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The Department of Defense

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Defense Advanced Research Projects Agency



Defense Nuclear Agency



Strategic Defense Initiative Organization

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DEFENSE SMALL BUSINESS INNOVATION RESEARCH PROGRAM (SBIR)

VOLUME IV DEFENSE AGENCIES ABSTRACTS OF PHASE I AWARDS 1988

VOLUME IV

**DEFENSE AGENCY PROJECTS
ABSTRACTS OF PHASE I AWARDS
FROM
FY 1988 SBIR SOLICITATION**

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May 1989

PREFACE

On September 1, 1988 Secretary of Defense Frank C. Carlucci announced the selection of small business firms proposals under Phase I of the Fiscal Year (FY) 1988 Department of Defense (DoD) Small Business Innovation Research (SBIR) Program to be funded upon successful completion of contract negotiations.

The selection of proposals for funding was made from proposals received by the Military Departments, the Defense Advanced Research Projects Agency (DARPA), the Defense Nuclear Agency (DNA), and the Strategic Defense Initiative Organization (SDIO) in response to the FY 1988 solicitation distributed on October 1, 1987 with a closing date of January 8, 1988.

FY 1988 Program

	<u>Number of Topics</u>	<u>Proposals Received</u>	<u>Phase I Awards</u>
Army	234	2426	214
Navy	250	2022	249
Air Force	242	2740	375
DARPA	38	555	61
DNA	8	187	19
SDIO	<u>15</u>	<u>730</u>	<u>138</u>
	787	8660	1056

In order to make information available on the technical content of the Phase I projects supported by the Department of Defense SBIR Program, this report presents, in four volumes, the abstracts of those proposals which have resulted in contract awards.

This is Volume IV which contains abstracts and contacts for the 218 Phase I projects funded by the three participating Defense Agencies (61 DARPA projects, 19 DNA projects and 138 SDIO projects). Projects funded by the Military Services are published in separate volumes as follows:

- Volume I - Army Projects (Pages 1 - 130)
- Volume II - Navy Projects (Pages 131 - 289)
- Volume III - Air Force Projects (Pages 290 - 525)

Venture capital and large industrial firms that may have an interest in the research described in the abstracts in this publication are encouraged to contact the SBIR firm whose name and address is shown.



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INTRODUCTION

On July 22, 1982 the President signed the "Small Business Innovation Development Act of 1982" (Public Law 97-219). This law became effective October 1, 1982 and was designed to give small high technology firms a greater share of Federal R&D contract awards.

The SBIR Program consists of three distinct phases. Under Phase I, DoD Components make awards to small businesses, typically of one-half to one man-year effort over a period generally not to exceed six months, subject to negotiation. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas or concepts submitted in response to SBIR topics. All DoD topics address specific R&D needs to improve our defense posture. Proposals selected for contract award are those which contain an approach or idea that holds promise to provide an answer to the specific problem addressed in the topic. The successful completion of Phase I is a pre-requisite for further DoD support in Phase II.

Phase II awards will be made only to firms on the basis of results from the Phase I effort, and the scientific and technical merit of the Phase II proposal. In addition, proposals which identify a follow-on Phase III funding commitment from non-Federal sources will be given special consideration. Phase II awards will typically cover two to five man-years of effort over a period generally not to exceed 24 months, also subject to negotiation. The number of Phase II awards will depend upon the success rate of the Phase I effort and availability of funds. Phase II is the principal research or research and development effort, and will require a more comprehensive proposal which outlines the intended effort in detail.

Phase III is expected to involve private-sector investment and support for any necessary development that will bring an innovation to the marketplace. Also, under Phase III, DoD may award follow-on contracts not funded by the SBIR Program for products or processes meeting DoD mission needs.

Selection Criteria

Phase I proposals received in each topic area in the DoD solicitation brochure are evaluated on a competitive basis in the organization which generated the topic, by scientists and engineers knowledgeable in that area and in accordance with the following criteria:

1. The scientific/technical quality of the research proposal and its relevance to the topic description, with special emphasis on its innovation and originality.
2. Qualifications of the principal investigator, other key staff, and consultants, if any, and the adequacy of available or obtainable instrumentation and facilities.

3. Anticipated benefits of the research to the total DoD research and development effort.

4. Adequacy of the Phase I proposed effort to show progress toward demonstrating the feasibility of the concept.

The Act mandates that all Federal Agencies establish an SBIR program if their FY 1982 extramural budgets for R&D exceeded a threshold figure of \$100 million. Beginning in FY 1983, DoD must make available the following percentages of its extramural R&D budget for this program:

	<u>FY 1983</u>	<u>FY 1984</u>	<u>FY 1985</u>	<u>FY 1986</u>	<u>FY 1987</u>	<u>FY 1988</u>
Percentage	0.1	0.3	0.5	1.0	1.25	1.25
Estimated Dollars	16.7M	43M	79M	150M	202M	221M
Actual Awarded Dollars	20.6M	44.6M	78.2M	150.7M	202M	221M

FY 1983 Program

	<u>Number of Topics</u>	<u>Proposals Received</u>	<u>Phase I Awards</u>	<u>Phase II Awards</u>
Army	182	1121	98	43
Navy	131	944	66	47
Air Force	75	496	99	49
DARPA	8	128	12	7
DNA	<u>10</u>	<u>88</u>	<u>8</u>	<u>2</u>
	406	2777	283	148

1984 Program

	<u>Number of Topics</u>	<u>Proposals Received</u>	<u>Phase I Awards</u>	<u>Phase II Awards</u>
Army	111	758	81	35
Navy	146	859	99	52
Air Force	283	1208	162	73
DARPA	17	107	15	7
DNA	<u>8</u>	<u>80</u>	<u>12</u>	<u>1</u>
	565	3012	369	168

FY 1985 Program

	<u>Number of Topics</u>	<u>Proposals Received</u>	<u>Phase I Awards</u>	<u>Phase II Awards</u>
Army	111	808	124	68
Navy	138	851	110	62
Air Force	218	1306	249	120
DARPA	17	130	13	6
DNA	7	95	18	6
SDIO	<u>18</u>	<u>415</u>	<u>36</u>	<u>16</u>
	509	3605	550	278

FY 1986 Program

	<u>Number of Topics</u>	<u>Proposals Received</u>	<u>Phase I Awards</u>	<u>Phase II Awards</u>
Army	225	1643	244	92
Navy	190	1222	225	87
Air Force	304	1795	307	138
DARPA	22	177	42	11
DNA	7	171	46	10
SDIO	<u>12</u>	<u>552</u>	<u>154</u>	<u>53</u>
	760	5560	1018	391

FY 1987 Program

	<u>Number of Topics</u>	<u>Proposals Received</u>	<u>Phase I Awards</u>	<u>Phase II Awards</u>
Army	330	2402	331	119
Navy	263	2004	286	74
Air Force	241	1863	351	64
DARPA	33	395	59	11
DNA	8	200	25	3
SDIO	<u>14</u>	<u>672</u>	<u>212</u>	<u>39</u>
	889	7536	1264	310

Public Law 99-443, the "Small Business Innovation Act of 1986" was signed by the President on October 6, 1986. This law re-authorized P.L. 97-219 to extend the "Sunset Clause" to 1993; to continue 1.25 percent taxation of the extramural research and development budget; and excludes from taxation those amounts of the DoD research and development budget obligated solely for operational systems development.

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM - PHASE 1
BY SERVICE
FISCAL YEAR 1988
DARPA

PAGE 526

SUBMITTED BY

ADVANCED COMPOSITE ENGINEERING INC
350 SAGAMORE PKWY - STE 6
WEST LAFAYETTE, IN 47906

CONTRACT NUMBER:

DR C T SUN

TITLE:

DEVELOPMENT OF A NEW BERYLLIUM/GRAPHITE-EPOXY SANDWICH COMPOSITE
TOPIC# 19 OFFICE: NASP IDENT#: 22821

MAJOR TECHNOLOGICAL ADVANCES IN MATERIAL ENGINEERING WILL BE REQUIRED IN ORDER TO MEET THE INCREASINGLY STRINGENT CONSTRAINTS OF HIGH STIFFNESS AND LOW WEIGHT STRUCTURAL MATERIALS FOR AEROSPACE VEHICLES. SIGNIFICANT EFFORT IS BEING SPENT ON DEVELOPING NEW EXOTIC METAL ALLOYS AND COMPOSITE MATERIALS IN AN ATTEMPT TO SATISFY THE STATED CHALLENGE. AN ALTERNATE APPROACH TO BE CONSIDERED IS THE CREATION OF A NEW MATERIAL BY THE COMBINATION OF TWO EXISTING 'PROVEN' STRUCTURAL MATERIALS, BERYLLIUM AND GRAPHITE-EPOXY. THE OBJECTIVE OF THE PROPOSED RESEARCH IS TO CONSTRUCT A SANDWICH COMPOSITE CONSISTING OF DISTINCT ALTERNATING LAYERS OF BERYLLIUM AND GRAPHITE-EPOXY. THE MECHANICAL PROPERTIES OF THE NEW SANDWICH LAMINATE WILL BE MEASURED EXPERIMENTALLY AND COMPARED TO THE INDIVIDUAL MATERIALS. THEORETICAL MODELS WILL ALSO BE DEVELOPED FOR PREDICTING THE MECHANICAL PROPERTIES OF THE NEW LAMINATE.

ADVANCED DECISION SYSTEMS
201 SAN ANTONIO CIR - STE 286
MOUNTAIN VIEW, CA 94040

CONTRACT NUMBER:

DR JAMES R GREENWOOD

TITLE:

A PROCEDURAL REASONING LANGUAGE FOR REAL-TIME MISSION PLANNING
TOPIC# 20 OFFICE: ASTO IDENT#: 22513

THE PRIMARY FOCUS OF THE RESEARCH IS TO DESIGN AND DEVELOP A CONCURRENT GOAL-DIRECTED PROGRAMMING LANGUAGE THAT IS SUITABLE FOR EMBEDDED SYSTEM REAL-TIME MISSION PLANNING. THIS LANGUAGE IS DESIGNATED THE PROCEDURAL REASONING LANGUAGE (PRL) SINCE IT MIXES TRADITIONAL PROGRAMMING LANGUAGE FEATURES WITH GOAL-DIRECTED REASON-

SUBMITTED BY

ING CONSTRUCTS IN A PROCEDURAL FORMAT. PRL IS A VISUAL PROGRAMMING LANGUAGE THAT ALLOWS THE EXPLICIT REPRESENTATION OF GOAL-DIRECTED SEARCH AND CONCURRENT PROCESS CONTROL IN A GRAPHICAL FORMAT. THE PRL COMPILATION SYSTEM TRANSLATES THIS GRAPHICAL PROGRAM INTO ADA CODE FOR SUBSEQUENT COMPILATION TO TARGET EMBEDDED SYSTEMS. THE LANGUAGE IS PARTICULARLY SUITABLE FOR ENCODING COMPLEX PLANNING SYSTEMS WHERE PERFORMANCE AND PREDICTABILITY ARE IMPORTANT.

ADVANCED DECISION SYSTEMS
201 SAN ANTONIO CIR - STE 286
MOUNTAIN VIEW, CA 94040
CONTRACT NUMBER:
DR THEODORE LINDEN

TITLE:
TRANSFORMATIONAL SYNTHESIS AND REASONING ABOUT THE FUTURE
TOPIC# 30 OFFICE: ISTO IDENT#: 22860

TWO KEY PROBLEMS FOR BUILDING PRACTICAL YET GENERAL KNOWLEDGE-BASED PLANNING APPLICATIONS ARE 1) REPRESENTING THE PLAN AND 2) PROJECTING THE PROBABLE EFFECTS OF EXECUTING THE PLAN. BOTH OF THESE PROBLEMS REQUIRE TECHNIQUES FOR REASONING ABOUT THE FUTURE. THE REPRESENTATION AND THE PROJECTION PROBLEMS BOTH NEED TO BE SOLVED FOR THE PARTIAL AND ABSTRACT PLANS THAT WILL BE GENERATED AT INTERMEDIATE STAGES OF THE PLANNING PROCESSES AS GOALS AND CONSTRAINTS ARE EVOLVED TOWARD AN EXECUTIBLE PLAN. WE PROPOSE TO EXTEND OUR CURRENT TRANSFORMATIONAL SYNTHESIS METHODOLOGY TO INCLUDE GENERAL SOLUTIONS FOR THESE PROBLEMS. TRANSFORMATIONAL SYNTHESIS IS AN INSTANCE OF WHAT WE BELIEVE IS AN EMERGING CONSENSUS METHODOLOGY FOR INTEGRATING MULTIPLE PLANNING TECHNIQUES IN A WAY THAT ALLOWS THE MOST APPROPRIATE TECHNIQUES TO BE USED FOR EACH ASPECT OF THE APPLICATION PROBLEM. IN PARTICULAR, WE PROPOSE TO EXTEND THE PLAN REPRESENTATIONS USED IN PAST APPLICATIONS OF TRANSFORMATIONAL SYNTHESIS TO SUPPORT CONSTRAINT-BASED REASONING ABOUT DEPENDENCIES BETWEEN PLAN STEPS (INCLUDING TEMPORAL DEPENDENCIES) AND TO BE ABLE TO PROJECT THE EFFECTS OF PARTIAL AND ABSTRACT PLANS FOR THE CASE WHERE THE STATE SPACE REPRESENTATION HAS COMPLEX INTERNAL DEPENDENCIES. PROJECTION WILL HANDLE UNCERTAINTY IN KNOWLEDGE ABOUT THE WORLD SITUATION AND ABOUT THE EFFECTS OF THE PRIMITIVE OPERATIONS INVOLVED IN THE PLAN.

ADVANCED RSCH & APPLICATIONS CORP/ARACOR
425 LAKESIDE DR
SUNNYVALE, CA 94086
CONTRACT NUMBER:
DR JAMES H STANLEY

TITLE:
COMPUTED TOMOGRAPH: SENSOR FOR INTELLIGENT CARBON-CARBON PROCESS
TOPIC# 23 OFFICE: DSO IDENT#: 22522

SUBMITTED BY

CARBON-CARBON COMPOSITES ARE INCREASINGLY BEING EMPLOYED IN ADVANCED DOD SYSTEMS. THE LENGTH AND COMPLEXITY OF THE MANUFACTURING PROCESS OF THESE COMPONENTS TEND TO MAKE THE PARTS COSTLY AND THE YIELDS LESS THAN OPTIMAL. AN ONGOING DARPA PROGRAM AIMS AT DEVELOPING AN INTELLIGENT CONTROL SYSTEM WHICH INTEGRATES PROCESS MODELING, OPERATOR KNOWLEDGE, AND IN-PROCESS SENSORS TO IMPROVE THE RELIABILITY, DURATION, AND MATERIAL PROPERTY CONTROL OF THE CARBON-CARBON MANUFACTURING PROCESS. AS AN ADJUNCT, THE PROPOSED PROGRAM WILL EVALUATE X-RAY COMPUTER TOMOGRAPHY AS A MEMBER OF AN INTEGRATED TEAM OF IN-PROCESS SENSORS PROVIDING LOCAL MEASUREMENT OF MATERIAL PROPERTIES. COMPUTED TOMOGRAPHY'S UNIQUE ABILITY TO LOCALLY DETERMINE DIMENSIONAL, DENSITY, AND CHEMICAL COMPOSITIONAL MATERIAL PARAMETERS WILL BE ADAPTED TO THE CARBON-CARBON PROCESS ENVIRONMENT AND THE ARTIFICIAL INTELLIGENCE REQUIREMENTS OF THE INTELLIGENT PROCESSING STRATEGY OUTLINED BY THE ONGOING DARPA PROGRAM.

ADVANCED TECHNOLOGY MATERIALS INC
520-B DANBURY RD
NEW MILFORD, CT 06776
CONTRACT NUMBER:
DR WARD C STEVENS
TITLE:

INTERMETALLIC COMPOSITES
TOPIC# 25 OFFICE: DSO

IDENT#: 22622

INTERMETALLIC COMPOUNDS ARE KNOWN FOR THEIR HIGH MELTING POINTS AND CORROSION AND OXIDATION RESISTANCE. MANY OF THESE COMPOUNDS HAVE LOW DENSITIES AND VERY HIGH STRENGTHS AND, THEREFORE, ARE OF INTEREST FOR HIGH TEMPERATURE AEROSPACE AND SPACE STRUCTURE APPLICATIONS. HOWEVER, CONVENTIONAL PROCESSING OF INTERMETALLIC COMPOUNDS SUFFERS SEVERE LIMITATIONS: REACTIONS WITH CONTAINERS, POROSITY, CONTAMINATION OF POWDER SURFACES, AND COMPOSITIONAL INHOMOGENEITIES. RECENT WORK ON LOW TEMPERATURE CHEMICAL VAPOR DEPOSITION (CVD) OF METALS FROM ORGANOMETALLIC COMPOUNDS SUGGESTS THE POSSIBILITY OF FABRICATING CERTAIN INTERMETALLIC COMPOUNDS BY CVD. BECAUSE ORGANOMETALLIC CVD OPERATES AT LOW TEMPERATURE, EMPLOYS HIGHLY PURE STARTING MATERIALS, DEPOSITS MATERIAL UNIFORMLY, AND REQUIRES COMPARATIVELY LITTLE MATERIALS HANDLING, IT HAS THE POTENTIAL TO SOLVE THE PROBLEMS DE-

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SCRIBED ABOVE. IN THE PROPOSED PHASE I STUDY, APPROACHES FOR CHEMICALLY VAPOR DEPOSITING TITANIUM ALUMINIDE WILL BE EXAMINED. SUITABLE SOURCE REAGENTS FOR TITANIUM AND ALUMINUM WILL BE EXPLORED AND THEN SYNTHESIZED. STRATEGIES FOR CHEMICALLY VAPOR DEPOSITING THE INTERMETALLIC WILL BE DEVELOPED TO SYNTHESIZE TITANIUM ALUMINIDE FOR PHYSICAL PROPERTY CHARACTERIZATION.

ALPHATECH INC
111 MIDDLESEX TURNPIKE
BURLINGTON, MA 01803
CONTRACT NUMBER:

THOMAS KURIEN

TITLE:

PROCESSING ALGORITHMS FOR SENSORS FUSION IN VISIBLE/IR/RADAR
TOPIC# 13 OFFICE: STO IDENT#: 22702

THE OBJECTIVE OF THIS RESEARCH IS TO DEMONSTRATE THE FEASIBILITY OF FUSING DATA OBTAINED SIMULTANEOUSLY FROM VISIBLE, INFRARED AND RADAR SENSORS, TO PROVIDE A HERETOFORE UNOBTAINABLE SURVEILLANCE CAPABILITY. THE DIFFICULTIES ASSOCIATED WITH SENSOR FUSION WHICH WILL BE ADDRESSED INCLUDE THE DIFFERENT FIELDS OF VIEW, DIFFERENT MEASUREMENTS, DIFFERENT RESOLUTIONS, AND DIFFERENT POSITIONS AND VELOCITIES OF THE SENSORS, AS WELL AS ACCOUNTING FOR SCENE REGISTRATION ERRORS. ALPHATECH PROPOSES TO ADDRESS THESE PROBLEMS BY FIRST FORMULATING THE FUSION PROBLEM IN A MATHEMATICALLY CONSISTENT THEORETICAL FRAMEWORK, AND BY THEN ADDING THE HEURISTIC TECHNIQUES REQUIRED FOR A PRACTICAL IMPLEMENTATION. OUR APPROACH TO FUSION IS A MODEL-BASED APPROACH; THEREFORE, WE WILL FIRST DEVELOP MODELS OF THE SENSORS AND OF THE TARGETS OF INTEREST. THE NEXT STEP WILL BE TO EXTEND OUR EXISTING MULTISENSOR FUSION ALGORITHM, TAILORING IT TO THE SPECIFIC PROBLEM AT HAND. FINALLY, WE PLAN TO DEMONSTRATE THE ABILITY TO PERFORM DATA FUSION WITH SPATIALLY AND SPECTRALLY DIVERSE SENSORS, AND TO SHOW THE SYNERGISTIC BENEFITS OBTAINED BY FUSION IN DETECTING AND TRACKING DIFFICULT-TO-OBSERVE TARGETS.

AMERICAN MATRIX INC
PO BOX 23556
KNOXVILLE, TN 37933
CONTRACT NUMBER:
DR SAMUEL C WEAVER

TITLE:

DEVELOPMENT OF COATINGS FOR FIBERS INCORPORATED IN HIGH TEMPERATURE COMPOSITE MATERIALS
TOPIC# 24 OFFICE: DSO IDENT#: 22462

SUBMITTED BY

DARPA HAS IDENTIFIED A NEED FOR NEW AND IMPROVED TECHNIQUES FOR COATING CERAMIC FIBERS FOR SUBSEQUENT INCORPORATION INTO METALLIC, CERAMIC OR HYBRID MATRICES. AMERICAN MATRIX, INC.'S PHASE I PROGRAM ADDRESSES THE SIGNIFICANT PERFORMANCE ATTRIBUTES (DEFINED BY DARPA AS INTERFACE CHEMICAL REACTION INHIBITION, INTERFACE BOND DEVELOPMENT, AND TAILORED PROPERTIES) WITH A MULTI-FACETED COATING PROGRAM. SELECTING SiC DISCONTINUOUS FIBERS AS THE COATING VEHICLE, AMERICAN MATRIX WILL INVESTIGATE THE FEASIBILITY OF USING ORGANO-CHLOROSILANE COUPLING AGENTS, LIQUID PHASE METALORGANICS, AND SELECTED METALS AS COATING AGENTS. PROPRIETARY APPLICATION AND BONDING PROCESSES WILL BE USED TO APPLY THE COATINGS TO THE FIBRES. A COMPREHENSIVE EVALUATION PROGRAM WILL BE USED TO DETERMINE THE BEST COATING SYSTEM AND PERMIT SELECTION OF CANDIDATE SYSTEMS FOR A PHASE II DEVELOPMENT PROGRAM.

