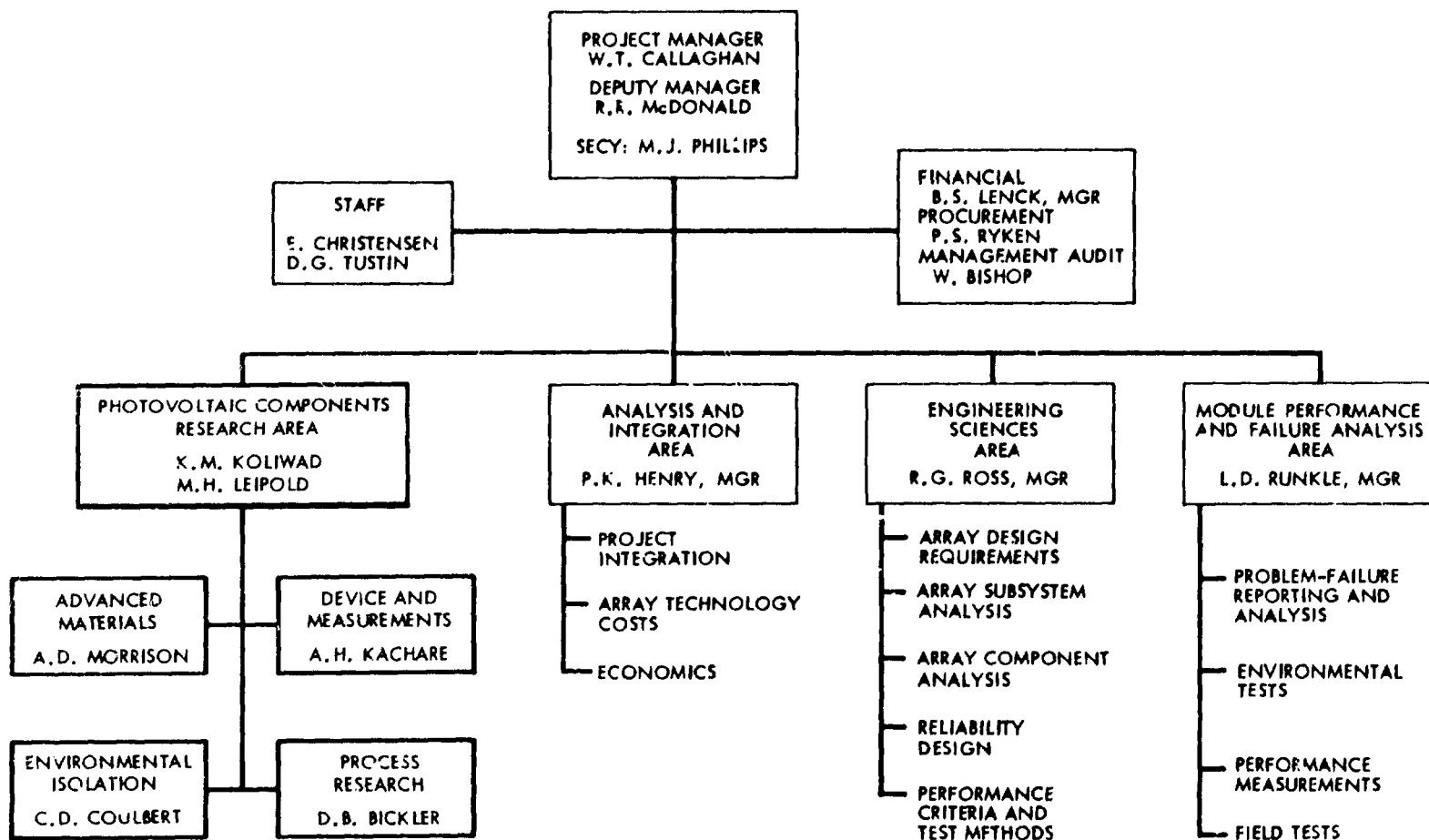
- TO PURSUE ADVANCED CRYSTALLINE SILICON PV TECHNOLOGIES FOR POTENTIAL USE LATE IN THE 1980s AND IN THE 1990s
- TO CONTINUE SPONSORSHIP OF RESEARCH AND TECHNOLOGY EVOLUTION ON ADVANCED THICK-MATERIAL FLAT-PLATE PHOTOVOLTAIC MODULES AND ARRAYS
- TO COMMENCE THE ACTIVITIES REQUIRED TO MOVE THIN-FILM TECHNOLOGIES INTO MODULE DEVELOPMENT
- TO CONTINUE TO STIMULATE TRANSFER OF KNOWLEDGE THROUGHOUT THE PHOTOVOLTAIC COMMUNITY