AMTEC ENGINEERING INC
11820 NORTHUP WY - #200
BELLEVUE, WA 98005
CONTRACT NUMBER:
KELTON M PEERY
TITLE:

A 3D NAVIER-STOKES FLOW ANALYSIS FOR A LARGE-ARRAY MULTIPROCESSOR
TOPIC# 28 OFFICE: ISTO IDENT#: 22613

COMPUTATIONAL FLUID DYNAMICS (CFD) CODES HAVE BECOME IMPORTANT DESIGN AND ANALYSIS TOOLS FOR ENGINEERS, PARTICULARLY IN THE AEROSPACE INDUSTRY. CFD CODES, HOWEVER, ARE SEVERELY LIMITED BY THE COMPUTING RESOURCES OF PRESENT-DAY SUPERCOMPUTERS. IT IS ESTIMATED THAT A THREE ORDER-OF-MAGNITUDE INCREASE IN COMPUTER SPEED IS NECESSARY FOR PERFORMING PRACTICAL ENGINEERING VISCOUS-FLOW ANALYSES OF FULL AIRCRAFT CONFIGURATIONS. SOME PRESENT SUPERCOMPUTERS HAVE NEARLY REACHED THE THEORETICAL LIMIT OF UNIPROCESSORS, MAJOR INCREASES IN COMPUTING SPEED WILL MOST LIKELY RESULT FROM PARALLEL PROCESSING. NEW ALGORITHMS MUST BE DEVELOPED FOR SOLVING THE CFD EQUATIONS ON PARALLEL COMPUTERS. IN PHASE I SEVERAL PARALLEL ALGORITHMS WILL BE DEVELOPED FOR SOLVING THE 3D NAVIER-STOKES EQUATIONS AND IMPLEMENTED IN PROTOTYPE COMPUTER CODES. THESE CODES WILL BE APPLIED TO A COMPUTATIONALLY DEMANDING FLOW PROBLEM. THE PERFORMANCE

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OF EACH ALGORITHM WILL BE MEASURED AND EVALUATED ON THE ENCORE MULTIMAX PARALLEL COMPUTER AND ENCORE'S (DARPA FUNDED) PRELIMINARY LARGE-ARRAY MULTIPROCESSOR (LAMP)--THE DUAL MULTIMAX. IN PHASE II AND III REFINEMENT OF THE MOST PROMISING ALGORITHM(S) WILL BE CONDUCTED AND IMPLEMENTED INTO A PRODUCTION COMPUTER CODE FOR SOLVING THE 3D NAVIER-STOKES EQUATIONS ON ENCORE'S ULTRAMAX (A 128 PROCESSOR LAMP BEING DEVELOPED WITH DARPA FUNDING).

ANTROPIX CORP
30 MEADOWFAIR CT
THE WOODLANDS, TX 77381
CONTRACT NUMBER:
DR MICHAEL BERRY

TITLE:
BROADBAND PLASMA BARRIERS FOR HARDENING OPTICAL SENSORS IN THE 8-12 MICRON REGION
TOPIC# 32 OFFICE: DEO IDENT#: 22872

ANTROPIX CORPORATION PROPOSES TO OBTAIN TIME - RESOLVE OPTICAL PROPERTIES MEASUREMENTS (PLASMA OPACITY IN THE 8 - 12 MICRON SPECTRAL REGION, AS WELL AS STARK BROADENING AND RELATIVE INTENSITY PARAMETERS) ON BROADBAND PLASMA BARRIERS (BPBs) GENERATED BY LASER ACTIVATION OF ALKALI METAL (E.G., Na AND Cs) VAPORS. SIMILAR MEASUREMENTS WILL BE COMPLETED ON KNOWN PHASE TRANSITION MATERIALS (PTMs) SUCH AS VANADIUM OXIDE IN ORDER TO CALIBRATE THE EXPERIMENTAL APPARATUS. ALKALI METAL VAPOR BPBs ARE PREDICTED TO BE EFFICIENT NONLINEAR OPTICAL SWITCHES THAT CAN BE ACTIVATED RAPIDLY (ON A NANOSECOND TIMESCALE) AT VERY LOW IRRADIANCE LEVELS, AFFORDING POTENTIALLY EXCEPTIONAL HARDENING FOR OPTICAL SENSORS EXPOSED TO LASER THREATS. PLASMA OPACITY, SPECTROSCOPIC DATA ON ELECTRON DENSITY AND TEMPERATURE, EMISSION SPECTRA (AND EMISSION INTENSITY WITHIN THE SENSOR BANDPASS), SWITCHING SPEED, DAMAGE THRESHOLDS, AND DURABILITY WILL BE MEASURED FOR ALKALI METAL VAPOR BPBs IN ORDER TO EVALUATE THE UTILITY OF THIS NEW NONLINEAR OPTICAL SWITCH FOR SENSOR HARDENING APPLICATIONS. IN PHASE I, EXPERIMENTS WILL EMPHASIZE PROTECTION OF 8 - 12 MICRON SENSORS, BUT IT IS ANTICIPATED THAT BROADBAND PLASMA BARRIERS WILL ALSO BE SUITABLE FOR PROTECTION OF SHORTER WAVELENGTH SENSORS.

AQUANAUTICS CORP
4560 HORTON ST
EMERYVILLE, CA 94608
CONTRACT NUMBER:
DR JOHN KERR

TITLE:
INTRODUCING LIQUID OXYGEN-CARRIERS DIRECTLY INTO FUEL CELLS
TOPIC# 7 OFFICE: NTO IDENT#: 22668

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DARPA'S CURRENT ARTIFICIAL GILL PROGRAM USES SPECIALLY DESIGNED OXYGEN-BINDING MOLECULES WHICH ARE ELECTROCHEMICALLY MODULATED TO RELEASE THE OXYGEN AS A GAS TO FEED A FUEL CELL FOR MARINE POWER. IT MAY BE POSSIBLE FOR A FUEL CELL CATHODE TO RELEASE AND CONSUME THE OXYGEN FROM THE LIQUID CARRIER MOLECULE WITHOUT THE INTERMEDIATE ELECTROCHEMICAL STEP. INTRODUCING THE LIQUID OXYGEN-CARRIER DIRECTLY INTO THE FUEL CELL WOULD ELIMINATE THE SEPARATE ELECTROCHEMICAL UNLOADING CELL, THEREBY REDUCING THE TOTAL VOLUME OF THE GILL AND POTENTIALLY DECREASING THE ENERGY REQUIRED FOR EXTRACTION. IT WOULD ALSO CREATE A MUCH SIMPLER FUEL CELL DESIGN BY REMOVING THE GAS/LIQUID INTERFACE THAT CAUSES SO MANY PROBLEMS IN CURRENTLY DESIGNED FUEL CELLS. FOR PHASE I, AQUANAUTICS WILL PERFORM PROOF OF PRINCIPLE EXPERIMENTS AND DEVELOP THE DESIGN OF SUCH A FUEL CELL. THIS COULD LEAD TO A PHASE II BENCH PROTOTYPE AND A PHASE III DEMONSTRATION THAT WOULD INTEGRATE WITH THE EXISTING DARPA PROGRAM. AQUANAUTICS HAS SIGNIFICANT EXPERIENCE IN OXYGEN CARRIER CHEMISTRY, ELECTROCHEMISTRY, AIR CATHODES AND FUEL CELLS AS PART OF ITS CURRENT DARPA CONTRACT. THE COMPANY HAS SBIR EXPERIENCE AND THE PEOPLE AND FACILITIES TO CONDUCT THE PROPOSED SCOPE OF WORK.

ASTRON CORP
470 SPRING PARK PL
HERNDON, VA 22070

CONTRACT NUMBER:

JOSEPH R JAHODA

TITLE:

INNOVATIVE SENSORS FOR DETECTION OF RELOCATABLE TARGETS

TOPIC# 14 OFFICE: STO IDENT#: 22722

AN INNOVATIVE RF EM MODULATION RADAR SENSOR IS PROPOSED WHICH WILL PROVIDE A RICH, MULTI-SPECTRAL RESPONSE FROM RELOCATABLE STRATEGIC TARGETS. THIS NOVEL RF SYSTEM HAS THE FOLLOWING MAJOR ADVANTAGES OVER COMPETING RADAR SYSTEMS. a. IN ADDITION TO PROVIDING THE CONVENTIONAL RADAR RETURN, A SECONDARY PHASE MODULATION IS INTRODUCED WHICH PROVIDES A UNIQUE RESPONSE CAPABLE OF FURTHER TARGET CHARACTERIZATION. b. A SIGNIFICANT PENETRATION INTO CAMAFLOUGE MATERIALS AND NON-METALIC STRUCTURES ARE REALIZED, PROVIDING AN ADDITIONAL DIMENSION TO THE RECOGNITION AND IDENTIFICATION OF THE

SUBMITTED BY

TARGET.

BONNEVILLE MICROELECTRONICS INC
918 E 900RD S
SALT LAKE CITY, UT 84105
CONTRACT NUMBER:
ALEN R GRAHN

TITLE:

STRUCTURED GaAs DESIGN TOOL
TOPIC# 29 OFFICE: ISTO

IDENT#: 22514

INTEREST IN GALLIUM ARSENIDE (GaAs) INTEGRATED CIRCUITS (IC) IS GROWING RAPIDLY BECAUSE THEY ARE VERY FAST AND RESISTANT TO RADIATION. HOWEVER, SOME SIGNIFICANT PROBLEMS ARE STILL OF CONCERN. FIRST, THE INCREASED SPEED OF THIS TECHNOLOGY HAS LED TO TIMING PROBLEMS IN CIRCUIT DESIGN. WITH THIS TECHNOLOGY THE GATE SWITCHING SPEEDS HAVE BEEN REDUCED TO WHERE THEY CAN BE EQUIVALENT TO THE WIRE TRANSMISSION TIMES, AND POWER SUPPLY PROBLEMS ARE DIFFICULT TO MANAGE. THIS PROPOSAL ADDRESSES AN APPROACH TO PROVIDE A VERY FAST DESIGN TOOL BASED UPON PATH PROGRAMMABLE LOGIC (PPL) A VERY FAST DESIGN TOOL FOR GaAs CIRCUITS WHICH WILL RESULT IN CIRCUITS WITH MINIMAL AND WELL CONTROLLED WIRE LENGTHS. THE DESIGN METHOD PROVIDES IMMEDIATE CIRCUIT FUNCTION VERIFICATION FOR TIMING PROBLEM CONTROL. IT ALSO RESULTS IN VERY COMPACT CIRCUIT LAYOUT WHICH IS EQUIVALENT TO FULL CUSTOM DESIGNS WITH THE REQUIRED DESIGN TIME BEING DECREASED BY AN ORDER OF MAGNITUDE. THE MORE COMPACT LAYOUT WILL RESULT IN BETTER CIRCUIT PERFORMANCE AND IMPROVE YIELDS. THE PPL WIRE GRID ALSO PROVIDES A SIMPLE SOLUTION TO GaAs POWER SUPPLY PROBLEMS.

CHRONOS RESEARCH LABS INC
4186 SORRENTO VALLEY BLVD - STE H
SAN DIEGO, CA 92121
CONTRACT NUMBER:
DR RANDALL B OLSEN

TITLE:

ADVANCED SUPERCONDUCTING MATERIALS
TOPIC# 38 OFFICE: DSO

IDENT#: 22960

SUBMITTED BY

THE RECENT DISCOVERY OF HIGH TEMPERATURE METAL OXIDE SUPERCONDUCTORS SUGGESTS THAT YET ANOTHER NEW CLASS OF SUPERCONDUCTING MATERIALS MAY BE FOUND. THE NEW CATEGORY OF MATERIALS WILL BE INEXPENSIVE TO MANUFACTURE AND EASILY FORMED INTO WIRES AND BANDS. THESE MATERIALS WILL BE MECHANICALLY TOUGH AND MAY HAVE HIGH CRITICAL TEMPERATURES. THE PHASE I GOAL IS TO ESTABLISH THE SUPERCONDUCTING CHARACTERISTICS OF A SPECIFIC MATERIAL WITHIN THE NEW CLASS. AFTER THE SUPER-CONDUCTING PROPERTIES ARE FIRMLY ESTABLISHED A SPECIMEN WHICH IS SEVERAL METERS LONG WILL BE PRODUCED I PHASE II.

COLEMAN RESEARCH CORP
401 WYNN DR
HUNTSVILLE, AL 35805
CONTRACT NUMBER:
ROBERT L HAWKINS
TITLE:
EXPENDABLE AIR VEHICLES/HIGH ALTITUDE BALLOON TECHNOLOGY
TOPIC# 1 OFFICE: NTO IDENT#: 22625

COLEMAN RESEARCH CORPORATION (CRC) PROPOSES TO DEVELOP THE CAPABILITY TO PERFORM COMPUTER SIMULATIONS OF UPPER-ATMOSPHERE BALLOON DRIFT PATTERNS. MODELS OF ZERO-PRESSURE AND SUPER-PRESSURE BALLOONS WILL BE DEVELOPED TO ACCOUNT FOR BUOYANCY, MASS PROPERTIES, AERODYNAMIC CONFIGURATION, PROPULSIVE CAPABILITY, AND OTHER PHYSICAL PARAMETERS WHICH INFLUENCE THE RESPONSE OF THE BALLOON SYSTEM TO EXTERNAL ENVIRONMENTS. AN ATMOSPHERE MODEL WILL BE DEVELOPED WHICH ACCOUNTS FOR REALISTIC ATMOSPHERIC PROPERTY VARIATIONS. THESE MODELS WILL BE INTEGRATED INTO A MODULAR, CRC-PROPRIETARY FLIGHT SIMULATION. THE RESULTING PROGRAM WILL BE EXERCISED TO PRODUCE 24-HOUR BALLOON DRIFT PATTERNS AT A NOMINAL OPERATING ALTITUDE OF 70,000 FEET AND ONE-YEAR DRIFT PATTERNS AT AN ALTITUDE OF 120,000 FEET. THE PRIMARY PRODUCT OF THIS EFFORT WILL BE PLOTS SHOWING BALLOON DRIFT PATTERNS FOR THE TWO SETS OF OPERATING CONDITIONS. ALSO, THE DEVELOPMENT OF THE BALLOON MODELS AND THE ATMOSPHERE MODEL WILL BE DOCUMENTED.

CORIUM INDUSTRIES INC
602 COUNTRY FAIR DRIVE - STE B
CHAMPAIGN, IL 61821
CONTRACT NUMBER:
DR CHIEN-PING JU
TITLE:
AN AUTOMATED SYSTEM FOR THE DEPOSITION OF HIGH T(c)
SUPERCONDUCTING THIN FILMS AND OTHER MULTI-COMPONENT OXIDE FILMS
TOPIC# 38 OFFICE: DSO IDENT#: 22961

SUBMITTED BY

THE DEVELOPMENT OF HIGH T_c SUPERCONDUCTING THIN FILMS WILL HAVE SIGNIFICANT IMPACT ON A LARGE NUMBER OF MODERN TECHNOLOGIES, ESPECIALLY IN THE AREA OF ADVANCED MICROCIRCUITRY. ALTHOUGH SUPERCONDUCTING THIN FILMS HAVE BEEN PREPARED BY A VARIETY OF METHODS, ALL OF THESE METHODS REQUIRE HIGH TEMPERATURE PROCESSING STEPS WHICH ARE INCOMPATIBLE WITH THE PRODUCTION OF HIGH DENSITY MICROCIRCUITRY, AND NONE OF THE METHODS DEVELOPED TO DATE ARE SUFFICIENTLY REPRODUCIBLE FOR LARGE SCALE PRODUCTION TO PERMIT ROUTINE MANUFACTURING OF CHIPS WHICH INCORPORATE SUPERCONDUCTING ELEMENTS. CORIUM INDUSTRIES PROPOSES A PROOF-OF-PRINCIPLE DEMONSTRATION OF A MULTICOMPONENT OXIDE THIN FILM DEPOSITION SYSTEM WHICH ELIMINATES MOST OF THE VARIABLES OF THE DEPOSITION PROCESS AND IN PRINCIPLE CAN BE USED AS THE BASIS OF A TOTALLY AUTOMATED MULTI-COMPONENT OXIDE THIN FILM DEPOSITION SYSTEM. ALTHOUGH THERE ARE A NUMBER OF SUCH OXIDE FILMS WHICH ARE OF SIGNIFICANT TECHNOLOGICAL INTEREST THE HIGH T_c SUPERCONDUCTING OXIDE $YBa(2)Cu(3)O(7-x)$ WILL BE USED TO DEMONSTRATE OPERATION OF THE SYSTEM. IN THIS CONTEXT, A NUMBER OF STEPS INCLUDING IN-SITU SUBSTRATE PREPARATION, AND DEPOSITION OF DIFFUSION BARRIERS, ELECTRICAL CONTACTS AND ENCAPSULANT MATERIALS TO PROTECT THE FILM FROM DEGRADATION BY CONTACT WITH ATMOSPHERIC MOISTURE WILL BE DEMONSTRATED AS PART OF A SINGLE, FULLY AUTOMATED DEPOSITION CYCLE.

DAMASKOS INC
PO BOX 469
CONCORDVILLE, PA 19331
CONTRACT NUMBER:
DAVID K COHOON
TITLE:
USE OF RESOLVENT KERNEL METHODS AND EXACT FINITE RANK INTEGRAL EQUATION METHODS (RKM-EFRIE) TO DESCRIBE SCATTERING COMPLEX STRUC
TOPIC# 17 OFFICE: DARPA/PMO IDENT#: 22768

A NOVEL METHOD OF COMPUTERIZING INTEGRAL EQUATIONS OF ELECTROMAGNETIC SCATTERING HAS BEEN DEVELOPED WHICH REQUIRES LESS MEMORY THAN OTHER METHODS WHICH SOLVE ONLY AN APPROXIMATE FINITE RANK INTEGRAL EQUATIONS AND WHICH ENABLES ONE, WITH ENOUGH COMPUTATIONAL EFFORT, TO COMPLETELY CORRECT THE DISCRETIZATION ERROR. APPLICATIONS ARE PROPOSED TO 1, 2, AND 3 DIMENSIONAL SCATTERING PROBLEMS WHICH ARE

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BENCH MARKED BY ROBUST DAMASKOS DESIGN CODES, SUCH AS TROMMA, WHICH TREATS MULTILAYER ANISOTROPIC SLABS, HPOLA, WHICH USES CONTOUR INTEGRATION TO TREAT SCATTERING BY A HOMOGENEOUS ANISOTROPIC CYLINDER WITH A GENERAL CROSS SECTION AND HAVING AN EMBEDDED ISOTROPIC CORE, AND AN IMPLEMENTATIONAL OF A MIE LIKE SOLUTION FOR A MULTILAYER ANISOTROPIC SPHERE.

DECISION SCIENCE CONSORTIUM INC
1895 PRESTON WHITE DR - STE 300
RESTON, VA 22091
CONTRACT NUMBER:
KATHRYN B LASKEY
TITLE:
GENERATING ROBUST PLANS IN ADVERSARIAL ENVIRONMENTS
TOPIC# 27 OFFICE: ISTO IDENT#: 22542

DECISION SCIENCE CONSORTIUM, INC. (DSC) PROPOSES TO ENGAGE IN AN INNOVATIVE RESEARCH PROGRAM TO DESIGN AND IMPLEMENT AN ADVERSARIAL PLANNING SYSTEM THAT IS ABLE TO REASON ABOUT THE PERSISTENCE OVER TIME OF AN ADVERSARY'S BELIEF AND INTENTIONS. SPECIFICALLY, THIS SYSTEM WILL UTILIZE EITHER A NONMONOLITHIC SITUATIONAL OR TEMPORAL LOGIC TO DETERMINE THE EXTENT TO WHICH AN ADVERSARY'S PRESENT BELIEFS AND INTENTIONS WILL PERSIST OVER POSSIBLE FUTURES CONSISTENT WITH A PLANNER'S PROPOSED PLAN. PHASE I OF THIS PROGRAM WILL FOCUS ON THE SPECIFICATION OF THE NONMONOLITHIC LOGIC FOR PERSISTENCE REASONING, THE IMPLEMENTATION OF THIS LOGIC IN A PROPOSITIONAL TRUTH-MAINTENANCE SYSTEM, AND THE OVERALL DESIGN OF AN AUTOMATED PLANNING SYSTEM THAT INCORPORATES THIS PERSISTENCE REASONING CAPABILITY. PHASE II WILL INVOLVE THE IMPLEMENTATION OF THE AUTOMATED PLANNING SYSTEM DESIGNED IN PHASE I, AND DEMONSTRATIONS OF THIS SYSTEM OPERATING IN TWO DIFFERENT PLANNING DOMAINS: BATTLEFIELD ROBOTICS AND BATTLE MANAGEMENT.

DECISION-SCIENCE APPLICATIONS INC
1901 N MOORE ST - STE 1000
ARLINGTON, VA 22209
CONTRACT NUMBER:
TERRY KROHN
TITLE:
RADAR SCATTERING OF COMPOSITE MATERIALS
TOPIC# 17 OFFICE: ASTO IDENT#: 22778

SUBMITTED BY

THE DEVELOPMENT OF NEW AND INNOVATIVE TECHNIQUES WHICH DETERMINE ELECTROMAGNETIC SCATTERING BEHAVIOR ARE NECESSARY IN ORDER TO ADVANCE THE STATE-OF-THE-ART IN RADAR CROSS SECTION (RCS) CONTROL. TWO OF THE MORE IMPORTANT ANALYTICAL PROBLEMS REQUIRING SOLUTION IN THIS AREA ARE THE CHARACTERIZATION OF RADAR SCATTERING FROM COMPOSITE MATERIALS AND OPTIMUM APPLICATION OF MATERIAL COATINGS TO METALLIC STRUCTURES. A TAPERED IMPEDANCE BOUNDARY CONDITION ON A STRUCTURE IS REPRESENTATIVE OF APPLYING AN ABSORBING COATING ON A STRUCTURE PROVIDED THE PENETRATION DEPTH OF THE RADIATION INTO THE MATERIAL IS LESS THAN THE MATERIAL THICKNESS. DSA WILL CHARACTERIZE THE RADAR SCATTERING FROM AN EXTENDED PANEL OF UNIDIRECTIONAL COMPOSITE (UDC) MATERIAL AND FOR A CYLINDER OF ARBITRARY CROSS SECTION USING AN INTEGRAL EQUATION FORMULATION -- FLOQUET-GALERKIN.

DELPHI RESEARCH INC
701 HAINES AVE NW
ALBUQUERQUE, NM 87102
CONTRACT NUMBER:
PATRICK M DHOOGHE
TITLE:

RESEARCH ON A THREE DIMENSIONAL NON-VOLATILE MASS STORAGE MEDIUM
TOPIC# 21 OFFICE: DSO IDENT#: 22474

A PROJECT IS PROPOSED TO INVESTIGATE THE FEASIBILITY OF COMBINING A PHASE-CHANGE NON-LINEAR OPTICAL MATERIAL WITH A PHOTOREFRACTIVE MATERIAL IN THIN LAYERS TO ACHIEVE A THREE DIMENSIONAL MASS STORAGE MEDIUM. ORGANIC COMPOUNDS POSSESSING GOOD POLARIZABILITY ALONG WITH COMPOSITION CONDUCTIVE TO PHASE CHANGE MECHANICS WILL BE TESTED FOR SHG AND PHASE CHANGE ABILITY, THEN PREPARED IN THIN FILMS ON PHOTOREFRACTIVE SUBSTRATE AND TESTED FOR ABILITY TO ALTER THE REFRACTIVE INDEX OF THE SUBSTRATED WITH SHG.

DIAMOND MATERIALS INSTITUTE INC
2820 E COLLEGE AVE
STATE COLLEGE, PA 16801
CONTRACT NUMBER:
DR RICHARD KOBAYASHI
TITLE:

NOVEL IN-SITU SPECTROSCOPIC ELLIPSOMETER FOR REAL TIME ANALYSIS OF CVD DIAMOND FILMS
TOPIC# 23 OFFICE: DSO IDENT#: 22468

SUBMITTED BY

SUCCESSFUL DIAMOND NUCLEATION AND GROWTH BY CVD WILL INVOLVE COMPLEX INDEPENDENT CONTROL OF MULTIPLE PROCESSING VARIABLES. THE PROPOSED IN-PROCESS SENSOR SHOULD ENABLE REAL TIME DETERMINATION OF THE STATE OF THE EVOLVING DIAMOND THIN-FILM. FURTHERMORE, DEVELOPMENT OF SUCH A SENSOR WOULD ENABLE INTELLIGENT PROCESS CONTROL CAPABLE OF MODIFYING A PROCESS TRAJECTORY TO ACHIEVE THE DESIRED MICROSTRUCTURE, CHEMISTRY AND FINAL PROPERTIES IN THE DIAMOND THIN-FILM OR STRUCTURE. THE OBJECTIVE OF THE PROPOSED PROGRAM IS TO DEVELOP A NOVEL SPECTROSCOPIC ELLIPSOMETER TO MEASURE THE DIELECTRIC RESPONSE OF DIAMOND FILMS AS THEY ARE GROWING BY PLASMA ENHANCED CVD. DIAMOND MATERIALS INSTITUTE PLANS TO ACHIEVE THIS GOAL IN TWO PHASES. PHASE I WILL BE THE ASSEMBLY AND TESTING OF A SPLIT RELECTED BEAM SPECTROSCOPIC ELLIPSOMETER (SRBSE). PHASE I WILL TEST TO SEE WHETHER THIS INSTRUMENT CAN DISTINGUISH BETWEEN DIAMOND, ARMORPHOUS CARBON AND GRAPHITE. IF PHASE I RESULTS INDICATE THAT THIS INSTRUMENT IS ABLE TO DISTINGUISH AMONG DIFFERENT TYPES OF CARBON BONDING, THEN PHASE II RESEARCH WILL DEVELOP SRBSE FOR IN-SITU DIAMOND FILM ANALYSIS. COMPUTER SOFTWARE WILL BE WRITTEN TO PERMIT AUTOMATIC DATA COLLECTION, REDUCTION AND DISPLAY. THE ELLIPSOMETER WILL BE MOUNTED ON A DMI PECVD REACTOR AND WILL BE USED TO MEASURE THE DIELECTRIC RESPONSE OF A DIAMOND FILM AS IT GROWS.

DIESEL DYNE CORP
3044 MIDDLEBORO RD
MORROW, OH 45152
CONTRACT NUMBER:
RICHARD P JOHNSTON
TITLE:

A STUDY OF AN ADVANCED VARIABLE CYCLE DIESEL ENGINE FOR USE IN A REMOTELY PILOTED VEHICLE
TOPIC# 18 OFFICE: ASTO IDENT#: 22796

THIS STUDY IS INTENDED TO DETERMINE THE OPERATING CHARACTERISTICS, THE CONFIGURATION AND THE ENGINE CONTROL PHILOSOPHY FOR A HIGH ALTITUDE VARIABLE CYCLE DIESEL ENGINE INSTALLED IN A RPV. WEIGHT, PERFORMANCE AND INSTALLATION INFORMATION WILL BE DEVELOPED IN THE STUDY.

DISPLAYTECH INC
2200 CENTRAL AVE
BOULDER, CO 80301
CONTRACT NUMBER:
MARK HANDSCHY
TITLE:

SILICON INTEGRATED CIRCUIT/FERROELECTRIC LIQUID CRYSTAL HYBRID SPATIAL LIGHT MODULATORS
TOPIC# 21 OFFICE: DSO IDENT#: 22520

SUBMITTED BY

THE PROPOSED WORK AIMS TO DEVELOP NOVEL, HIGH-PERFORMANCE SPATIAL LIGHT MODULATORS (SLMs) BY JOINING FERROELECTRIC LIQUID CRYSTALS (FLCs), A FAST, LOW-VOLTAGE, LOW-POWER ELECTRO-OPTIC MATERIAL, WITH SILICON INTEGRATED CIRCUITS (ISC). THE RESULTING SLMs MAY BE EITHER ELECTRONICALLY OR OPTICALLY ADDRESSED, HAVE FRAME RATES FROM 10 KHz (PRESENT) TO 10 MHz (FUTURE), AND CAN BE USED TO MODULATE OPTICAL INTENSITY, POLARIZATION, OR PHASE, ALL WITH HIGH THROUGHPUT. THE IC TECHNOLOGY IS ALREADY MATURE, ALLOWING SCALE-UP TO SLMs WITH LARGE NUMBERS OF ELEMENTS (512 X 512) TO OCCUR IN THE NEAR TERM, AND AT LOW COST. THE PHASE I WORK WILL DEMONSTRATE A CONCEPT-PROVING ELECTRICALLY ADDRESSED SLM WITH A 10 KHz FRAME RATE AND UP TO 256K ELEMENTS. DURING PHASE II, FULL-SCALE CUSTOM ICs AND IMPROVE FLC MATERIALS WILL BE DEVELOPED, INCREASING THE NUMBER OF ELEMENTS AND FRAME RATE, AND PERMITTING SENSITIVE OPTICAL ADDRESSING.

DOTY SCIENTIFIC INC
600 CLEMSON RD
COLUMBIA, SC 29223
CONTRACT NUMBER:
F DAVID DOTY
TITLE:
HIGH PERFORMANCE AIRCRAFT SURFACE HEAT TRANSFER TECHNOLOGY
TOPIC# 19 OFFICE: NASP IDENT#: 22832

A NEW APPROACH TO HIGH EFFICIENCY HEAT EXCHANGER DESIGN SHOWS THAT THEORETICAL LIMITS TO SPECIFIC CONDUCTANCE ARE ABOUT 100,000 TIMES GREATER THAN IS CURRENTLY ACHIEVED IN MOST STATE-OF-THE-ART COMPACT EXCHANGERS, BUT PRACTICAL CONSIDERATIONS REDUCE THIS FACTOR TO PERHAPS 100. PROTOTYPE MICRO-TUBE STRIP (MTS) HIGH PRESSURE He-He EXCHANGERS HAVE DEMONSTRATED SPECIFIC CONDUCTANCE GREATER THAN 350W/kgK AT FLOW VELOCITIES BELOW 1% OR THE SPEED OF SOUND. THIS MTS EXCHANGER CAN BE ADVANTAGEOUSLY ADAPTED TO GENERAL THERMAL MANAGEMENT AT ULTRA-HIGH POWER-DISTANCE PRODUCTS, FOR COOLING OF HOT AIRCRAFT SURFACES AT HEAT FLUX DENSITIES UP TO 20MW/m², ELECTRONIC POWER COMPONENTRY, AND BOUNDARY LAYER FLOW ENHANCEMENT. IT ALSO OPENS MANY NEW AVENUES FOR UTILIZATION OF WASTE HEAT BY GREATLY INCREASING THE ABILITY TO EFFECTIVELY USE REMOTE SURFACE FOR HEAT RADIATION. THE MTS TECHNOLOGY IS EXPECTED TO ULTIMATELY PROVE

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ECONOMICAL FOR MANY TERRESTRIAL MOBILE APPLICATIONS. IMPLEMENTATION
DEPENDS PRIMARILY ON PROGRESS IN SEVERAL NEW MANUFACTURING
TECHNOLOGIES INCLUDING SUPERPRECISION PROGRESSIVE FINEBLANKING,
HIGH SPEED DIFFUSION WELDING, AND HIGH SPEED PRECISION ROBOTICS.

EIC LABS INC
111 DOWNEY ST
NORWOOD, MA 02062
CONTRACT NUMBER:

JAMES D KLEIN

TITLE:

TUNABLE HIGH T(c) SUPERCONDUCTING INFRARED DETECTORS

TOPIC# 37 OFFICE: TTO IDENT#: 22939

A SUPERCONDUCTOR BASED INFRARED DETECTOR WITH A CONTINUOUSLY
VARIABLE SENSITIVITY IS PROPOSED. THE SUPERCONDUCTING THIN FILM IS
TO HAVE A POLYCRYSTALLINE NATURE TO ACHIEVE JOSEPHSON JUNCTION
BEHAVIOR DIRECTLY THROUGH THE ANISOTROPIC SUPERCONDUCTING PROPERTIES
OF $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$. THE DEPOSITION SUBSTRATE IS TO BE AN OXYGEN
ION CONDUCTOR THAT WILL PERMIT CONTINUOUS AND CONTROLLED ADJUSTMENT
OF THE SUPERCONDUCTOR'S OXYGEN STOICHIOMETRY. BECAUSE SUCH A DEVICE
CAN BE TUNED FOR VARIOUS OPERATING CONDITIONS, THE LIMITATIONS PLACED
ON PREVIOUS SUPERCONDUCTING INFRARED DETECTORS, SUCH AS THE NEED FOR
DEMANDING TEMPERATURE CONTROL DURING OPERATION, WILL BE CIRCUMVENTED.
PHASE I WILL BE CONCERNED WITH DEFINING FILM DEPOSITION CONDITIONS
AND DETERMINING THE INFRARED CHARACTERISTICS OF THE SUPERCONDUCTING
FILMS ON THE CHOSEN SUBSTRATE.

EMCORE CORP
35 ELIZABETH AVE
SOMERSET, NJ 07052
CONTRACT NUMBER:

PETER NORRIS

TITLE:

IN-SITU PROCESS MONITORING OF MOCVD BY PHOTOREFLECTANCE

TOPIC# 23 OFFICE: DSO IDENT#: 22470

METAL-ORGANIC CHEMICAL VAPOR DEPOSITION (MOCVD) IS A VAPOR-PHASE

SUBMITTED BY

METHOD OF EPITAXIAL GROWTH WHICH YIELDS HIGH-PURITY SEMICONDUCTORS. COMPOSITIONAL AND STRUCTURAL CONTROL HAVE BEEN ACHIEVED BY UTILIZING PROCESS PARAMETERS/MATERIALS PROPERTIES RELATIONSHIPS DERIVED FROM EX-SITU MATERIALS CHARACTERIZATION DATA. THE PRODUCTION CAPABILITY OF THE MOCVD TECHNIQUE GREATLY EXCEEDS THAT OF MOLECULAR BEAM EPITAXY (MBE). THIS ADVANTAGE MAY NOT BE FULLY REALIZED UNTIL AN ACCURATE AND RELIABLE IN-PROCESS SENSOR IS DEVELOPED. THE GOAL OF THIS PROPOSED RESEARCH IS TO ESTABLISHED PHOTOREFLECTANCE (PR) AS A VIABLE IN-SITU PROCESS MONITOR OF THE MOCVD EXPITAXIAL GROWTH TECHNIQUE. THIS OBJECTIVE WILL BE ACCOMPLISHED BY (1) OBTAINING A USABLE AND REPRODUCIBLE PR SIGNAL, FROM GaAs IN THE GROWTH CHAMBER AT ROOM TEMPERATURE, GROWTH TEMPERATURE, AND DURING GROWTH; (2) ACHIEVING THE SAME RESULTS FROM AlGaAs SAMPLES WITH A VARIETY OF Al CONCENTRATIONS; AND (3) MONITORING THE PR SIGNAL, IN-SITU, DURING GROWTH OF GaAs/AlGaAs HETEROSTRUCTURES. THE DATABASE ESTABLISHED IN STEPS (1) AND (2), AS WELL AS OTHER EXISTING DATA, WILL BE USED TO EVALUATED THIS PR SIGNAL AND TO DETERMINE THE Al COMPOSITION PRESENT AS THE HETEROSTRUCTURE IS GROWN. THE EFFECTIVENESS OF THIS TECHNIQUE WILL THEN BE CONFIRMED BY EX-SITU MATERIALS ANALYSIS.

ENSCO INC
5400 PORT ROYAL RD
SPRINGFIELD, VA 22151

CONTRACT NUMBER:

DR ZOLTAN DER

TITLE:

STATISTICAL PROCEDURES FOR DETERMINING COMPLIANCE WITH YIELD THRESHOLD NUCLEAR TEST LIMITATIONS

TOPIC# 10

OFFICE: NRMO

IDENT#: 22681

IN VIEW OF THE RECENT DEVELOPMENT OF UNIFIED MAGNITUDE MEASURES FOR SEISMIC ESTIMATION OF THE YIELDS OF NUCLEAR EXPLOSIONS THE STATISTICAL PROCEDURES FOR VERIFYING COMPLIANCE WITH TEST BAN TREATIES WILL BE RECAST IN A MULTIVARIATE FRAMEWORK. THIS WILL BE DONE BY CONSIDERING YIELD CLUSTERING, DATA CENSORING, CORRELATIONS AND STOCHASTIC TEST SITE BIAS TERMS. THE POSSIBLE EFFORT OF LOWERING TREATY THRESHOLD LIMITS WILL ALSO BE CONSIDERED.

EVANS C & ASSOCS
301 CHESAPEAKE DR
REDWOOD CITY, CA 94063

CONTRACT NUMBER:

DR MICHAEL H HERMAN

TITLE:

EVALUATION OF HETEROJUNCTION INTERFACES USING ELECTRO BEAM ELECTROREFLECTANCE

TOPIC# 22

OFFICE: DSO

IDENT#: 22478

SUBMITTED BY

IN PHASE I, THE INITIAL CHARACTERIZATION OF ELECTRONIC STRUCTURE AT AlGaAs/GaAs INTERFACES BY ELECTRON BEAM ELECTRO-REFLECTANCE (EBER) IS PROPOSED, SPECIFICALLY FOR THE INVESTIGATION OF QUANTUM WELL AND HEMT STRUCTURES. THESE INTERFACES HAVE BEEN STUDIED BY RELATED TECHNIQUES, AND HAVE BEEN SHOWN TO POSSESS UNIQUE SPECTRAL FEATURES. NONETHELESS, BOTH FUNDAMENTAL AND APPLIED QUESTIONS REMAIN ABOUT THE PHYSICAL PARAMETERS OF THESE SYSTEMS. THE PHASE I WORK WILL DEMONSTRATE THE APPLICABILITY OF EBER TO ANALYSIS OF THESE PROBLEMS. FOR THIS PURPOSE, WE WILL EXAMINE THE ELECTRONIC LEVELS ASSOCIATED WITH SINGLE QUANTUM WELLS, USED IN LASER DEVICES, AND SINGLE HETEROJUNCTION INTERFACES, CHARACTERISTICS OF HEMT DEVICES. OUR OBJECTIVE IS TO OBSERVE AND PARAMETRIZE THE ADDITIONAL SPECTRAL FEATURES OF THESE INTERFACES, USING EBER.

EXCEL TECHNOLOGY INC
20 WESTFIELD RD
CORAM, NY 11727
CONTRACT NUMBER:
DR RAMA RAO

TITLE:

HIGHLY SENSITIVE INFRARED DETECTOR FABRICATED WITH THIN FILM OF HIGH T_c Y-Ba-CuO SUPERCONDUCTOR USING PULSED EXCIMER LASER
TOPIC# 37 OFFICE: TTO IDENT#: 22941

IN THE PROPOSED WORK, FEASIBILITY OF DEVELOPING A HIGHLY SENSITIVE AND HIGH SPEED OPTICAL DETECTOR IN THE INFRARED REGION USING A SUPERCONDUCTING WEAK LINK FABRICATED BY LASER INDUCED DEPOSITION OF Y-Ba-Cu-O THIN FILMS, IS EXAMIED. THE DETECTION PRINCIPLE IS BASED ON THE FACT THAT INCIDENT INFRARED RADIATION PRODUCES A VOLTAGE ACROSS THE JOSEPHSON JUNCTION WHICH CAN SERVE AS A USEFUL DETECTOR OUTPUT. IN THE PRESENT WORK, BULK SUPERCONDUCTOR SAMPLES OF Y-Ba-Cu-O WILL BE PREPARED BY SOLID STATE REACTION METHOD. THIN SUPERCONDUCTING FILM ON A SUITABLE SUBSTRATE WILL BE PREPARED BY LASER INDUCED DEPOSITION TECHNIQUE USING PULSED EXCIMER LASER. IN THIS TECHNIQUE, THE U.V. LASER REMOVES MOLECULES (PHOTO-ABLATION) FROM THE SUPERCONDUCTOR TARGET WHICH ARE SUBSEQUENTLY DEPOSITED ON MgO SUBSTRATE WHICH HAS BEEN CLEAVED TO FORM A WEAK LINK. A MAJOR ADVANTAGE OF THE PROPOSED TECHNIQUE IS THAT DUE TO EXCELLENT SPATIAL QUALITY AND SHORT

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WAVELENGTH (0.28 MICRO) OF THE LASER, IT PROVIDES A PRECISE CONTROL OVER THE DEPOSITION PROCESS WITH SUBMICRON RESOLUTION. FOR DETECTION, INFRARED SIGNALS WILL BE MODULATED AND GUIDED THROUGH A OPTICAL FIBER TO THE DETECTOR. DETECTOR PERFORMANCE IN TERMS OF, RESPONSIVITY AND DYNAMIC RANGE, IN THE SPECTRAL REGION OF 1-10 MICRON WILL BE EVALUATED.

FLOW RESEARCH INC
21414 - 68TH AVE S
KENT, WA 98032

CONTRACT NUMBER:

MAGDI RIZK

TITLE:

AN INVESTIGATION OF V/STOL JET INTERACTIONS IN A CROSS FLOW

TOPIC# 16 OFFICE: ASTO IDENT#: 22765

THE ABILITY TO OPTIMIZE THE DESIGN OF V/STOL AIRCRAFT AND TO PREDICT THEIR PERFORMANCE REQUIRES A GOOD UNDERSTANDING OF THE COMPLEX JET-INDUCED PHENOMENA ASSOCIATED WITH THESE AIRCRAFT. PRESENTLY, EXPERIMENTAL WORK IS THE MAIN AVENUE FOLLOWED TO GAIN AN UNDERSTANDING OF V/STOL FLOWS. NUMERICAL SIMULATION HAS MANY ADVANTAGES NOT SHARED BY EXPERIMENTAL TOOLS. IT, THEREFORE, CAN COMPLEMENT EXPERIMENTAL EFFORTS IN GAINING A DEEP UNDERSTANDING OF THE COMPLEX FLOW PHENOMENA ASSOCIATED WITH V/STOL FLOWS. USING THE LARGE-EDDY SIMULATION APPROACH, THE OBJECTIVE OF THE PROPOSED WORK IS TO INVESTIGATE THE COMPLEX JET INDUCED INTERACTIONS ASSOCIATED WITH AN AIRCRAFT IN PITCH AND A FORWARD MOVING AIRCRAFT.