### Project Plans

- TO SPONSOR TECHNOLOGY ACTIVITIES THAT HAVE THE POTENTIAL FOR MAKING MODULES/ARRAYS VIABLE FOR LARGE-SCALE APPLICATIONS, SUCH AS CENTRAL STATIONS AND ROOF-TOPS
- TO STRIVE FOR HIGH EFFICIENCY COUPLED WITH SIGNIFICANT COST REDUCTION FOR LOWEST POWER GENERATION COSTS
- TO REDUCE TECHNICAL BARRIERS TO HIGH-PERFORMANCE, LONG-LIFE, RELIABLE MODULES AND ARRAYS
- TO CONTINUE TO FUND UNIVERSITIES, INDUSTRY, AND OTHER ORGANIZATIONS FOR PERFORMANCE OF MOST OF THE WORK
- TO CONTINUE ECONOMIC ANALYSIS TECHNIQUES FOR COMPARISON OF ALTERNATIVE RESEARCH OPTIONS

# FLAT-PLATE SOLAR ARRAY PROJECT

PLENARY SESSION: W.T. CALLAGHAN



New Task Objectives

**TO EXTEND OUR KNOWLEDGE AND CAPABILITIES TO USE THE FOLLOWING TECHNOLOGIES FOR PHOTOVOLTAIC COMPONENTS:**

- **ADVANCED MATERIALS (A.D. MORRISON)**  
SILICON AND NON-SILICON MATERIAL SYNTHESIS,  
PREPARATION AND SHEET GROWTH FOR PHOTOVOLTAIC  
DEVICES
  
- **DEVICE AND MEASUREMENTS (A.H. KACHARE)**  
DEVICE STRUCTURE, MATERIAL-DEVICE PROPERTY  
INTERACTION, SILICON AND NON-SILICON DEVICE  
PHYSICS, MEASUREMENT TECHNIQUES FOR PHYSICAL,  
CHEMICAL AND ELECTRICAL EVALUATION, AND  
MATERIAL CHARACTERIZATION
  
- **ENVIRONMENTAL ISOLATION (C.D. COULBERT)**  
ENCAPSULATION MATERIAL FORMULATION, PROPERTIES,  
LIFE-LIMITING DEGRADATION MECHANISMS, MODULE  
DURABILITY, PERFORMANCE PREDICTABILITY,  
ASSESSMENT METHODOLOGIES AND ADVANCED  
PACKAGING CONCEPTS FOR SILICON AND NON-SILICON  
DEVICES
  
- **PROCESS RESEARCH (D.B. BICKLER)**  
RESEARCH IN SILICON AND NON-SILICON PROCESS  
ELEMENTS SUCH AS SURFACE PREPARATION, JUNCTION  
FORMATION, METALLIZATION, ANTI-REFLECTION  
COATING, AND SYNERGISTIC EFFECTS OF THESE STEPS  
ON CELL AND MODULE FABRICATION

## Objectives and Plans

### SILICON MATERIAL

#### OBJECTIVE

SPONSOR THEORETICAL AND EXPERIMENTAL RESEARCH ON SILICON MATERIAL REFINEMENT TECHNOLOGY SUITABLE FOR FLAT PLATE SOLAR ARRAYS