FOSTER-MILLER INC
350 SECOND AVE
WALTHAM, MA 02254

CONTRACT NUMBER:

JOSEPH S BOYCE

TITLE:

LEADING EDGE STRUCTURAL CONCEPT FOR HYPERVELOCITY VEHICLE

TOPIC# 19 OFFICE: NASP IDENT#: 22838

A MAJOR PROBLEM FACING PHYPERSONIC VEHICLE DESIGNERS IS THE

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DEVELOPMENT OF FLIGHT STRUCTURES WHICH CAN WITHSTAND MULTIPLE HEATING CYCLES TO OVER 3500 DEG F. ADVANCED CARBON/CARBON COMPOSITES (ACC) ARE A LEADING CANDIDATE BUT WILL REQUIRE IMPROVED STRUCTURAL CONCEPTS AND OXIDATION RESISTANT COATINGS. CURRENT 2-D ACC MADE FROM CARBON-PHENOLIC HAVE POOR TRANSVERSE STRENGTH AND THERMAL CONDUCTIVITY. 3-D ACC ARE HIGH COST AND CURRENT 3-D WEAVING METHODS CANNOT PRODUCE INTEGRALLY STIFFENED-SKIN PANELS OF COMPLEX SHAPE. FOSTER-MILLER IS PROPOSING A LOW-COST INNOVATIVE METHODS TO CONVERT A 2-D CARBON PHENOLIC PREPREG TO 3-D DURING AUTOCLAVE PROCESSING. THE RESULTING ACC WILL HAVE IMPROVED TRANSVERSE (THROUGH-THICKNESS) STRENGTH AND CONDUCTIVITY. THE PROCESS CAN HANDLE THINWALL STRUCTURES OF COMPLEX SHAPE. INTEGRAL ATTACHMENT OF STIFFENERS IS POSSIBLE ELIMINATING THE NEED FOR SEPARATE C/C FASTENERS. CANDIDATE TRANSVERSE REINFORCING MATERIALS INCLUDE: BORON, SiC, TUNGSTEN, AND EXTRUDED CARBON-PHENOLIC RODS. IN PHASE I SAMPLE TRANSVERSE REINFORCED C/C SPECIMENS WILL BE MADE AND TESTED.

FOSTER-MILLER INC
350 SECOND AVE
WALTHAM, MA 02254
CONTRACT NUMBER:
JOSEPH BOYCE

TITLE:

NOVEL CARBON-CARBON COMPOSITE WITH IMPROVED STRUCTURAL PROPERTIES AND PROVISIONS FOR ACTIVE LEADING EDGE COOLING

TOPIC# 19 OFFICE: NASP IDENT#: 22839

EFFECTIVE PERFORMANCE OF REUSABLE HYPERSONIC VEHICLES WILL DEPEND ON THE DEVELOPMENT OF THERMAL PROTECTION SYSTEMS (TPS) FOR NOSE TIP, WING LEADING EDGE, AND FUSELAGE STRUCTURES CAPABLE OF OPERATION FOR EXTENDED PERIODS IN AN EXTREME AEROHEATING ENVIRONMENT. MINIMUM WEIGHT DESIGN MAY BE ACHIEVED VIA A COMBINATION OF ACTIVE/PASSIVE TPS APPROACHES. THIS WOULD INVOLVE THE DEVELOPMENT OF A HIGH TEMPERATURE STRUCTURAL MATERIAL SYSTEM WHICH DISPLAYS GOOD STRENGTH, STIFFNESS AND DAMAGE TOLERANCE AT ELEVATED TEMPERATURE. SUCH A MATERIAL COULD BE PROTECTED BY A THIN LIGHTWEIGHT BARRIER MATERIAL AND WOULD REQUIRE ONLY MINIMAL ACTIVE COOLING. FOSTER-MILLER, INC. IS PROPOSING A NOVEL HYBRID ACTIVE/PASSIVE COOLING CONCEPT BASED ON STRUCTURAL ADVANCED CARBON-CARBON (ACC). THE CONCEPT IS AN INTEGRATED APPROACH

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WHICH COMBINES STRUCTURAL AND COOLING ELEMENTS FOR MINIMUM WEIGHT. FOSTER-MILLER IS PROPOSING A LOW COST INNOVATIVE METHOD TO CONVERT 2-D CARBON/PHENOLIC PREPREG TO 3-D DURING AUTOCLAVE PROCESSING. THE RESULTING ACC WILL HAVE IMPROVED TRANSVERSE (THROUGH-THICKNESS) STRENGTH AND CONDUCTIVITY. THE PROCESS CAN HANDLE THINWALL STRUCTURES OF COMPLEX SHAPE. INTEGRAL ATTACHMENT OF STIFFENERS IS POSSIBLE ELIMINATING THE NEED FOR SEPARATE C/C FASTENERS. CANDIDATE STRANSVERSE REINFORCING MATERIALS INCLUDE: BORON, SiC, TUNGSTEN, AND EXTENDED CARBON/PHENOLIC RODS. IN PHASE I SAMPLE TRANSVERSE REINFORCED C/C SPECIMENS WILL BE MADE AND TESTED FOR THERMAL PROPERTIES.

GEO-CENTERS INC
7 WELLS AVE
NEWTON CENTRE, MA 02159
CONTRACT NUMBER:
GRANT STOKES
TITLE:
NOVEL SENSOR SYSTEM FOR WIDE AREA MINES
TOPIC# 35 OFFICE: TTO IDENT#: 22899

GEO-CENTERS, INC. PROPOSED TO DESIGN, DEVELOP, AND TEST A NOVEL SENSOR SYSTEM FOR WIDE AREA MINES (WAMS) THAT WILL ULTIMATELY DETECT ARMORED VEHICLES AT DISTANCES EXCEEDING 100 METERS. A MAGNETIC SENSOR TECHNOLOGY HAS BEEN DEVELOPED AND DEMONSTRATED WHICH PROMISES TO UNIQUELY COMBINE HIGH SENSITIVITY WITH EXTREME SIMPLICITY, RELIABILITY, RUGGEDNESS, COMPACT SIZE AND LOW COST. PROJECTED SENSITIVITIES PREDICT A THEORETICAL DETECTION RANGE OF GREATER THAN 200 METERS FOR A 20 TON TANK. THIS PHASE I SBIR PROGRAM WILL ANALYTICALLY DETERMIE AND EXPERIMENTALLY DEMONSTRATE THE ABILITY OF THIS MAGNETIC SENSOR TECHNOLOGY TO DETECT TARGET VEHICLES AT LARGE DISTANCES IN THE FIELD. DATA COLLECTED IN THE FIELD WILL DEMONSTRATE THE CAPABILITY OF THE SENSOR FOR WAM APPLICATIONS AND ANALYTIC CALCULATIONS WILL BE PERFORMED TO DETERMINE THE CAPABILITY OF THE FULLY DEVELOPED SENSOR TO DETECT MILITARILY SIGNIFICANT TARGETS. THE ADDITIONAL CAPABILITY GAINED BY USING THIS MAGNETIC SENSOR IN AN ARRAY OF COMMUNICATING AND COOPERATING WAMS WILL BE EXPLORED.

GORHAM ADVANCED MATERIALS INSTITUTE
211 MOSHER RD
WINDHAM, ME 04062
CONTRACT NUMBER:
DR ANDREW C NYCE
TITLE:
GAS PRESSURE SINTERING AND CONTAINERLESS HIP'ING OF Si(3)N(4)/SiC COMPOSITES
TOPIC# 25 OFFICE: DSO IDENT#: 22502

SUBMITTED BY

THIS PROPOSAL DESCRIBES AND R&D PROGRAM, THE OBJECTIVE OF WHICH IS TO INITIATE DEVELOPMENT OF SILICON NITRIDE/SILICON CARBIDE WHISKER COMPOSITES FABRICATED BY GAS PRESSURE SINTERING AND CONTAINERLESS HOT ISOSTATIC PRESSING (HIP). THE TARGET MATERIALS WILL BE BASED ON CERAMIC MATRICES FORMED FROM STARTING COMPOSITIONS OF Si_3N_4 + OR Y_2O_3 AND REINFORCED BY RANDOMLY ORIENTED SILICON CARBIDE WHISKERS ($\text{SiC}(w)$). A PRINCIPAL AIM OF THE STUDY WILL BE TO DETERMINE THE FEASIBILITY OF SINTERING THESE MATERIALS TO HIGH DENSITY, USING GAS PRESSURE SINTERING AND CONTAINERLESS HIP. THE PRODUCT MATERIALS SHOULD POSSESS GOOD HIGH TEMPERATURE STRENGTH AND OXIDATION RESISTANCE, OWING TO THE SMALL AMOUNTS OF SINTERING AIDS USED IN THE STARTING COMPOSITIONS, WHILE THE $\text{SiC}(w)$ SHOULD ENHANCE THE RESULTANT FRACTURE TOUGHNESS. TO PRECLUDE OR MITIGATE THE POSSIBILITY OF HIGH TEMPERATURE REACTIONS OCCURRING BETWEEN THE $\text{SiC}(w)$ AND N_2 OR OTHER REACTANT SPECIES PRESENT IN THE MATRIX (E.G., SiO_2 , MOLTEN SILICATES) DURING FIRING, THE $\text{SiC}(w)$ WILL BE COATED WITH INERT THIN FILMS OF BORON NITRIDE, USING CHEMICAL VAPOR DEPOSITION TECHNOLOGY, PRIOR TO THEIR INTRODUCTION INTO THE STARTING POWDER MIX. BY SUPERIMPOSING CONTAINERLESS HIP'ING ON SINTERING, IT SHOULD BE POSSIBLE TO ELIMINATE OR MARKEDLY REDUCE RESIDUAL POROSITY, THEREBY MINIMIZING FLAWS, AND HOMOGENIZE THE PROPERTIES OF THE MATERIALS.

GUMBS ASSOCS INC
11 HARTS LN
EAST BRUNSWICK, NJ 08816
CONTRACT NUMBER:
DR RONALD W GUMBS
TITLE:
INFRARED AND RADAR SUPPRESSIVE COATINGS
TOPIC# 15 OFFICE: ASTO IDENT#: 22753

THERE IS A NEED FOR A TECHNOLOGY BASE THAT WILL PERMIT THE SUPPRESSION OF INFRARED SIGNATURES CONTRIBUTING TO AIRCRAFT DETECTION OR MISSILE GUIDANCE AGAINST AIRCRAFT. MATERIALS AND COATINGS WITH REDUCED EMISSIVITY OR WHICH CAN DEFLECT AIRCRAFT RADIANCE ARE DESIRED. IN VIEW OF THIS, THE PRESENT PROPOSAL OUTLINES A PROGRAM TO DEVELOP SOLUBLE POLYMERS THAT POSSESS BROADBAND RADAR AND THERMAL

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INFRARED SUPPRESSIVE PROPERTIES. THESE POLYMERS WILL BE FORMULATED AS COATINGS AND THE PRIMARY OBJECTIVE OF PHASE I IS TO DEMONSTRATE THE FEASIBILITY OF THE CONCEPT, AND TO DEVELOP A MODEL TO PREDICT THE RADAR REFLECTIVITY OF A COATED OBJECT WITH THE CANDIDATE COATINGS. THE TECHNICAL APPROACH, IF SUCCESSFUL, SHOULD PERMIT THE DEVELOPMENT OF INFRARED CONTROL THAT WILL SYNERGISTICALLY SUPPORT BOTH RADAR AND OPTICAL SIGNATURE CONTROL.

HIGH TECHNOLOGY CORP
PO BOX 7262 - 28 RESEARCH DR
HAMPTON, VA 23666
CONTRACT NUMBER:
DR MUJEEB R MALIK

TITLE:

STABILITY AND TRANSITION IN CHEMICALLY REACTING NONEQUILIBRIUM FLOWS

TOPIC# 19

OFFICE: NASP

IDENT#: 22843

IT IS PROPOSED HERE TO DEVELOP A METHOD FOR PREDICTION OF TRANSITION ON NASP (NATIONAL AERO-SPACE PLANE) CONFIGURATION AND FOR THE CONTROL/ENHANCEMENT OF SUPERSONIC COMBUSTION IN THE SCRAMJET. THE METHOD IS BASED UPON LINEAR STABILITY ANALYSIS WITH NONE-EQUILIBRIUM EFFECTS WHICH TYPIFY THE BOUNDARY LAYERS ON NASP AIR-FRAME AND THE MIXING LAYER IN THE SCRAMJET. THESE THREE-DIMENSIONAL VISCOUS LAYERS, DEPENDING UPON FLOW PARAMETERS, MAY BE SUBJECTED TO VARIOUS TYPES OF INSTABILITIES SUCH AS TOLLMIE-SCHLICHTING, CROSS-FLOW AND GORTLER INSTABILITY. IN ORDER TO DELAY TRANSITION OR AUGMENT MIXING, A STUDY OF THESE INSTABILITIES WILL BE MADE AND MEANS FOR THEIR CONTROL WILL BE DEVISED. PHASE I WILL BE A FEASIBILITY STUDY IN WHICH LINEAR VISCOUS STABILITY THEORY WITH FINITE-RATE CHEMISTRY EFFECTS WILL BE DEVELOPED.

HNC INC/HECHT-NIELSEN NEUROCOMPUTER CORP
5501 OBERLIN DR
SAN DIEGO, CA 92121
CONTRACT NUMBER:
DR DOUGLAS A PALMER

TITLE:

NEUROCOMPUTER FOR IMAGE/SPECTRAL PATTERN RECOGNITION AND ANALYSIS

TOPIC# 36

OFFICE: TTO

IDENT#: 22916

SUBMITTED BY

NEUROPHYSIOLOGICAL RESEARCH IN VISION HAS SHOWN THAT MANY ASPECTS OF PREATTENTIVE VISION PROCESSING ENTAIL SIMPLE ALGORITHMS WHICH ARE IMPLEMENTED IN A HIGHLY PARALLEL ARCHITECTURE. LIKEWISE, ARTIFICIAL NEURAL SYSTEM RESEARCH AND APPLICATIONS HAVE RESULTED IN MANY PARADIGMS WHICH SHARE MANY OF THE SAME PROCESSING STEPS. WE PROPOSE TO DESIGN A SINGLE, UNIFIED TWO-DIMENSIONAL NEURAL NET PROCESSOR ARCHITECTURE CAPABLE OF DUPLICATING THE MOST IMPORTANT "LOCAL" VISION PROCESSING ALGORITHMS. THE ARCHITECTURE OF THIS PATTERN MATCHING ENGINE WILL ADDRESS THE PROBLEMS OF MEMORY, PROGRAMMING AND PARALLEL IMPLEMENTATION BY EXECUTING A PRIMITIVE INSTRUCTION SET BASED UPON TWO-DIMENSIONAL ADDRESSING. IN PARTICULAR, EMPHASIS WILL BE PLACED ON STEP-AND-REPEAT AND LOCAL AREA TRANSFORMS. THIS PROCESSOR IS TERMED A "COMPUTATIONAL MAP PROCESSOR" OR CMP.

INSITEC

2110 OMEGA RD - STE F
SAN RAMON, CA 94583

CONTRACT NUMBER:

DR DONALD J HOLVE

TITLE:

IN SITU PARTICLE SENSOR FOR MICROELECTRONIC MANUFACTURING PROCESS

TOPIC# 23 OFFICE: DSO IDENT#: 22493

REAL TIME, ON-LINE PARTICLE CONTAMINATION SENSORS FOR MICROELECTRONIC MANUFACTURING IN PROCESS EQUIPMENT ENVIRONMENTS HAVE THE POTENTIAL TO IMPROVE CHIP YIELDS THROUGH IMPROVED PROCESS CONTROL. CURRENT MICROELECTRONIC MANUFACTURING MONITORS ARE LIMITED TO LOW EFFICIENCY SAMPLING RATES AND GENERAL CLEAN-ROOM MONITORING DURING THE PRODUCTION PROCESS. PRESENTLY THERE IS NO ON-LINE SENSOR CAPABLE OF QUANTITATIVELY ASSESSING LOCAL PARTICLE CONTAMINATION DURING SHORT TIME CHANGES IN THE PROCESS ENVIRONMENT, E.G. GAS PURGING, CHEMICAL VAPOR DEPOSITION, ETC. WE PROPOSE TO DEVELOP AN IN-SITU PARTICLE MONITOR WHICH EXTENDS THE CAPABILITIES OF CURRENT CLEAN-ROOM PARTICLE COUNTER TECHNOLOGY TO RAPID MEASUREMENTS OF SUBMICRON PARTICLE SIZE AND LOW CONCENTRATION CONTAMINANTS IN MICROELECTRONIC PROCESSING EQUIPMENT.

INTER-SCIENCE INC

105 JORDAN RD
TROY, NY 12180

CONTRACT NUMBER:

JAMES T WOO

TITLE:

ADVANCED RADAR CROSS SECTION MEASUREMENT ANALYSIS

TOPIC# 17 OFFICE: ASTO IDENT#: 22780

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TO DESIGN MILITARY DELIVERY SYSTEMS OF MINIMUM RADAR CROSS SECTIONS (RCS) AND RADAR SYSTEMS CAPABLE OF DETECTING MINIMUM RCS OBJECTS, THERE IS THE NEED FOR AN EFFICIENT ALGORITHM THAT CAN ACCURATELY CALCULATE THE PERTURBATION TO THE WAVE FIELD CAUSED BY OBJECTS OF ARBITRARY SHAPE. A METHOD OF SOLUTION BASED ON THE USE OF A NATURAL COORDINATE SYSTEM WHICH CONFORMS TO THE ARBITRARY SHAPES OF THE SCATTERING OBJECT IS PROPOSED. IT IS SHOWN THAT THE ELECTRO-MAGNETIC SCATTERING PROBLEM CAN BE FORMULATED IN THIS COORDINATE SYSTEM RIGOROUSLY AND CAN TREAT OBJECTS CONTAINING A NESTED SET OF SHARP INTERFACES SEPARATING MATERIALS WITH INHOMOGENEOUS AND ANISOTROPIC PROPERTIES IN THE REGIONS BETWEEN THE INTERFACES. NUMERICAL SOLUTIONS BASED ON THIS FORMULATION CAN BE EXPECTED TO BE MORE EFFICIENT AND ACCURATE. THE TECHNIQUE IS ALSO GENERAL AND CAN BE APPLIED TO EITHER TWO- OR THREE-DIMENSIONAL PROBLEMS. UTILIZING THIS TECHNIQUE, IT SHOULD ALSO BE POSSIBLE TO DO THE INVERSE PROBLEM AND UNFOLD, NOT ONLY THE SHAPE, BUT ALSO THE MATERIAL PROPERTIES FROM THE SCATTERING DATA TO DISTINGUISH REAL THREATS FROM DECOYS. THE PROPOSED SIX-MONTH PHASE I EFFORT IS TO DEVELOP THE BASIC FORMULATION OF THE PROBLEM AND IDENTIFY THE COMPUTATIONAL REQUIREMENTS TO TREAT THE FULLY GENERAL PROBLEM IN THREE DIMENSIONS.

IRVINE SENSORS CORP
3001 REDHILL AVE - BLDG III/STE 208
COSTA MESA, CA 92626
CONTRACT NUMBER:
DAVID E LUDWIG

TITLE:

STACKED HIGH TEMPERATURE SUPERCONDUCTING ELECTRONIC FOR IR FOCAL PLANE SIGNAL PROCESSING

TOPIC# 37 OFFICE: TTO

IDENT#: 22943

IRVINE SENSORS CORPORATION (ISC), SUPPORTED BY TRW, PROPOSED TO UTILIZE THE ELECTRONICS REAL ESTATE AFFORDED BY THE ISC HYMOSS FOCAL MODULE AND THE TRW SUPERCONDUCTING JOSEPHSON-JUNCTION (J2) TECHNOLOGY TO DEVELOP A NEW AND POWERFUL IR ON-FOCAL PLANE SIGNAL PROCESSING CAPABILITY. ISC HAS DEVELOPED THE HYMOSS MODULE TO READ OUT AND PROCESS SIGNALS FROM 128 X 128 TWO-DIMENSIONAL ARRAYS OF IR DETECTORS. OVER A SQUARE MILLIMETER OF ELECTRONICS AREA PER DETECTOR

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IS AVAILABLE FOR PROCESSING. TRW HAS BEEN THE LEADING GROUP DEVELOPING LOW POWER, HIGH PERFORMANCE CIRCUITS APPROPRIATE FOR LWIR FOCAL PLANE PROCESSING USING BOTH NIOBIUM AT 4 DEG KELVIN AND NEW HIGHER TEMPERATURE SUPERCONDUCTORS WILL EXTEND THE CAPABILITY TO AT LEAST 60-80 DEG KELVIN MAKING IT MORE SUITABLE FOR TACTICAL APPLICATIONS AND NIOBIUM NITRIDE AT 10 DEG KELVIN. OF PARTICULAR INTEREST IS TRW'S DEMONSTRATED SUPERCONDUCTING ANALOG-TO-DIGITAL CONVERTER CAPABLE OF 13 BIT RESOLUTION AND 10⁷ WORDS PER SECOND AT LESS THAN 10 MICROWATTS POWER DISSIPATION. THEREFORE, ISC AND TRW PROPOSE TO MARRY THEIR TECHNOLOGIES TO PRODUCE HIGH PERFORMANCE LWIR FOCAL PLANE SIGNAL PROCESSING. PHASE I WILL ADDRESS ELECTRONICS CONFIGURATION TRADES AND CONCEPT DESIGN; PHASE II WILL BE AN EXPERIMENTAL PROGRAM TO DEVELOP HIGH TEMPERATURE SUPERCONDUCTOR DEVICES COMPATIBLE WITH HYMOSS STACKING TECHNOLOGY.

KMS FUSION INC
3850 RESEARCH PARK DR
ANN ARBOR, MI 48106
CONTRACT NUMBER:
PAUL D ROCKETT

TITLE:
SYSTEMATIC X-RAY LITHOGRAPHY WITH A HIGH AVERAGE POWER LASER
TOPIC# 31 OFFICE: DEO IDENT#: 22867

A HIGH AVERAGE POWER LASER CAN MEET THE NEAR TERM DOD GOAL OF DEVELOPING AN X-RAY SOURCE FOR SUBMICRON X-RAY LITHOGRAPHY. DESIGN RULES OF 0.25 MICROMETER AND SMALLER ARE ACHIEVABLE ON THE FACTORY FLOOR WITHIN THE NEXT FIVE YEARS WITH SUCH A SYSTEM. A TIGHTLY FOCUSED SOLID STATE LASER CAN PRODUCE A HIGH-TEMPERATURE, HIGH-DENSITY PLASMA WHICH RADIATES X-RAYS INTO THE IMPORTANT 1-2 keV SPECTRAL REGION. BY CLEVER USES OF PULSE SHAPING AND LASER-TARGET DESIGN, WE WILL LAY PLANS FOR A RELIABLE, COMPACT, EFFICIENT X-RAY EXPOSURE SYSTEM. PHASE I WILL INCLUDE THE DESIGN OF THE TARGET (MATERIAL AND CONFIGURATION), THE BEST LASER APPROACH, OPTICAL SWITCH-OUT AND PULSE SHAPE CONTROL, X-RAY FILTERING AND SPECTRAL CONTROL INSTRUMENTATION, FOCUSING OPTICS, AND MATCHING TO PARTICULAR X-RAY PHOTORESISTS. WE WILL USE OUR XCALIBR SOFT X-RAY CALIBRATION FACILITY TO EVALUATE THE WAVELENGTH SENSITIVITY OF SEVERAL COMMERCIAL RESISTS. THE RESULTS OF THIS EFFORT WILL LEAD TO PHASE II

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EXPERIMENTS USING A KMSF LASER (OR A SPECIALLY DESIGNED LASER) TO QUANTIFY THE SPECTRAL X-RAY OUTPUT OF THE CHOSEN LASER-PLASMA TARGETS AND TO DEMONSTRATE RESIST EXPOSURE. THE FINAL PHASE II EQUIPMENT WILL BE ATTACHED TO EXISTING STEP-AND-REPEAT EXPOSURE EQUIPMENT, SUCH AS THAT BUILT AT PERKIN-ELMER FOR X-RAY LITHOGRAPHY.

MEMBRANE TECHNOLOGY & RESEARCH INC

1360 WILLOW RD

MENLO PARK, CA 94025

CONTRACT NUMBER:

DR CARL-MARTIN BELL

TITLE:

SEPARATION OF OXYGEN FROM SEAWATER BY MEMBRANE PERMEATION

TOPIC# 7

OFFICE: NTO

IDENT#: 22673

A RELIABLE METHOD OF EXTRACTING DISSOLVED OXYGEN FROM SEAWATER IS REQUIRED FOR A NUMBER OF NAVAL APPLICATIONS. THIS PROPOSAL DESCRIBES THE DEVELOPMENT OF A MEMBRANE SYSTEM TO PERFORM THIS SEPARATION. IN THIS SYSTEM, SEAWATER CONTAINING DISSOLVED AIR IS BROUGHT IN CONTACT WITH A SUITABLE SELECTIVE MEMBRANE, AND A PARTIAL VACUUM IS APPLIED TO THE OTHER SIDE OF THE MEMBRANE. WATER AND DISSOLVED AIR PERMEATE THE MEMBRANE. THE WATER IS CONDENSED, PRODUCING A POTABLE WATER STREAM AND LEAVING AN OXYGEN-ENRICHED AIR STREAM. WE WILL USE THIN-FILM COMPOSITE POLY(DIMETHYLSILOXANE) OR ETHYLCELLULOSE MEMBRANES ALREADY PRODUCED AT MEMBRANE TECHNOLOGY AND RESEARCH, INC. (MTR), FOR THIS APPLICATION. IN THE PHASE I PROGRAM, THE TECHNICAL FEASIBILITY OF THE APPROACH WILL BE DEMONSTRATED USING A SMALL-BENCH SCALE SYSTEM AND 0.2-M(2) SPIRAL-WOUND MEMBRANE MODULES. BASED ON THESE RESULTS, A PRELIMINARY DESIGN ANALYSIS OF A UNIT FOR A 50-PERSON SUBMARINE CREW WILL BE PERFORMED. IN A PHASE II PROGRAM, A COMPLETE PILOT UNIT SUITABLE FOR FIELD EVALUATION WOULD BE PRODUCED.

MENTOR TECHNOLOGIES INC

53-50 - 206TH ST

BAYSIDE, NY 11364

CONTRACT NUMBER:

DR MITCHELL R BELZER

TITLE:

ACOUSTIC DATA PROCESSING USING THE DECENTRALIZED SQUARE ROOT

INFORMATION FILTER

TOPIC# 2

OFFICE: NTO

IDENT#: 22649

SUBMITTED BY

VLSI (VERY LARGE SCALE INTEGRATION) TECHNOLOGY HAS BEEN DEVELOPED TO THE POINT WHERE HIGH SPEED FLOATING POINT PROCESSORS MAY BE CASCADATED TO FORM COMPACT SUPERCOMPUTERS WITH FAR GREATER THROUGHPUT THAN UNIPROCESSOR MACHINES. MTI PROPOSES TO DESIGN AND DEVELOP A MULTIPROCESSOR COMPUTER ARCHITECTURE FOR REAL-TIME DIGITAL FILTERING OF UNDERWATER ACOUSTIC DATA FROM MULTIPLE SENSORS. THE ARCHITECTURE WILL BE OPTIMIZED FOR IMPLEMENTATION OF OUR NEW DECENTRALIZED SQUARE ROOT INFORMATION FILTER (DSRIF). PHASE I RESEARCH WILL DEMONSTRATE FEASIBILITY OF THE DSRIF AS A MEANS FOR SOLVING THE LINEAR LEAST SQUARES ESTIMATION PROBLEM IN DECENTRALIZED FORM. PHASE II RESEARCH WILL FOCUS UPON DEVELOPMENT AND TESTING OF A PROTOTYPE DEVICE.

METRON INC
1479 CHAIN BRIDGE RD
McLEAN, VA 22101

CONTRACT NUMBER:

DR LAWRENCE D STONE

TITLE:

THE APPLICATION OF PARALLEL PROCESSING TO COORDINATE ASW OPERATIO
TOPIC# 2 OFFICE: NTO IDENT#: 22648

THE PROBLEM AREA WE PROPOSE TO INVESTIGATE IS THE APPLICATION OF PARALLEL PROCESSING ALGORITHMS AND TECHNOLOGY TO COORDINATE ANTI-SUBMARINE WARFARE (ASW) OPERATIONS. OUR TECHNICAL OBJECTIVES ARE TWO-FOLD: 1) TO CONSIDER A SPECIFIC EXAMPLE OF DISCRETE NONLINEAR FILTERING, ANALYZE THE PARALLELISM IN THE DISCRETE FILTERING ALGORITHM, AND DEVELOP NEW ALGORITHMS FOR PARALLEL PROCESSORS COUPLED WITH A THEORETICAL ASSESSMENT OF THE TYPES OF ARCHITECTURES ON WHICH THE FILTERING ALGORITHM WOULD PERFORM BEST; AND 2) TO IMPLEMENT AND EVALUATE SELECTED ALGORITHMS ON A MOTOROLA 68020-BASED PARALLEL MACHINE IN ORDER TO EXPERIMENTALLY VERIFY THE UTILITY OF THE NEW ALGORITHMS. THE DISCRETE FILTERING ALGORITHM WE PROPOSE TO ANALYZE IS A NON-LINEAR TRACKER PREVIOUSLY DEVELOPED BY METRON. WE WILL SHOW THAT THE DISCRETE FILTERING ALGORITHM IS MASSIVELY PARALLEL, AND THAT MOST OF THE OPERATIONS COULD BE CARRIED OUT BY A SIMD COMPUTER USING A RECTANGULAR ARRAY OF PROCESSORS. HOWEVER, SEVERAL STEPS IN THE ALGORITHM REQUIRE NON-TRIVIAL INTERPROCESSOR COMMUNICATION, SO THE OPTIMAL PROCESSOR INTERCONNECTION SCHEME IS NOT OBVIOUS.

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METSAT INC
515 S HOWES ST
FORT COLLINS, CO 80521
CONTRACT NUMBER:
DR EDWARD TOMLINSON

TITLE:
ADVANCED COMPUTER TECHNIQUES FOR WEATHER INFORMATION IN REAL-TIME
MISSION PLANNING
TOPIC# 20 OFFICE: ASTO IDENT#: 22580

THE REAL-TIME MISSION PLANNING ASPECTS OF AIR LAND BATTLE MANAGEMENT (ALBM) REQUIRE EFFICIENT AND EFFECTIVE USE OF ALL AVAILABLE INTELLIGENCE DATA TO OPTIMIZE EMPLOYMENT OF MODERN MILITARY ASSETS. ALTHOUGH SIGNIFICANT PROGRESS HAS BEEN MADE IN DEVELOPING ADVANCED COMPUTER TECHNIQUES FOR MANY FACETS OF BATTLEFIELD MANAGEMENT, APPLICATIONS IN THE AREA OF BATTLEFIELD WEATHER HAVE BEEN LACKING. PHASE I OF THE PROPOSED WORK WILL ADDRESS THE USE OF ADVANCED COMPUTER TECHNIQUES FOR MERGING VARIOUS WEATHER DATA FROM THE LOCAL BATTLEFIELD REGION TO SUPPORT REAL-TIME MISSION PLANNING AND BATTLEFIELD MANAGEMENT. METSAT, INC. PROPOSES TO DEVELOP SPECIFIC TECHNIQUES FOR WEATHER DATA INTEGRATION INTO A DATA-BASE ARCHITECTURE OPTIMIZE FOR REAL-TIME MISSION SUPPORT. THE GOAL OF THIS RESEARCH IS THE EFFECTIVE USE OF APPROPRIATE WEATHER INFORMATION TO OPTIMIZE THE EMPLOYMENT OF BOTH AIR AND GROUND COMBAT RESOURCES. THE ADVANCED TECHNIQUES DEVELOPED IN PHASE II WILL UTILIZE MODERN COMPUTING TECHNOLOGIES SUCH AS PARALLEL PROCESSING.

MISSION GORGE RANGE CORP
PO BOX 203389 - 7080 MISSION GORGE RD
SAN DIEGO, CA 92120
CONTRACT NUMBER:
HARRY L BLACKWELL

TITLE:
TECHNIQUES FOR MEASUREMENT OF COMPLETE RADAR CROSS SECTION AT
LARGE BISTATIC ANGLES
TOPIC# 17 OFFICE: ASTO IDENT#: 22773

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THE PURPOSE OF THE PROPOSED EFFORT IS TO ADVANCE THE STATE OF THE ART IN BISTATIC RADAR CROSS SECTION MEASUREMENT TECHNOLOGY THROUGH DEVELOPMENT OF INNOVATIVE INSTRUMENTATION AND TECHNIQUES APPLICABLE TO LARGE BISTATIC ANGLE MEASUREMENTS ON AN OUTDOOR RANGE FACILITY. SPECIFIC OBJECTIVES ARE THE IDENTIFICATION OF VALID APPROACHES FOR THE INCORPORATION OF COMPLETE POLARIZATION SCATTERING MATRIX AND WIDEBAND TARGET IMAGING CAPABILITY INTO THE MISSION GORGE RANGE (MGR) BISTATIC RANGE FACILITY.

MSNW INC
PO BOX 865
SAN MARCOS, CA 92069
CONTRACT NUMBER:
DR GEORGE H REYNOLDS
TITLE:
FIBER COATINGS FOR INTERMETALLIC MATRIX COMPOSITES
TOPIC# 24 OFFICE: DSO IDENT#: 22551

THE PROPOSED RESEARCH WILL EXAMINE THE UTILITY OF DUPLEX COATINGS, CONSISTING OF AN INNER, WEAKLY-BONDED COATING IMMEDIATELY ADJACENT TO THE FIBER AND AN OUTER, CHEMICAL-COMPATIBILITY COATING ADJACENT TO THE MATRIX. MODEL DUPLEX COATING SYSTEMS, WHERE EACH CONSTITUENT MATERIAL IS THERMOCHEMICALLY COMPATIBLE WITH THE ADJACENT MATERIALS, WILL BE PREPARED BY LOW-PRESSURE CHEMICAL VAPOR DEPOSITION ON COMMERCIAL CARBON, SILICON CARBIDE, BORON AND ALUMINUM OXIDE YARNS AND FILAMENTS. COATED YARNS AND FILAMENTS WILL BE INCORPORATED INTO TIAL MATRICES, AND THE MECHANICAL PROPERTIES OF THE PRODUCT COMPOSITES EVALUATED. THE PRODUCT COMPOSITES ARE EXPECTED TO BE USEFUL AS STRUCTURAL MATERIALS FOR BOTH HYPERSONIC VEHICLES AND ADVANCED TURBOJET ENGINES. THE PROJECT WILL BE PERFORMED WITH THE ENGINEERING AND TECHNICAL ASSISTANCE OF THE UNIVERSITY OF CALIFORNIA-SANTA BARBARA FOR COMPOSITE PREPARATION AND EVALUATION.

PARA-SOFT CORP
27415 TRABUCO CIR
MISSION VIEJO, CA 92692
CONTRACT NUMBER:
DR JON FLOWER
TITLE:
DESIGN OF A PARALLEL CAD SYSTEM
TOPIC# 28 OFFICE: ISTO IDENT#: 22544

SUBMITTED BY

WE PROPOSE TO STUDY AND EVALUATE ALGORITHMS WHICH ARE APPROPRIATE TO TWO NUMERICALLY INTENSIVE PARTS OF ELECTRICAL CAD SYSTEMS, VIA. COMPONENT PLACEMENT AND CIRCUIT ROUTING. BOTH PROBLEMS ARE EXTREMELY COMPUTATIONALLY INTENSIVE OFTEN REQUIRING TIMES OF THE ORDER OF HOURS ON SEQUENTIAL MACHINES. THE NEED IS FOR TURNAROUND TIMES ON THE ORDER OF MINUTES AND PARALLEL PROCESSING IS A NATURAL WAY TO GAIN THE REQUIRED SPEEDUPS. IN THE ROUTING AREA WE INTEND TO EXAMINE ALGORITHMS IN USE OF SEQUENTIAL MACHINES AND THEIR APPLICABILITY TO PARALLEL COMPUTERS AS WELL AS DEVELOPING NEWER ALGORITHMS DERIVED FROM GRAPH THEORETICAL CALCULATIONS WHICH MAY HAVE BETTER PARALLELISM. THE COMPONENT PLACEMENT PROBLEM WILL BE STUDIED ON THE BASIS OF APPLYING MONTE CARLO TECHNIQUES WHICH ARE KNOWN TO HAVE GOOD PARALLEL EFFICIENCIES. WE WILL ATTEMPT TO DERIVE A MONTE CARLO PROCEDURE THAT LINKS THE PLACEMENT AND ROUTING PHASES OF CAD SYSTEM MORE CLOSELY SO THAT SIGNIFICANTLY ENHANCED ROUTING PERFORMANCE CAN BE EXPECTED. WE WILL EVALUATE OUR ALGORITHMS ON A NUMBER OF ARCHITECTURES INCLUDING A SMALL SCALE PARALLEL PROCESSOR DESIGNED AS A PERFORMANCE ACCELERATOR AND EDUCATIONAL TOOL FOR PC MACHINES.

PDA ENGINEERING
2975 REDHILL AVE
COSTA MESA, CA 92626
CONTRACT NUMBER:
DR LARRY A HARRAH

TITLE:

SILICON CARBIDE COATINGS FOR HIGH TEMPERATURE APPLICATION OF
CARBON FIBERS

TOPIC# 24

OFFICE: DSO

IDENT#: 22540

CARBON AND GRAPHITE FIBERS HAVE RELATIVELY POOR OXIDATION RESISTANCE. THEIR UTILITY IN HIGH TEMPERATURE APPLICATIONS CAN BE ENHANCED BY A WELL ADHERING OXIDATION RESISTANT COATING. SUCH COATINGS ALSO HAVE THE POTENTIAL FOR IMPROVING INTERFACIAL ADHESION WITH MATRIX RESINS. THE GOAL OF THIS PROGRAM IS TO DEMONSTRATE THAT A SiC COATING CAN BE APPLIED TO CARBON FIBERS WITH A SUFFICIENTLY STRONG BOND AT THE INTERFACE TO INSURE SURVIVAL AND TO ACT AS AN OXIDATION BARRIER. THE APPROACH IS TO CHEMICALLY MODIFY THE FIBER SURFACE TO FORM COVALENT BONDS WITH A POLYMERIC SiC PRECURSOR THAT IS THEN PYROLYTICALLY CON-

SUBMITTED BY

VERTED TO AN ADHERENT SiC COATING.

PHYSICAL OPTICS CORP
2545 W - 237TH ST
TORRANCE, CA 90505
CONTRACT NUMBER:
DR TOMASZ JANNSON
TITLE:
COMPOUND HOLOGRAPHIC STRUCTURES FOR ULTRA-HIGH CAPACITY INFORMATIO
STORAGE
TOPIC# 21 OFFICE: DSO IDENT#: 22541

IN THIS PROGRAM, THE FEASIBILITY OF A NEW GENERATION OF VOLUME HOLOGRAPHIC STRUCTURES WILL BE INVESTIGATED FOR ULTRA-HIGH CAPACITY INFORMATION STORAGE. THE STRUCTURES TO BE STUDIED WILL BE COMPOSED OF COHERENTLY COUPLED SUBHOLOGRAMS RECORDED IN PHOTSENSITIVE MATERIALS. THIS APPROACH WILL ALLOW US TO SIGNIFICANTLY INCREASE THE THICKNESS OF THE STORAGE MEDIUM THUS INCREASING ITS INFORMATION CAPACITY BEYOND THE CURRENT STATE OF THE ART. IN PARTICULAR, BY USING OUR NOVEL APPROACH KNOWN AS COMPOUND COHERENTLY COUPLED (C3) HOLOGRAPHIC STRUCTURES, WE CAN ACHIEVE LARGE-THICKNESS (> 1cm) VOLUME HOLOGRAPHIC STORAGE WITH MERELY CONVENTIONAL PASSIVE MATERIALS. THIS APPROACH WILL ALSO CIRCUMVENT THE PROBLEMS ASSOCIATED WITH PHOTOFRACTIVE CRYSTALS, AND DRASTICALLY INCREASE THE STORAGE CAPACITY UP TO 10(12) BITS/CM(3).

PHYSICAL OPTICS CORP
2545 - W 237TH ST
TORRANCE, CA 90505
CONTRACT NUMBER:
DR TOMASZ JANNSON
TITLE:
HOLOGRAPHIC ALL-OPTIC NEURAL NETWORK
TOPIC# 36 OFFICE: TTO IDENT#: 22926

IN ORDER TO MAKE HIGHLY-PARALLEL OPTICAL NEURAL NETWORKS A SHORT-TERM TARGET FOR DARPA'S AUTOMATIC TARGET RECOGNITION (ATR) PROGRAM, POC

SUBMITTED BY

PROPOSES A NEW TECHNOLOGICAL APPROACH TO "OPTICAL NEURONS AND SUNAPESE" OF A WINDROW-HOFF-TYPE OPTICAL NEURAL NETWORK. THIS WILL TAKE THE FORM OF TWO HOLOGRAPHIC SUB-SYSTEMS: POLYMER SUPER-THICK VOLUME (PSTV) HOLOGRAPHIC INTERCONNECTIVITY MATRIX AND ALL-OPTIC HARD THRESHOLDING BASED ON FABRY-PEROT HOLOGRAPHIC NON-LINEAR ETALONS (HNLEs). POC'S ALL-OPTIC NEURAL NETS SATISFY THE ANDERSON-GROSSBERG BRAIN-STATE-IN-A-BOX (BSB) MODEL (SIMULATING AN ANIMAL CORTICAL HYPERCOLUMN), WITH VERY HIGH NUMBER OF "OPTICAL NEURONS": $N=(256)^2=65,536$, AND VERY HIGH INTERCONNECTABILITY RELATED TO NUMBER OF FULLY-PARALLEL OPTICAL SYNAPSES: $N(2)=4,294,967,296$, I.E., 40-TIMES HIGHER THAN THAT OF A HUMAN CORTICAL HYPERCOLUMN (WHERE $N=10(4)$). POC'S PSTV HOLOGRAPHIC MEMORY HAS A MUCH LARGER INTERCONNECTABILITY AND SNR THAN ITS LiNbO_3 EQUIVALENT, WHILE POC'S HNLEs OFFER A UNIQUE HARDWARE SOLUTION FOR HIGH-DENSITY ALL-OPTIC THRESHOLDING.