#### PLANS

- CONDUCT RESEARCH IN NEW REACTOR CONCEPTS THAT ENABLE SIGNIFICANT INCREASES IN SILICON DEPOSITION RATES USING CHLOROSILANE AND SILANE PRECURSORS
- CONDUCT RESEARCH IN NEW CONCEPTS FOR FLUIDIZED BED REACTOR TECHNOLOGY FOR CHLOROSILANE OR SILANE CHEMICAL SYSTEMS
- COMPLETE ONGOING EFFORTS TO RESOLVE THE KEY CRITICAL TECHNICAL PROBLEMS REMAINING IN THE SILANE TO SILICON AND THE DICHLOROSILANE TO SILICON PROCESSES

### SILICON SHEET

#### OBJECTIVE

CONDUCT RESEARCH ON THE CRITICAL ELEMENTS OF SILICON SHEET GROWTH TO ACHIEVE THE TARGETS OF A SILICON SHEET TECHNOLOGY COMPATIBLE WITH FUTURE SOLAR CELL REQUIREMENTS

#### PLANS

- PERFORM RESEARCH ON THE LIMITS TO CRYSTALLIZATION RATES IN SILICON GROWTH
- PERFORM THEORETICAL AND EXPERIMENTAL RESEARCH ON THERMAL STRESSES GENERATED IN THE GROWTH OF WIDE AND THIN SILICON RIBBONS
- PERFORM RESEARCH TO FURTHER UNDERSTANDING OF THE INFLUENCE OF GROWTH AMBIENT ATMOSPHERE CHEMISTRY ON THE CRYSTALLIZATION PROCESS AND SILICON MATERIAL QUALITY
- CONTINUE RESEARCH ON THE BASIC MECHANISMS OF CUTTING SILICON AND THE INTERACTION OF SILICON SURFACES WITH EXPERIMENTAL PARAMETERS
- CONTINUE CHARACTERIZATION OF SILICON SHEET MATERIAL WITH INNOVATIVE TECHNIQUES

### CELL AND MODULE FORMATION

#### OBJECTIVE

SPONSOR RESEARCH ON ADVANCED CELL AND MODULE FORMATION TECHNIQUES

#### PLANS

- CONDUCT RESEARCH IN THE FORMATION AND CHARACTERIZATION OF ELECTRICALLY CONDUCTIVE SILICIDES
- CONDUCT RESEARCH ON THE INFLUENCE OF POLYCRYSTALLINE GRAIN BOUNDARIES UPON JUNCTION FORMATION AND METALLIZATION
- PERFORM RESEARCH ON THE PHYSICS OF SURFACE FIELD FORMATION
- PERFORM RESEARCH ON THE PHYSICS OF CORROSION REACTIONS AT METALLIC INTERFACES
- CONTINUE RESEARCH ON NON MASS ANALYZED ION IMPLANTATION TECHNIQUES, METALLIZATION AND CELL INTERCONNECTION SYSTEMS AND MODULE ASSEMBLY TECHNIQUES

### ENVIRONMENTAL ISOLATION

#### OBJECTIVE

SPONSOR RESEARCH ON AGING DEGRADATION CHARACTERISTICS AND THEIR INFLUENCE UPON MODULE DURABILITY AND RELIABILITY

#### PLANS

- CONDUCT RESEARCH IN LONG TERM PHOTOTHERMAL DEGRADATION MECHANISMS IN POLYMERS, ESTABLISH MODELS AND VALIDATE
- INVESTIGATE ENCAPSULANT INTERFACE STABILITY CRITERIA AS AFFECTED BY BONDING TECHNIQUES, DISSIMILAR MATERIALS, AND OPERATIONAL ENVIRONMENTS
- CONDUCT RESEARCH IN CORROSION MECHANISMS IN MODULE INTERNAL CIRCUIT ELEMENTS, VERIFY DEGRADATION RATES AND CONTROL CRITERIA
- INVESTIGATE OPERATING TEMPERATURE LIMITATIONS IMPOSED BY MODULE DESIGN AND MOUNTING, AND HOT SPOT SENSITIVITY
- INVESTIGATE AND APPLY ACCELERATED AND DURABILITY TESTING TECHNIQUES AND LIFE PREDICTION METHODS

### ENGINEERING SCIENCES

#### OBJECTIVE

SPONSOR RESEARCH ON ADVANCED MODULE AND ARRAY ENGINEERING SCIENCE ACTIVITIES THAT WILL LEAD TO HIGH PERFORMANCE, SAFE, RELIABLE LONG LIFE DESIGNS

#### PLANS

- CONTINUE THEORETICAL AND EXPERIMENTAL RESEARCH TO CHARACTERIZE AND DEFINE SAFE, RELIABLE MODULE AND ARRAY DESIGN CONCEPTS AND ASSOCIATED TECHNOLOGY
- CONTINUE TO EVOLVE ANALYTICAL AND EXPERIMENTAL METHODS OF EVALUATING MODULES AND ARRAYS INCORPORATING EXPERIENCE GAINED BY THE PROJECT AND JOE ACTIVITIES

### MODULE PERFORMANCE AND FAILURE ANALYSIS

#### OBJECTIVE

EVALUATE RELIABILITY AND DURABILITY OF MODULES THAT USE MATERIALS AND TECHNIQUES RESEARCHED IN THE PROJECT THROUGH A STRUCTURED PROGRAM

#### PLANS

- PROCURE MODULE SAMPLES CONSTRUCTED USING INNOVATIVE CONCEPTS
- MEASURE PERFORMANCE CHARACTERISTICS
- IMPLEMENT MEASUREMENT TECHNIQUES NEEDED TO ASSESS MODULE PERFORMANCE IN RESPONSE TO EVOLVING REQUIREMENTS
- PERFORM A BROAD PROGRAM OF ENVIRONMENTAL TESTING IN THE LABORATORY
- PLACE MODULES IN FIELD SITES FOR ENDURANCE TESTING
- CORRELATE FIELD AND LABORATORY TESTING RESULTS TO EVALUATE THE ENVIRONMENTAL TESTING PROGRAM
- PERFORM DIAGNOSTIC ANALYSES OF MODULE PROBLEMS OR FAILURES

FSA Project Meetings

- **REDUCE NUMBER OF PIMS PER YEAR**
  - **TWO IN 1982**
  - **ONE OR TWO IN 1983**
- **CONDUCT IN-DEPTH TECHNICAL WORKSHOPS**
  - **LOW-COST SOLAR ARRAY WAFERING WORKSHOP** **JUNE 1981**
  - **SCIENCE OF SILICON MATERIAL PREPARATION** **AUGUST 1982**
  - **HIGH-SPEED GROWTH AND CHARACTERIZATION OF CRYSTALS FOR JUNCTION CELLS** **NOVEMBER 1982**

Possible Workshops During 1983

- **HIGH-EFFICIENCY CRYSTALLINE SILICON SOLAR CELLS**
- **METALLIZATION FOR HIGH-EFFICIENCY, LONG-LIFE CELLS**
- **ENCAPSULATION MATERIAL TECHNOLOGY FOR SOLAR CELL MODULES**
- **TEMPERATURE/HUMIDITY AND ELECTROCHEMICAL CORROSION EFFECTS ON CELL AND MODULE DEGRADATION**
- **CENTRAL-STATION ARRAY DESIGN CRITICAL PARAMETERS**
- **ROOF-TOP ARRAY DESIGN CRITICAL PARAMETERS**
- **ARRAY/POWER CONDITIONER ELECTRICAL INTERFACE DESIGN**