PLASMATRON INC
503 N VALLEY AVE
VINELAND, NJ 08630
CONTRACT NUMBER:
KAMBIZ POURREZAEI

TITLE:
COATING OF CARBON AND SiC FIBERS FOR HIGH TEMPERATURE APPLICATION
TOPIC# 24 OFFICE: DSO IDENT#: 22559

PLASMATRON HAS DEVELOPED A RF-HOLLOW CATHODE MAGNETRON (RF-HCM) SYSTEM TO UNIFORMLY COAT TOWS OF FIBERS. IN THIS SYSTEM WE HAVE THE PROVISION FOR RF BIASING THE TOW, CONSEQUENTLY THE COATING UNIFORMITY OF THE INDIVIDUAL FIBERS IS SIGNIFICANTLY IMPROVED. ALSO, AT PLASMATRON WE HAVE DEVELOPED THE FABRICATION PROCEDURE FOR CONSTRUCTION OF CYLINDRICAL TARGETS OF KEY HIGH TEMPERATURE MATERIALS, NAMELY SUPER IRON ALLOY FeCrAlY, TiN, TiC, AND SiC. MONO AND MULTIFILAMENTS OF CARBON AND SiC FIBERS WILL BE COATED WITH FeCrAlY/SiC, Ti/TiN/ti, AND Ti/SiC/ti TO PROVIDE A GOOD DIFFUSION BARRIER AND SUFFICIENT ADHESION TO BOTH THE CARBON FIBER AND THE MATRIX (E.G. FeCrAlY ALLOY OR Ti MATRICES). THE DEVELOPED TECHNOLOGY IS SUFFICIENTLY GENERIC SO THAT ALMOST ALL FIBER REINFORCED COMPOSITES COMBINATION CAN BE FABRICATED. EXTENSIVELY THIN FILM CHARACTERIZATION TECHNIQUE WILL BE USED TO INVESTIGATE FILM UNIFORMITY, ADHESION, CHEMICAL AND MECHANICAL PROPERTIES. NAMELY SEM-EDX, EMPA, GRAVIMETRIC ANALYSIS; XPS, AND RBS

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TECHNIQUES WILL BE EMPLOYED. WE ARE PARTICULARLY INTERESTED IN HIGH TEMPERATURE BEHAVIOR OF THE DEPOSITED FIBERS. THE COATED FIBERS WILL BE TESTED AT 800 DEG C AND THE FIBER CROSS SECTION WILL BE CHECKED TO INVESTIGATE ANY DIFFUSION OF ALUMINUM AND CREATION OF CRACKS DUE TO THERMAL STRESS. FOR SELECTED FINAL PLANAR SAMPLES, A SIMILAR TEST WILL BE PERFORMED WITH 200 HRS INCREMENTS USING RBS TECHNIQUE. THE RBS RESULT WILL ALSO BE EMPLOYED FOR INVESTIGATION OF INTERFACE INTERMIXING.

RADAR GUIDANCE INC
7011 EVERGREEN CT
ANNANDALE, VA 22003

CONTRACT NUMBER:

WILLIAM J COX

TITLE:

REMOTELY PILOTED VEHICLE (RPV) TECHNOLOGY

TOPIC# 18

OFFICE: ASTO

IDENT#: 22812

RGI, THROUGH ITS ARRANGEMENTS WITH SCIENCE APPLICATIONS INTERNATIONAL CORPORATION, PROPOSES TO DEMONSTRATE THROUGH ANALYSIS THE FEASIBILITY OF USING MODIFIED VERSIONS OF THE OMAR (OPTICAL MICROWAVE APPROACH AND RANGING) SYSTEM TO ENHANCE THE RELIABILITY OF RPVs. OMAR, CURRENTLY UNDER DEVELOPMENT AS A PRECISION, LOW VISIBILITY LANDING SYSTEM FOR AIRCRAFT (WITH EMPHASIS ON HELICOPTERS), LENDS ITSELF UNIQUELY TO RPV REQUIREMENTS. MODIFICATIONS TO OMAR WILL BE REQUIRED FOR SPECIALIZED RPV USE BUT BASIC CONCEPTS OF LUNEBERG LENS BEAM SHAPING WITH ANGLE/RANGE PROCESSING WILL REMAIN VALID. OMAR CHARACTERISTICS, INCLUDING THE ABILITY TO OPERATE IN A PASSIVE (COVERT) MODE, MAKE IT ATTRACTIVE AS A PORTABLE MILITARY POSITIONING AND CONTROL SYSTEM. FOR RPV APPLICATIONS ITS RESPONSE TO AUTHENTICATION CODED INTERROGATION, STRUCTURED IN DIRECTIONAL, LOW-POWER REFLECTIVE BEAMS, PROVIDE A LOW PROBABILITY OF INTERCEPT ENVIRONMENT.

SANGLAPPERS

PO BOX 1298

SIMPSONVILLE, SC 29681

CONTRACT NUMBER:

HUGH E REDICK

TITLE:

OUTPUT AND STABILITY OF GRAPHITE FIBER THERMOCOUPERS

TOPIC# 23

OFFICE: DSO

IDENT#: 22475

SUBMITTED BY

A UNIQUE THERMOCOUPLE FOR MEASURING TEMPERATURES ABOVE THE TUNGSTEN/TUNGSTEN-RHENIUM RANGE OF 2400 DEG C HAS BEEN DESCRIBED IN OUR COMPANY'S U.S. PATENT 4,650,920. THE USE OF THIS GRAPHITE FIBER THERMOCOUPLE OFFERS MANY ADVANTAGES IN TESTING OF MATERIALS AT HIGH TEMPERATURES AS COMPARED TO RADIATION SENSORS. TO BE COMMERCIALY SUCESSFUL THIS GRAPHITE FIBER THERMOCOUPLE MUST HAVE A REPRODUCIBLE AND STABLE SEEBECK VOLTAGE. THIS PROPOSAL WILL FUND RESEARCH TO EXAMINE THE OUTPUT AND STABILITY OF FOUR VARIOUS FIBER THERMOCOUPLES REPLICATED FOUR TIMES EACH.

SCIENCE HORIZONS INC
710 ENCINITAS BLVD - STE 200
ENCINITAS, CA 92024
CONTRACT NUMBER:
DR DANNY J HARVEY
TITLE:
SEISMIC RADAR
TOPIC# 9 OFFICE: NRMO IDENT#: 22678

SCIENCE HORIZONS HAS DEVELOPED A PROPRIETARY METHOD OF DISPLAYING SEISMIC DATA, CALLED SEISMIC RADAR, WHICH USES THE HIGH RESOLUTION, COLOR GRAPHICS CAPABILITIES OF THE DARPA SCIENTIFIC WORKSTATION TO PROVIDE A "RADAR LIKE" DISPLAY OF THE SEISMIC DATA GENERATED BY AN ARRAY OF SEISMOMETERS. THE PARAMETERS ABLE TO BE EXTRACTED BY AN ANALYST FROM THE SEISMIC. RADAR DISPLAY ARE THE VELOCITY, AZIMUTH, AND AMPLITUDE OF THE PHASE. SEISMIC RADAR WAS DEVELOPED BY SCIENCE HORIZONS TO FULFILL THE DEMONSTRATION REQUIREMENTS ASSOCIATED WITH THE DARPA SCIENTIFIC WORKSTATION. HOWEVER, IT SOON BECAME APPARENT THAT THE INFORMATION CONTYAINED IN THE SEISMIC RADAR DISPLAY, WHILE AN EFFECTIVE DEMONSTRATION VEHICLE FOR THE WORKSTATION, SHOULD ALSO BE EXTREMELY USEFUL TO AN ANALYST WHO REQUIRES NEAR-REAL-TIME, COMPREHENSIBLE ESTIMATES OF THE AZIMUTH, VELOCITY, AND AMPLITUDE OF THE INDIVIDUAL PHASES WHICH COMPRISE A SEISMIC EVENT. THEREFORE, THE PROBLEM TO BE ADDRESSED DURING PHASE I IS TO DEMONSTRATE THE FEASIBILITY OF USING THE PROCESSING AND DISPLAY FEATURES EMBODIED IN SEISMIC RADAR IN ORDER TO ASSIST AN ANALYST IN DETECTING AND LOCATING SEISMIC EVENTS.

SCIENTIFIC COMPUTING ASSOCS INC
246 CHURCH ST - STE 307
NEW HAVEN, CT 06510
CONTRACT NUMBER:
DR DAVID E FOULSER
TITLE:
HIGHLY PARALLEL INTERATIVE METHODS FOR MASSIVELY PARALLEL MULTIPROCESSORS
TOPIC# 28 OFFICE: ISTO IDENT#: 22508

SUBMITTED BY

FOR THE REST OF THIS CENTURY, TWO OF THE POTENTIALLY MOST IMPORTANT ADVANCES IN THE "TECHNOLOGY" OF LARGE SCALE SCIENTIFIC COMPUTING ARE SPARSE MATRIX (ITERATIVE) ALGORITHMS AND MASSIVELY PARALLEL PROCESSING. IN THIS PROPOSAL, WE OUTLINE OUR PLANS TO BUILD A SOFTWARE PACKAGE FOR THE CONNECTION MACHINE CM-2 THAT WILL BRING THE POWER OF BOTH ADVANCES TO THE AID OF THE SCIENTIFIC COMMUNITY WITHOUT FORCING THAT COMMUNITY TO BECOME EXPERT IN EITHER TECHNOLOGY. WE PROPOSE TO DEVELOP EFFICIENT MASSIVELY PARALLEL ALGORITHMS FOR THE ITERATIVE SOLUTION OF LARGE SPARSE LINEAR SYSTEMS OF EQUATIONS. WE WILL IMPLEMENT THESE ALGORITHMS IN A PACKAGE PCGPAK/CM EXPLICITLY DESIGNED AND OPTIMIZED FOR THE CONNECTION MACHINE. PCGPAK/CM WILL BE BASED ON OUR EXISTING PROPRIETARY PACKAGE PCGPAK(tm), THE PRECONDITIONED CONJUGATE GRADIENT PACKAGE OF SUBROUTINES FOR THE ITERATIVE SOLUTION OF LARGE, SPARSE NONSYMMETRIC SYSTEMS OF LINEAR EQUATIONS. PCGPAK IS A STATE-OF-THE-ART SOLVER FOR UNIPROCESSOR ARCHITECTURES. IT WAS DESIGNED AND DEVELOPED BY SCIENTIFIC COMPUTING ASSOCIATES AND IS CURRENTLY MARKETED IN A HIGHLY-PORTABLE SEQUENTIAL PROCESSOR FORTRAN IMPLEMENTATION AND A HIGHLY VECTORIZED IMPLEMENTATION FOR THE CRAY-X/MP. PCGPAK IS CURRENTLY BEING USED AT MANY SITES INCLUDING SEVERAL OF THE NSF NATIONAL SUPERCOMPUTER CENTERS. WE BELIEVE THAT COMBINATION OF THE CM-2 AND PCGPAK/CM WILL BE SO MUCH FASTER THAN EXISTING SOLUTION TECHNOLOGIES SO AS TO COMPLETELY REVOLUTIONIZE THE STATE-OF-THE-ART IN COMPUTER SIMULATION.

SPARTA INC
21 WORTHEN RD
LEXINGTON, MA 02173
CONTRACT NUMBER:
ROBERT DILLON
TITLE:
AN ACTIVE OPTICAL SENSOR FOR ADVANCED MINE AND BARRIER SYSTEMS
TOPIC# 35 OFFICE: TTO IDENT#: 22907

THIS PROPOSAL PRESENTS A PLAN FOR DEVELOPING A LOW-COST, SIMPLE ACTIVE OPTICAL DETONATION SENSOR FOR ADVANCED MINE AND BARRIER SYSTEMS. DUBBED THE ACTIVE RANGING, TRACKING AND SIGNATURE SENSOR (ARTS), THE PROPOSED SYSTEM IS CAPABLE OF DETERMINING THE RANGE, VECTOR VELOCITY, AND GEOMETRIC PROFILE OF OBJECTS PASSING THROUGH

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ITS FIELD OF VIEW. IT TAKES ADVANTAGE OF RECENT ADVANCES IN OFF-THE-SHELF OPTICAL SCANNERS, SOLID-STATE LASER DIODES, OPTICAL DETECTORS AND SIGNAL PROCESSING COMPONENTS IN A WAY THAT ALLOWS EACH SENSOR TO BE BUILT FOR A FEW THOUSAND DOLLARS WHEN FABRICATED IN LARGE QUANTITIES. ITS VERSATILITY, LOW COST, LOW POWER REQUIREMENTS, LOW WEIGHT, AND RELATIVE SIMPLICITY MAY MAKE IT THE SENSOR OF CHOICE FOR CERTAIN BARRIER AND MINE CONCEPTS OF THE FUTURE.

SULLIVAN MINING CORP
PO BOX 4615
SAN DIEGO, CA 92104
CONTRACT NUMBER:
THOMAS M SULLIVAN
TITLE:
HARD-FACED CARBON-CARBON FOR SPACECRAFT
TOPIC# 25 OFFICE: DSO IDENT#: 22460

SULLIVAN SURFACES FOR CARBON SUBSTRATES ARE STABLE TO 2300 DEG C (4173 DEG F) UNDER VACUUM. COATING MATERIAL IS IMPERVIOUS TO ATOMIC OXYGEN ATTACK. STATE OF THE ART COATINGS FOR CARBON-CARBON ARE LIMITED TO 1400 DEG C FOR BRIEF PERIODS. SULLIVAN MIXED SURFACES ARE POTENTIALLY SPALL AND OXIDATION RESISTANT AFTER MANY CYCLES OF PROLONGED PERIODS AT 1900 DEG C. MIXING THE SURFACE BY MEANS OF NEW HIGH ENERGY TECHNOLOGY CAN PRODUCE, HERETOFORE, IMPOSSIBLE OR PRACTICAL SURFACES. CARBON-CARBON CAN BE "HARD-FACED" FOR ABRASION RESISTANCE.

SUPERCON INC
830 BOSTON TURNPIKE
SHREWSBURY, MA 01545
CONTRACT NUMBER:
DR ERIC GREGORY
TITLE:
J(c) ENHANCEMENT OF YB(a)(2)Cu(3)O(7-x) FIBERS USING LASER ZONE REFINEMENT
TOPIC# 38 OFFICE: DSO IDENT#: 23005

TREMENDOUS EXCITEMENT AND INTEREST HAS BEEN GENERATED IN RECENT

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MONTHS OVER THE DISCOVERY OF THE $\text{YBa}(2)\text{Cu}(3)\text{O}(7-x)$ ("123"), LIQUID NITROGEN SUPERCONDUCTORS. HOWEVER, THIS EXITEMENT HAS BEEN TEMPERED BY THE INABILITY TO ACHIEVE LARGE TRANSPORT $J(c)$ 'S IN BULK-PROCESSED POLYCRYSTALLINE MATERIALS BECAUSE OF WEAK LINK BEHAVIOR. THESE WEAK LINKS HAVE TWO POSSIBLE ORIGINS; FIRSTLY, THE PRESENCE OF NON-SUPERCONDUCTING PHASES AT THE GRAIN BOUNDARIES AND SECONDLY, THE INTRINSIC ANISTROPY OF THE SUPERCONDUCTIVITY IN THE HIGH $T(c)$ SUPERCONDUCTORS. IN THIS PHASE I PROPOSAL CONVENTIONAL ZONE REFINEMENT TECHNIQUES WILL BE USED TO FABRICATE "123" CERAMIC FIBERS WITH CLEAN, TEXTURED GRAINS. WE WILL LASER ZONE REFINE RODS OF THE "123" MATERIALS FABRICATED AT SUPERCON INC., AND STUDY IN DETAIL THE EFFECTS OF THIS PROCESS ON THE TRANSPORT CRITICAL CURRENTS IN $\text{YBa}(2)\text{Cu}(3)\text{O}(7-x)$ SUPERCONDUCTING COMPOSITES.

TECHNICAL RESEARCH ASSOCS INC

760 LAS POSAS RD - STE A-4

CAMARILLO, CA 93010

CONTRACT NUMBER:

EDWIN M WINTER

TITLE:

ALGORITHMS FOR PARALLEL COMPUTERS

TOPIC# 28

OFFICE: ISTO

IDENT#: 22538

THE TECHNOLOGY OF INFRARED AND OPTICAL SURVEILLANCE IS AN EXCELLENT CANDIDATE FOR PARALLEL PROCESSING. INCREASED SENSITIVITY AND GREATER COVERAGE HAS GREATLY MAGNIFIED THE OVERALL PROCESSING PROBLEM. TRA WITH MRJ PROPOSES TO UTILIZE A STATE-OF-THE-ART PARALLEL PROCESSOR, THE CONNECTION MACHINE, TO DEVELOP AND EVALUATE ALGORITHMS FOR TARGET DETECTION. TRA AND MRJ FEEL THAT THE APPLICATION OF PARALLEL PROCESSING TO THIS PROBLEM WILL OPEN NEW AVENUES FOR SOLVING THIS COMPUTATIONALLY INTENSE PROBLEM. ALGORITHMS WILL BE EVALUATED ON HI-CAMP DATA ON THE CONNECTION MACHINE AND COMPARED TO CONVENTIONAL PROCESSOR IMPLEMENTATIONS.

TECHNOLOGY INTERNATIONAL INC

429 W AIRLINE HWY - STE S

LaPLACE, LA 70068

CONTRACT NUMBER:

DR EDWIN STEVENS

TITLE:

A MINE AND EXPLOSIVES DETECTION CAPABILITY EMPLOYING X-RAYS

(MINEDECX)

TOPIC# 34

OFFICE: TTO

IDENT#: 22896

SUBMITTED BY

TECHNOLOGY INTERNATIONAL INCORPORATED (TII) PROPOSES A PROGRAM TO DESIGN, TEST, AND MANUFACTURE A MINE AND EXPLOSIVES DETECTION CAPABILITY EMPLOYING X-RAYS (MINEDECX), UTILIZING MULTIPLE-ENERGY BACKSCATTER IMAGING. THE MINEDECX IS EXPECTED TO PROVIDE A PRECISE MEANS OF DETECTING BURIED ANTI-VEHICULAR AND ANTI-PERSONNEL LAND MINES. THE MAIN GOALS INCLUDE, DESIGN AND EVENTUAL FABRICATION OF A MINE DETECTOR OF HIGH EFFICIENCY, LOW MASS, HIGH RELIABILITY, AND LOW MANUFACTURING COST. HISTORICALLY, MINES AND HIDDEN EXPLOSIVE DEVICES HAVE PROVEN TO BE OF SIGNIFICANCE IN BOTH LOW AND HIGH INTENSITY CONFLICTS. MINES HAVE DESTROYED OVER TWENTY FIVE PERCENT OF THE VEHICLES IN WORLD WAR II. THAT PERCENTAGE HAS ALMOST TRIPLED (NEARLY SEVENTY PERCENT) IN VIET NAM. THIS IS IN ADDITION TO EXTENSIVE LOSS OF PERSONNEL.

WINZEN INTERNATIONAL INC
6800 PARK TEN BLVD - STE 126E
SAN ANTONIO, TX 78213
CONTRACT NUMBER:
JAMES L RAND
TITLE:
LONG DURATIONN BALLOON TECHNOLOGY
TOPIC# 1 OFFICE: NTO IDENT#: 22639

THIS PROPOSAL ADDRESSES THE DESIGN AND FABRICATION OF A LONG ENDURANCE BALLOON VEHICLE HAVING A ONE-YEAR LIFE AT 120,000 FEET. THE CONCEPT MAKES USE OF THE EXPERIENCE GAINED BY THE SCIENTIFIC COMMUNITY OVER THE PAST TWO DECADES IN FLYING SMALLER PAYLOADS FOR LONG PERIODS OF TIME. THE APPROACH TO BE TAKEN WILL RESULT IN THE DESIGN OF A SUPERPRESSURE BALLOON WITH A WELL-DEFINED BIAXIAL STRESS DISTRIBUTION WHICH WILL MAKE USE OF THE STRENGTH CAPABILITIES OF A NEW FILM THAT IS TO BE "ENGINEERED" FOR THIS APPLICATION. CONVENTIONAL TECHNIQUES WILL BE USED TO MANUFACTURE A FLEXIBLE FILM WITH THE NECESSARY ULTRAVIOLET RADIATION PROTECTION FOR THE STRENGTH ELEMENT OF THE COMPOSITE FILM. AN APPROPRIATE HEAT TRANSFER MODEL WILL BE DEVELOPED WHICH WILL PERMIT THE DIURNAL PRESSURE VARIATIONS TO BE PREDICTED WITH BETTER CONFIDENCE THAN IS CURRENT POSSIBLE. IN ORDER TO DEMONSTRATE THE FEASIBILITY OF THIS CONCEPT, SIMILITUDE ANALYSIS WILL BE USED TO DESIGN A SCALE MODEL BALLOON FOR GROUND

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TESTING THAT WILL DEMONSTRATE VARIOUS FEATURES OF THE BALLOON, SUCH AS FILM PERMEABILITY, FABRICATION TECHNIQUES, AND LONG DURATION CAPABILITY.

DARPA

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ADVANCED RSCH & APPLICATIONS CORP/ARACOR
425 LAKESIDE DR
SUNNYVALE, CA 94086
CONTRACT NUMBER: DNA001-88-C-0167
LOUIS N KOPPEL

TITLE:
NEW-TECHNOLOGY X-RAY SPECTROMETER DEVELOPMENT FOR EFFECTS TESTING
TOPIC# 3 OFFICE: DNA IDENT#: 22037

THE EMERGING IMPORTANCE OF NUCLEAR-WEAPON AND DIRECTED ENERGY WEAPON (DEW) EFFECTS TESTING IN THE SOFT X-RAY REGIME HAS HIGHLIGHTED THE NEED FOR A ROBUST, ACCURATE AND RELIABLE SOFT X-RAY SPECTROMETER THAT WILL MEASURE FLUENCE INCIDENT ON UGT TEST-ARTICLES. THE NEW LAYERED SYNTHETIC MICROSTRUCTURE (LSM) X-RAY INTERFERENCE MIRROR TECHNOLOGY IS PROPOSED AS THE BASIS FOR A SPECTROMETER RESPONSIVE TO THIS NEED. THE PHASE I PROJECT WILL RESOLVE TECHNICAL RISK ISSUES ASSOCIATED WITH THE SURVIVABILITY OF SPECTROMETER COMPONENTS IN THE UGT ENVIRONMENT, WITH THE ARCHITECTURE OF A MULTICHANNEL INSTRUMENT, AND WITH THE QUALITY OF THE DATA IT WILL PROVIDE AS A PRIME UGT DIAGNOSTIC. THE PHASE I EFFORT WILL ESTABLISH A DESIGN BASIS FOR A PROTOTYPE INSTRUMENT THAT WILL BE CONSTRUCTED AND EXPERIMENTALLY EVALUATED IN PHASE II.

ANRO ENGINEERING CONSULTANTS INC
5 MILITIA DR - STE 104
LEXINGTON, MA 02173
CONTRACT NUMBER: DNA001-88-C-0142
DR GERALD F ROSS

TITLE:
AN OPTICAL FIBER INTRUSION LOCATION (FIBLOC) SENSOR FOR SURFACE
AND SUBSURFACE PERIMETER PROTECTION
TOPIC# 6 OFFICE: DNA IDENT#: 22031

THE PROPOSED FIBLOC SENSOR PROVIDES AN ECONOMIC MEANS TO PROTECT, LITERALLY, MILES OF A PREFERRED PERIMETER REGION AGAINST UNAUTHORIZED INTRUSIONS. THE OPTICAL FIBERS EMPLOYED IN THE FIBLOC SENSOR PROPAGATE CW OR PULSED INFRARED LIGHT SIGNALS WHOSE TRANSMISSION AND/OR REFLECTION SENSITIVITY IS AFFECTED BY MECHANICAL PRESSURE SUCH AS

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WOULD BE PRODUCED BY THE DISTENSION OF SURFACED MOUNTED FIBERS ALONG, FOR EXAMPLE, A CHAIN LINK FENCE OR BY A FOOTSTEP ABOVE SUBSURFACED FIBER BUNDLES. THE DISTANCE FROM THE MONITORING STATION TO THE POINT OF PERIMETER INTRUSION IS DETERMINED BY SEVERAL NOVEL FIBER BUNDLE CONFIGURATIONS AND SIGNAL PROCESSING SCHEMES DESCRIBED IN THE PROPOSAL. THE PRINCIPAL TASK OF THE PHASE 1 PROGRAM IS TO STUDY AND EVALUATE THESE SCHEMES IN THE LABORATORY WITH SOME FIELD EXPERIMENTS AND TO RECOMMEND A PREFERRED AND COST-EFFECTIVE CONFIGURATION FOR THE PHASE 2 DEVELOPMENT EFFORT.

APPLIED RESEARCH ASSOCS INC
4300 SAN MATEO BLVD NE - STE B380
ALBUQUERQUE, NM 87110
CONTRACT NUMBER: DNA001-88-C-0182
HARRY J BEWLEY

TITLE:
DEVELOPMENT OF A HIGH DYNAMIC RANGE DOWNHOLE SIGNAL CONDITIONING
MODULE
TOPIC# 3 OFFICE: DNA IDENT#: 22044

HIGH RANGE (200,000 g) ACCELEROMETERS ARE THE ONLY TRANSDUCERS THAT PROVIDE THE REQUIRED LONG-TERM DATA IN THE ENVIRONMENTS OF INTEREST TO THE BLAST AND SHOCK COMMUNITY. THESE GAGES HAVE A VERY LARGE DYNAMIC RANGE AND NOISE OFTEN MASKS THE LATE TIME (BUT EXTREMELY IMPORTANT) DATA. WE PROPOSE TO DEVELOP A CLOSE COUPLED LOGARITHMIC GAIN SIGNAL CONDITIONING SYSTEM THAT WILL CORRECT THE LATE TIME NOISE PROBLEM AND RESULT IN HIGH QUALITY DATA.

APPLIED RESEARCH ASSOCS INC
4300 SAN MATEO BLVD NE - STE A220
ALBUQUERQUE, NM 87110
CONTRACT NUMBER: DNA001-88-C-0172
DONALD M COLE

TITLE:
SUBSCALE TESTING OF ROCKBOLTED TUNNELS IN JOINTED MEDIA
TOPIC# 1 OFFICE: DNA IDENT#: 22055

DEVELOPMENT OF AN INNOVATIVE AND ECONOMICAL EXPERIMENTAL METHOD IS

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PROPOSED WHICH CAN PROVIDE THE BASIC BEHAVIOR DATA NECESSARY TO MEET THE DNA OBJECTIVE OF PROVIDING ADEQUATE ANALYSIS, DESIGN AND ASSESSMENT METHODS FOR MINIMALLY HARDENED TUNNELS. THIS DEVELOPMENT IS ACCOMPANIED BY ANALYSIS CAPABLE OF REPRESENTING THE COMPLEX INELASTIC MATERIAL BEHAVIOR OF THE ROCK MASS AND OF REPRESENTING SIMPLE JOINT AND ROCKBOLT CONFIGURATIONS. THIS COMBINED EXPERIMENTAL AND ANALYTICAL APPROACH ALLOWS THE DEVELOPMENT AND EVALUATION OF BASIC MODELING PROCEDURES AND PARAMETERS WHICH CAN BE LATER INCORPORATED INTO A NUMERICAL PROCEDURE SUCH AS AN ADVANCED DISCRETE ELEMENT CODE, CAPABLE OF REPRESENTING THE NONLINEAR RESPONSE OF COMPLEX TUNNEL, JOINT AND BOLT CONFIGURATIONS. THIS STUDY CAN ALSO PROVIDE IMPORTANT GUIDANCE TO THE LATER DEVELOPMENT OF SIMPLIFIED ASSESSMENT AND DESIGN METHODS REFLECTING THE MAJOR RESPONSE MECHANISMS OF ROCKBOLTED TUNNELS IN JOINTED ROCK. THE PROPOSED EXPERIMENTAL PROCEDURE WILL BE AVAILABLE TO SUPPORT THE RECOMMENDATIONS OF THE EXPERIMENTAL REVIEW AND REQUIREMENTS STUDY NOW UNDERWAY AT DNA.

APTEK INC
1257 LAKE PLAZA DR
COLORADO SPRINGS, CO 80906
CONTRACT NUMBER: DNA001-88-C-0117
ANTHONY Wm RASKOB JR
TITLE:
HARDENED IMPROVED DYNAMIC RESPONSE DECOY
TOPIC# 5 OFFICE: DNA IDENT#: 22033

A FEASIBILITY STUDY OF IMPROVING DECOY PENETRATION AID (PEN AID) PERFORMANCE BY SUPPLYING MEANS TO 1) ALLOW FOR DUAL CENTER OF GRAVITY (CG) LOCATION, THEREBY ENABLING INDEPENDENT FULFILLMENT OF IMPULSE BALANCING AND REENTRY STABILITY REQUIREMENTS; AND/OR 2) COUNTERACT DECOY CONING BY SENSING ITS PRESENCE, AND CORRECTING THE ANGULAR MOMENTUM OF THE DECOY TO ELIMINATE CONING.

ATSS INC
606 E MILL ST - STE 2044
SAN BERNARDINO, CA 92408
CONTRACT NUMBER: DNA001-88-C-0116
HENRY L MOODY
TITLE:
LOW IMPULSE-HIGH STRENGTH HEATSHIELD
TOPIC# 5 OFFICE: DNA IDENT#: 22036

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HIGH ALTITUDE NUCLEAR THREATS GENERALLY REQUIRE THE USE OF OVERLAYS/UNDERLAYS TO ACHIEVE THE NUCLEAR SURVIVABILITY REQUIREMENTS OF ADVANCED REENTRY VEHICLES (RVs). MATERIALS AND FABRICATION PROCESSES EXIST THAT WITH SOME MINOR VARIATIONS SHOULD PRODUCE A HEATSHIELD MATERIAL THAT CAN EITHER ELIMINATE THE NEED FOR, OR REDUCE THE REQUIREMENTS OF, OVERLAYS/UNDERLAYS. THE PROPOSED MATERIAL, RELATIVE TO CURRENT AIR FORCE AND NAVY RV HEATSHIELDS, WILL: a) REDUCE IMPULSE AND HOT X-RAY SHINE-THROUGH, b) INCREASE ABLATION/EROSION RESISTANCE AND STRENGTH AND c) MAINTAIN EQUIVALENT THERMAL INSULATION PROPERTIES.

CRYSTALLUME

3180 PORTE DR - STE 2

PALO ALTO, CA 94304

CONTRACT NUMBER: DNA001-88-C-0161

DR K V RAVI

TITLE:

CVD DIAMOND PROTECTIVE COATINGS FOR ALPHA MEASURING SURVEY INSTRUMENTS

TOPIC# 3

OFFICE: DNA

IDENT#: 22128

THE OBJECTIVE OF THIS RESEARCH IS TO ACHIEVE GREATER SENSITIVITY, RUGGEDNESS AND EASE OF USE OF ALPHA MEASURING DEVICES IN POTENTIALLY HARSH FIELD ENVIRONMENTS BY APPLYING THIN FILM DIAMOND TO THE INSTRUMENT DETECTOR FACE. TO ACHIEVE THIS OBJECTIVE WE WILL ATTEMPT TO COAT SILVER ACTIVATED ZINC SULPHIDE WITH DIAMOND USING CHEMICAL VAPOR DEPOSITION TECHNIQUES DEVELOPED BY THE COMPANY AND APPLY AN APPROPRIATE OPACITY COATING SUCH AS ALUMINUM OR CARBON BLACK. WE WILL THEN CHARACTERIZE THE RESULTING COMPOSITE FOR COATING ADHERENCE, RUGGEDNESS AND OPACITY TO VISIBLE LIGHT. BASED UPON THESE RESULTS, WE WILL ATTEMPT TO COAT COMMERCIALY AVAILABLE ALPHA SCINTILLATION DETECTORS TO PERMIT FUNCTIONAL TESTING IN EXISTING ALPHA RADIATION SURVEY INSTRUMENTS. PHASE II WILL INVOLVE PRODUCT ENGINEERING AND TESTING OF DIAMOND-PROTECTED ALPHA SURVEY INSTRUMENTS IN A VARIETY OF FIELD ENVIRONMENTS.

EARTH TECHNOLOGY CORP

3777 LONG BEACH BLVD

LONG BEACH, CA 90807

CONTRACT NUMBER: DNA001-88-C-0190

DR KHOSROW BAKHTAR

TITLE:

RESPONSE OF SUBSURFACE SCALE MODEL STRUCTURES IN FLUID-SATURATED FRACTURED MEDIA TO SIMULATED FREE FIELD NUCLEAR DETONATION

TOPIC# 1

OFFICE: DNA

IDENT#: 22192

SUBMITTED BY

THE EXTENSION OF A PHYSICAL MODELING TECHNIQUE UTILIZING ROCK-SIMULANTS AND SIMULATED BLAST LOADING TO MODEL PROPAGATION OF DILATIONAL WAVES THROUGH FLUID-SATURATED FRACTURED ROCK MASSES WILL BE EVALUATED. ROCK-SIMULANTS, WITH NEGLIGIBLE MATRIX PERMEABILITY, WILL BE DEVELOPED FOR SPECIMEN PREPARATION. A STEP-BY-STEP CASTING PROCEDURE WILL BE EMPLOYED TO SIMULATE JOINTING AND BEDDING PLANES. ATTEMPTS WILL BE MADE TO MODEL THE SHAPE AND DURATION OF THE LOAD-RISE TIME CURVES EXPECTED AT DEPTH DUE TO FREE-FIELD NUCLEAR DETONATION. A UNIQUE LOADING TECHNIQUE FOR SIMULATING ATTENUATED DILATIONAL WAVES AT DEPTH, WHICH UTILIZES A HIGH VELOCITY, RAIL DRIVEN TOW SLED, WILL BE EVALUATED. MATHEMATICAL EXPRESSIONS FOR DETERMINING THE MASS AND SPEED OF THE SLED TO GIVE THE REQUIRED IMPULSE FORCE, AS WELL AS THE SHAPE AND MATERIAL PROPERTIES OF THE SLED TO GIVE THE DURATION OF IMPULSE FORCE, WILL BE DERIVED AND SYSTEMATICALLY EVALUATED. MOST OF THE RESEARCH EFFORT IN PHASE I WILL BE CONCENTRATED TOWARDS SCALING THE IMPULSE FORCE AND DEVELOPMENT OF A "ROCK SIMULANT" WITH LOW MATRIX PERMEABILITY. THE PROPOSED PHYSICAL MODELING STUDY WILL PROVIDE A POWERFUL APPROACH FOR UNDERSTANDING THE DYNAMIC RESPONSE OF FLUID-SATURATED FRACTURES AND PROVIDE A UNIQUE TOOL FOR CODE VALIDATION.

ENERGY CONVERSION DEVICES INC
1675 W MAPLE RD
TROY, MI 48084
CONTRACT NUMBER: DNA001-88-C-0117
ROGER W PRYOR
TITLE:

RESEARCH ON THE FABRICATION OF EMP HARDENED CONNECTORS AND CABLE
HARDWARE FOR AIRCRAFT AND SHIPBOARD USE
TOPIC# 5 OFFICE: DNA IDENT#: 22163

THIS DOCUMENT PROPOSES RESEARCH ON THE FABRICATION OF A FAMILY OF EMP HARDENED CONNECTORS AND CABLE HARDWARE FOR AIRCRAFT AND SHIPBOARD APPLICATIONS. THESE CONNECTORS AND CABLE HARDWARE WOULD SUPPRESS EMP TRANSIENTS THROUGH THE INTEGRAL INCORPORATION OF A THIN FILM, HIGH SPEED, HIGH CURRENT OVONIC THRESHOLD SWITCH (OTS). CABLES AND HARDWARE OF THIS TYPE WOULD SIGNIFICANTLY INCREASE THE SURVIVABILITY OF AIRCRAFT AND SHIPS UNDER EMP CONDITIONS.

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM - PHASE 1
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EWA INC
133 FIRST AVE N
MINNEAPOLIS, MN 55401
CONTRACT NUMBER: DNA001-88-C-0192
DR ANTOUN Y CALASH
TITLE:
DEEP UNDERGROUND OPENINGS UNDER NUCLEAR WEAPONS EFFECTS
TOPIC# 1 OFFICE: DNA IDENT#: 22104

THE SAFE DESIGN OF DEEP MISSILE BASING STRUCTURES SUBJECTED TO STRESS TRANSIENTS GENERATED BY SURFACE DISTURBANCES SUCH AS NUCLEAR OR CONVENTIONAL EXPLOSIONS IS A VERY IMPORTANT PROBLEM FOR J.S. NATIONAL SECURITY INTEREST. THE PROPAGATION OF SURFACE DISTURBANCES THROUGH INHOMOGENEOUS, JOINTED, FRACTURED, AND LAYERED GEOLOGIC MEDIUM OF THE INFINITE DOMAIN IS A VERY COMPLEX PROBLEM ESPECIALLY NEAR DEEP UNDERGROUND OPENINGS/STRUCTURES. THE DEVELOPMENT OF AN OPTIMUM HYBRID NUMERICAL SCHEME COMBINING DIFFERENT NUMERICAL SCHEMES OF INDIVIDUAL SUBDOMAINS SUCH AS DEEP UNDERGROUND STRUCTURE, THIN-LAYER MEDIUM-STRUCTURE INTERFACE, DISTURBED FIELD NEAR THE OPENING/STRUCTURE, INTACT FIELD AWAY FROM THE OPENING/STRUCTURE, AND BOUNDARY OF INFINITE DOMAIN IS ESSENTIAL FOR ANALYSIS OF DEEP MISSILE BASING SYSTEMS. PHASE I INVESTIGATION IS TO STUDY THE FEASIBILITY OF AN OPTIMUM HYBRID NUMERICAL SCHEME COMBINING THE FINITE ELEMENT, FINITE DIFFERENCE, DISTRICT ELEMENT, AND BOUNDARY ELEMENT/INFINITE ELEMENT MODELING TECHNIQUES. SUCCESSFUL COMPLETION OF PHASE I STUDY WILL PROVIDE THE FEASIBILITY OF A UNIFIED AND ECONOMICAL SCHEME AS A TOOL TO ANALYZE DEEP UNDERGROUND STRUCTURES SUBJECTED TO SURFACE OR NEAR SURFACE NUCLEAR BURSTS. THIS WILL PROVIDE THE ESSENTIAL FOUNDATION FOR THE DEVELOPMENT OF AN OPTIMUM UNIFIED HYBRID NUMERICAL SCHEME, SOLUTION ALGORITHM AND A COMPUTER CODE FOR THE ANALYSIS OF DEEP MISSILE BASING SYSTEMS.

GEO-CENTERS INC
7 WELLS AVE
NEWTON CENTRE, MA 02159
CONTRACT NUMBER: DNA001-88-C-0186
BRUCE N NELSON
TITLE:
FIBER OPTIC GROUND MOTION SENSOR
TOPIC# 1 OFFICE: DNA IDENT#: 22102

SUBMITTED BY

THE PHASE I EXPERIMENTAL EFFORT WILL DEMONSTRATE THE FEASIBILITY OF A FIELD WORTHY GROUND MOTION SENSOR TO REPLACE PIEZO-ELECTRIC ACCELEROMETERS FOR CONVENTIONAL EXPLOSIVES AND NUCLEAR TESTING. THE OUTPUT SIGNALS OF PIEZO-ELECTRIC ACCELEROMETERS MUST BE INTEGRATED TWICE TO DETERMINE GROUND MOTIONS. THIS PROCESS REDUCES SYSTEM ACCURACY AND MEASUREMENT BANDWIDTH. ADDITIONALLY, AS PIEZO-ELECTRIC SENSORS ARE ELECTRONIC IN NATURE, THEY ARE SUSCEPTABLE TO THE ADVERSE EFFECTS OF ELECTROMAGNETIC INTERFERENCE (EMI) AND ELECTROMAGNETIC PULSES (EMP). THE PROPOSED SENSOR USES AN INERTIALLY DAMPED PASSIVE REFLECTOR, AND LIGHT DELIVERY AND COLLECTION OPTICS. THE PROPOSED SENSOR OUTPUT SIGNAL IS A DIRECT MEASURE OF THE GROUND MOTION. ADDITIONAL SENSOR PROPERTIES, WHICH INCLUDE INCREASED MEASUREMENT BANDWIDTH CAPABILITY, IMMUNITY TO THE EFFECTS OF EMI AND EMP, AND IMMEDIATE COMPATIBILITY WITH FIBER OPTIC DATA TRANSMISSION LINES ENHANCE THE UTILITY OF THIS SENSOR FOR DNA MEASUREMENT APPLICATIONS.

HY-TECH RESEARCH CORP
PO BOX 3422
RADFORD, VA 24143
CONTRACT NUMBER: DNA001-88-C-0168
ROBERT C HAZELTON

TITLE:
DIAGNOSING INSTABILITIES IN PLASMA EROSION OPENING SWITCHES USING
RESONANT RAYLEIGH SCATTERING
TOPIC# 2 OFFICE: DNA IDENT#: 22075

PLASMA EROSION OPENING SWITCHES (PEOS) ARE FINDING MANY APPLICATIONS IN PULSE POWER MULTIPLICATION AND THE SWITCHING OF INDUCTIVE STORAGE DEVICES FOR PULSED POWER APPLICATIONS. SUCH A SWITCH OPERATES BY USING AN EXTERNAL PLASMA SOURCE TO SHORT A GAP WHICH CONDUCTS CURRENT FROM A LOW VOLTAGE CAPACITIVE SOURCE FOR 100 NANOSECOND TIME SCALES. AT A CRITICAL CURRENT DENSITY THE PLASMA ERODES AND THE SWITCH OPENS ON A 10 NANOSECOND TIME SCALE TRANSFERRING A MULTIPLIED VOLTAGE TO THE LOAD. THE GAP PLASMA CONDUCTS IN A DIFFUSE MANNER THROUGHOUT THE OPERATION OF THE PEOS, A PHENOMENA WHICH CAN BE ACHIEVED IN SIMULATIONS ONLY BY INVOKING AN ANOMALOUS RESISTIVITY. A LIKELY SOURCE FOR THIS RESISTIVITY IS STREAMING PLASMA INSTABILITIES WHICH ARE MANIFESTED BY THE GROWTH OF ION ACOUSTIC WAVES. RESONANT-RAYLEIGH

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SCATTERING IS PROPOSED AS A METHOD TO DIRECTLY VERIFY THE EXISTENCE OF THESE INSTABILITIES AND TO STUDY THEIR PROPERTIES IN THE PEOS PLASMA. AT A WAVELENGTH NEAR AN ATOMIC TRANSITION THE RAYLEIGH LIGHT SCATTERING CROSS SECTION IS ENHANCED BY UP TO TEN ORDERS TO MAGNITUDE. WITH TYPICAL PULSED DYE LASER POWERS, THIS ALLOWS ONE TO DETECT ATOMIC OR IONIC SPECIES WITH DENSITIES AS LOW AS $10(10)\text{CM}(-3)$ WELL WITHIN THE RANGE OF PEOS PLASMAS.

METATECH CORP
358 S FAIRVIEW - STE E
GOLETA, CA 93117
CONTRACT NUMBER: DNA001-88-C-0153
MICHAEL A MESSIER
TITLE:
AN SREMP TIME WAVEFORM DATABASE SYSTEM
TOPIC# 1 OFFICE: DNA IDENT#: 22096

A TIME WAVEFORM DATABASE SYSTEM IS PROPOSED FOR THE PURPOSE OF ARCHIVING SOURCE REGION ELECTROMAGNETIC PULSE (SREMP) DATA OBTAINED THROUGH NUCLEAR UNDERGROUND TESTING (UGT). THE PERMANENT FORM OF THE DATABASE IS EXPECTED TO BE STORED ON SOME FORM OF OPTICAL MEDIUM, ENSURING DURABILITY WHILE ALLOWING RANDOM ACCESS OF RECORDS. THE DISTRIBUTION MEDIUM CAN BE OF ANY CONVENIENT FORM. THE SYSTEM WOULD BE DESIGNED AROUND MICROCOMPUTER TECHNOLOGY; APPROPRIATE USER INTERFACES WOULD ALSO BE DEVELOPED.

MISSION RESEARCH CORP
PO DRAWER 719 - 735 STATE ST
SANTA BARBARA, CA 93102
CONTRACT NUMBER: DNA001-88-C-0194
ROBERT L BOGUSCH
TITLE:
NUCLEAR EFFECTS SIMULATION: COMPUTER-AIDED DESIGN OF SATELLITE COMMUNICATIONS RECEIVERS FOR OPERATION IN SCINTILLATING CHANNELS
TOPIC# 2 OFFICE: DNA IDENT#: 22071

THE OBJECTIVE OF THE PROPOSED EFFORT IS TO DEVELOP A SOFTWARE

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PACKAGE TO FACILITATE THE DESIGN OF DIGITAL COMMUNICATIONS EQUIPMENT TO PROVIDE SPECIFIED LEVELS OF PERFORMANCE IN NUCLEAR-DISTURBED PROPAGATION ENVIRONMENTS HAVING SPECIFIED RANGES OF SIGNAL SCINTILLATION PARAMETERS (...). THIS SOFTWARE PACKAGE WILL ALLOW SIGNAL STATISTICAL PARAMETERS OBTAINED FROM DNA OR NCGS SPECIFICATIONS TO BE READILY INCORPORATED INTO THE COMMUNICATIONS LINK DESIGN PROCESS. THE RESULTING PERSONAL COMPUTER (PC) BASED COMPUTER-AIDED DESIGN (CAD) PACKAGE WILL ASSIST THE LINK DESIGNER IN MAKING APPROPRIATE CHOICES OF MODULATION, CODING, TRACKING, AND DIVERSITY TECHNIQUES TO ACHIEVE THE SPECIFIED LEVELS OF PERFORMANCE OVER THE SPECIFIED RANGES OF NUCLEAR DISTURBANCES.

PHYSICAL RESEARCH INC
25500 HAWTHORNE BLVD - STE 2300
TORRANCE, CA 90505
CONTRACT NUMBER: DNA001-88-C-0158
D MODARRESS

TITLE:
NUMERICALLY GENERATED FLOW VISUALIZATION FOR DIRECT COMPARISON WITH EXPERIMENTS IN NON-IDEAL AIRBLAST STUDIES
TOPIC# 2 OFFICE: DNA IDENT#: 22067

DNA PRESENTLY SPONSORS EXPERIMENTAL INVESTIGATIONS OF NON-DEAL AIR BLAST AT ERNST MACH INSTITUTE (EMI), AND MODELING EFFORTS AT NSWC. PRESENTLY, THE EXPERIMENTAL RESULTS, IN THE FORM OF MACH-ZEHNDER INTERFEROMETER, BEING BOTH FUNCTIONS OF TEMPERATURE AND CONCENTRATION, CANNOT BE REDUCED FOR COMPARISON WITH THE COMPUTER RESULTS. IT IS PROPOSED THAT THE NECESSARY CAPABILITIES BE DEVELOPED TO FACILITATE THE TRANSFORMATION OF THE COMPUTED RESULTS OF THE NON-IDEAL AIRBLAST MODELING IN THE FORM OF NUMERICAL MACH-ZEHNDER INTERFEROGRAMS FOR DIRECT COMPARISON WITH THE EXPERIMENTS. THE FEASIBILITY OF THIS NOVEL CONCEPT WILL BE EVALUATED DURING PHASE I. THE NECESSARY SOFTWARE MODULES WILL BE DEVELOPED AND INSTALLED AT EMI & NSWC IN PHASE II OF THE PROPOSED PROGRAM.

PHYSICS APPLICATIONS INC
930 S LA BREA AVE - STE 2
LOS ANGELES, CA 90036
CONTRACT NUMBER: DNA001-88-C-0179
JAMES W WORKMAN

TITLE:
GAUGES FOR MEASURING DISPLACEMENTS FROM MILLIMETERS TO INCHES INCLUDING FREE FIELD DISPLACEMENT
TOPIC# 3 OFFICE: DNA IDENT#: 26912

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THE PURPOSE OF THE PROPOSED EFFORT IS TO MODIFY AN EXISTING PAI-DEVELOPED GAUGE SO THAT a) ITS OUTPUT SIGNALS ARE EASIER TO INTERPRET IN TERMS OF DISPLACEMENT, b) THE DISPLACEMENTS INFERRED ARE ACCURATE ENOUGH TO BE USED TO CORRECT BASELINE OFFSETS (E.G., OF ACCELEROMETERS), AND c) THE RANGE OF MEASURABLE DISPLACEMENT AMPLITUDES IS EXTENDED. THE GAUGE OPERATES BY MEASURING THE DISTANCE BETWEEN ITS HOUSING AND A FREE-FALLING OBJECT - AN "INERTIAL FRAME". INCOMPLETE CALIBRATION OF OUTPUT SIGNALS OVER THE RANGE OF DEPOSITION AVAILABLE TO THE FREE-FALLING OBJECT HAS MADE THE DEDUCTION OF DISPLACEMENT DIFFICULT AND UNCERTAIN. WE INTEND TO MODIFY THE GAUGE SO THAT ITS FULL CALIBRATION BECOMES A STRAIGHTFORWARD TASK, AND IMPROVE MECHANICAL AND ELECTRONIC SYSTEM ELEMENTS TO REDUCE MEASUREMENT ERROR FROM THOSE SOURCES.

SPIRE CORP
PATRIOTS PARK
BEDFORD, MA 01730
CONTRACT NUMBER: DNA001-88-C-0195
DR FERREYDOON NAMAVAR
TITLE:
DEFECT REDUCTION IN SIMOX WAFERS
TOPIC# 5 OFFICE: DNA IDENT#: 22144

CREATION OF BURIED INSULATING LAYERS IN SILICON WAFERS BY HIGH DOSE OXYGEN IMPLANTATION (SIMOX) HAS GAINED SIGNIFICANT ATTENTION IN THE LAST TWO YEARS. THE SIMOX TECHNOLOGY IS POSITIONED TO BE A PRIME CONTENDER IN THE SILICON-ON-INSULATOR (SOI) ARENA MAINLY BECAUSE OF THE INHERENT RELIABILITY/REPRODUCIBILITY OF THE ION IMPLANTATION TECHNOLOGY. ONE OBSTACLE TO BROADER USE OF THE SIMOX MATERIAL IS THE HIGH DENSITY OF DISLOCATIONS THAT APPEARS IN THE TOP-LAYER-SILICON FOLLOWING THE HIGH TEMPERATURE ANNEALING REQUIRED FOR THE PROCESS. THE DISLOCATIONS ARE PARTICULARLY HARMFUL IN THE FABRICATION OF BIPOLAR DEVICES ON SIMOX MATERIAL. SPIRE CORPORATION HAS CONTRIBUTED SIGNIFICANTLY TO THE DEVELOPMENT OF SIMOX TECHNOLOGY AND IS PERFORMING ONGOING RESEARCH IN THIS FIELD. SPIRE PROPOSES TO PERFORM SECONDARY ION IMPLANTATION OF SPECIES SUCH AS Ge INTO THE SIMOX WAFERS FOR REMOVING THE DISLOCATIONS CREATED BY THE HIGH TEMPERATURE ANNEAL. PRELIMINARY RESULTS INDICATE THAT LOW DOSES OF

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Ge IN THE TOP-LAYER-SILICON CAUSE AMORPHIZATION AND CREATED STRESS
FIELDS. SUBSEQUENT ANNEALING OF THE WAFERS HAS RESULTED IN
DISLOCATION DENSITIES BELOW THE DETECTABLE LIMIT OF THE X-TEM OR
PLANE VIEW TEM METHODS.

SUNBURST RECOVERY INC
PO BOX 1173
STEAMBOAT SPRINGS, CO 80477
CONTRACT NUMBER: DNA001-88-C-0191
CHAPMAN YOUNG
TITLE:
ELECTROMAGNETIC GAGE TECHNIQUES FOR HEST MEASUREMENTS
TOPIC# 3 OFFICE: DNA IDENT#: 22112

DATA ON THE RESPONSE OF MATERIALS AND STRUCTURES TO NUCLEAR WEAPONS
IS CRITICAL TO THE IMPROVED DESIGN OF WEAPONS AND DEFENSE SYSTEMS.
MUCH OF THIS DATA IS OBTAINED IN HIGH EXPLOSIVE SIMULATION (HES)
TESTS. FOR BOTH HES AND NUCLEAR TESTS, INSTRUMENTATION TO OBTAIN
THE REQUISITE DATA MUST BE ABLE TO FUNCTION PROPERLY IN THE HARSH
ENVIRONMENT OF THE TESTS. INSTRUMENTATION TRADITIONALLY EMPLOYED IN
SUCH TESTS UTILIZES GAGES GENERALLY DEPENDENT UPON SOLID-STATE
PIEZOELECTRIC OR PIEZORESISTIVE PHENOMENON. AS BOTH PIEZORESISTIVE
AND PIEZOELECTRIC CALIBRATION FACTORS CAN BE ADVERSELY AFFECTED BY
THE HIGH STRESS AND/OR RADIATION LEVELS IN THE TEST ENVIRONMENT,
ALTERNATIVE GAGE TECHNIQUES ARE DESIRABLE. THE ELECTROMAGNETIC
TECHNIQUE, WHICH DEPENDS RIGOROUSLY UPON FARADAY'S THEORY OF INDUC-
TION, HAS THE POTENTIAL OF BEING LESS SENSITIVE TO ADVERSE SHOCK,
RADIATION, THERMAL AND EMP EFFECTS. IT IS PROPOSED TO MODIFY, IM-
PROVE AND HARDEN A VARIETY OF EXISTING ELECTROMAGNETIC GAGE DESIGNS
SO THAT SUCH GAGES MAY BE SUCCESSFULLY DEPLOYED IN HES, AND POSSIBLY
NUCLEAR, TESTS. THE PROPOSED EFFORTS WOULD BE FOCUSED UPON
DEVELOPING IMPROVED TECHNIQUES FOR GENERATING THE MAGNETIC FIELDS
REQUISITE FOR GAGE FUNCTIONING, NEW GAGE SENSING ELEMENT DESIGNS AND
DATA ACQUISITION AND REDUCTION TECHNIQUES.

TECH REPS INC
5000 MARBLE AVE NE - STE 222
ALBUQUERQUE, NM 87110
CONTRACT NUMBER: DNA001-88-C-0181
NOEL H ETHRIDGE
TITLE:
DYNAMIC PRESSURE GAGE DEVELOPMENT FOR SUBSONIC FLOWS
TOPIC# 3 OFFICE: DNA IDENT#: 22107

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THE OBJECTIVE OF THIS PROJECT IS TO DEVELOP AN IMPROVED DIFFERENTIAL PRESSURE GAGE FOR DETERMINING DYNAMIC PRESSURE WITHIN BLAST AND SHOCK WAVE FLOWS WHERE THE FLOWS ARE SUBSONIC. DERIVATION OF DYNAMIC PRESSURE FROM A MEASUREMENT OF THE DIFFERENCE BETWEEN STAGNATION PRESSURE AND SIDE-ON OR STATIC PRESSURE REQUIRES USE OF THE SIDE-ON PRESSURE RECORD TO CORRECT FOR COMPRESSIBILITY EFFECTS. CURRENTLY THE SIDE-ON PRESSURE WAVEFORM MUST BE MEASURED BY A SEPARATE GAGE LOCATED APART FROM THE DIFFERENTIAL PRESSURE GAGE. THIS WAVEFORM MAY DIFFER FROM THAT OCCURRING AT THE DIFFERENTIAL PRESSURE GAGE LOCATION. UNDER THIS PROJECT, THE DIFFERENTIAL PRESSURE GAGE PROBE WILL BE MODIFIED TO ADD A GAGE TO MEASURE THE SIDE-ON PRESSURE IN ADDITION TO THE DIFFERENTIAL PRESSURE. THIS MODIFIED PROBE WILL BE EVALUATED IN SHOCK TUBE TESTS.

DNA

TOTAL NUMBER OF AWARDS: 19

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ADVANCED FUEL RESEARCH INC
PO BOX 18343 - 87 CHURCH ST
EAST HARTFORD, CT 06118

CONTRACT NUMBER:

DR DAVID G HAMBLLEN

TITLE:

INFRARED DETECTORS USING BULK HIGH T GRANULAR JOSEPHSON JUNCTIONS

TOPIC# 15

OFFICE:

IDENT#: 30579

THE RECENT DISCOVERY OF PEROVSKITE-LIKE COPPER-OXIDE SUPERCONDUCTORS WITH TRANSITION TEMPERATURES HAS LED TO RENEWED INTEREST IN THE APPLICATION OF SUPERCONDUCTIVITY. THESE NEW YBaCuO MATERIALS COULD LEAD TO DETECTORS MORE CONVENIENT THAN THE CLASSICAL SUPERCONDUCTORS. THE LARGER ENERGY GAP OF THESE NEW HIGH T_c MATERIALS ALSO PROVIDES THE OPPORTUNITY TO FABRICATE JOSEPHSON JUNCTION (JJ) DETECTORS CAPABLE OF SENSING OPTICAL RADIATION AT MUCH LOWER WAVELENGTHS, OFFERING NEW COMPETITION TO PREVIOUS SEMICONDUCTOR INFRARED (IR) DETECTORS IN THE 10 TO 100 MICROMETER REGION. IR SENSORS BASED ON GRAINY JOSEPHSON JUNCTIONS IN YBaCuO-TYPE SUPERCONDUCTORS ARE BEING INVESTIGATED IN THIS STUDY. BULK YBaCuO MATERIALS AS IR DETECTORS, AVOIDING THE THIN FILM FABRICATION PROBLEMS. WAVELENGTH AND TEMPERATURE RANGE OF SUCH DETECTORS IS BEING INVESTIGATED. A LATER PHASE WOULD CONCENTRATE ON OPTIMIZING THE PERFORMANCE AND TESTING THESE DEVICES. THE POTENTIAL FOR OPERATING JJ DETECTORS AT LIQUID NITROGEN TEMPERATURES PROVIDES NEW COMPETITION TO OTHER IR DETECTOR TECHNOLOGY SUCH AS HgCdTe, Si:Ga, AND Si:As SEMICONDUCTOR DEVICES WITH POTENTIAL FOR SENSITIVITY TO LONGER WAVELENGTHS.

ADVANCED FUEL RESEARCH INC
PO BOX 18343 - 87 CHURCH ST
EAST HARTFORD, CT 06118

CONTRACT NUMBER:

DR DAVID G HAMBLLEN

TITLE:

IN-SITU DIAGNOSTICS FOR DEPOSITION OF HIGH T SUPERCONDUCTING FILM

TOPIC# 15

OFFICE:

IDENT#: 30580

A RENEWED INTEREST IN THE APPLICATIONS OF SUPERCONDUCTIVITY HAS

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RESULTED FROM THE RECENT DISCOVERY OF PEROVSKITE-LIKE COPPER-OXIDE SUPERCONDUCTORS WITH TRANSITION TEMPERATURES ABOVE LIQUID NITROGEN TEMPERATURES. ALTHOUGH THE THIN FILMS AS DEPOSITED GENERALLY HAVE THE APPROPRIATE Y:Ba:Cu STOICHIOMETRY, A SUBSEQUENT HIGH TEMPERATURE ($T > 900$ DEGREE CELCIUS) OXYGEN TREATMENT IS REQUIRED TO ACHIEVE THE CORRECT OXYGEN CONCENTRATION AND THE REQUIRED ORTHORHOMBIC CRYSTAL STRUCTURES. IN THIS STUDY, MONITORING TECHNIQUES ARE BEING DEVELOPED BY COUPLING IN-SITU DIAGNOSTICS WITH A UNIQUE LASER ABLATION TECHNIQUE FOR DEPOSITING FILM. TECHNIQUES BEING EVALUATED INCLUDE RAMAN, X-RAY TRANSFORM INFRARED (FT-IR) SPECTROSCOPIES. THIN FILM SAMPLES OF COPPER DIFFRACTION, AND FOURIER TRANSFORM INFRARED (FT-IR) SPECTROSCOPIES. THIN FILM SAMPLES OF COPPER OXIDE PEROVSKITE MATERIALS ARE BEING ANALYZED IN BOTH THE UNANNEALED, NON-SUPERCONDUCTING AND THE ANNEALED, SUPERCONDUCTING STATE USING THE ABOVE TECHNIQUES AT ROOM TEMPERATURE IN ORDER TO ESTABLISH BASELINE DATA. IN ADDITION, FT-IR EMISSION AND DIFFUSE REFLECTANCE TECHNIQUES ARE BEING USED TO MONITOR THE DEPOSITION PROCESS IN-SITU. WHEN SUCCESSFULLY DEMONSTRATED, THE FIRST APPLICATION OF THESE PRESENT MATERIALS (WHICH ARE GRANULAR) IS LIKELY TO BE IN THE AREA OF MICROELECTRONICS (IR DETECTORS, SUPERCONDUCTING INTERCONNECTS) RATHER THAN LARGER APPLICATIONS REQUIRING DUCTILE WIRES.

ADVANCED TECHNOLOGY MATERIALS INC
520-B DANBURY RD
NEW MILFORD, CT 06776
CONTRACT NUMBER:
DR DUNCAN W BROWN
TITLE:
METALORGANIC MOLECULAR BEAM EPITAXY
TOPIC# 14 OFFICE: IDENT#: 30581

METALORGANIC MOLECULAR BEAM EPITAXY (MOMBE) IS A SEMICONDUCTOR GROWTH TECHNIQUE THAT HAS THE POTENTIAL FOR COMBINING THE BEST FEATURES OF MOLECULAR BEAM EPITAXY WITH THOSE OF ORGANOMETALLIC VAPOR PHASE EPITAXY (OMVPE). A MAJOR PROBLEM HINDERING DEVELOPMENT OF MOMBE TECHNIQUES FOR GROWING GROUP III/V SEMICONDUCTORS IS THE AVAILABILITY OF APPROPRIATELY DESIGNED SOURCE REAGENTS THAT PERMIT EFFICIENT DECOMPOSITION IN THE REACTOR COUPLED WITH VOLATILITY AND PURITY THAT MAXIMIZE THE INHERENT BENEFITS OF THE PROCESS. ADDITIONALLY, LESS

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TOXIC REAGENTS ARE REQUIRED TO MINIMIZE THE DIFFICULT HANDLING PROBLEMS ASSOCIATED WITH THE USE OF A RESINE IN OMVPE. THE FEASIBILITY IS BEING INVESTIGATED OF DEVELOPING A PROGRAM THAT WILL FACILITATE SCREENING OF A GROUP OF NOVEL SOURCE REAGENT COMPOUNDS THAT HOLD HIGH PROMISE FOR MOMBE. SOURCES FOR CARBON-FREE INCORPORATION OF ALUMINUM AND GALLIUM ARE BEING IDENTIFIED, SYNTHESIZED, AND THEN EVALUATED IN A MOMBE REACTOR. PRELIMINARY LOW PRESSURE PYROLYSES OF ARSENIC SOURCE REAGENTS ARE BEING PERFORMED. USING THE EXPERIMENTAL DATA, A THEORY TO ACCOUNT FOR THE KINETICS AND PRODUCT DISTRIBUTION FROM THE LOW PRESSURE PYROLYSIS OF ALKYLARSINES IS BEING DEVELOPED THAT WILL PERMIT THE PREDICTION OF OPTIMUM SOURCE REAGENTS. IN A LATER EFFORT, THE OPTIMUM ELEMENT SOURCE REAGENTS WOULD BE PREPARED AND ALUMINUM GALLIUM ARSENIDE DEVICES PREPARED AND TESTED.

ALABAMA CRYOGENIC ENGINEERING INC
PO BOX 2451
HUNTSVILLE, AL 35804
CONTRACT NUMBER:
DR JOHN B HENDRICKS
TITLE:
INTEGRATED CRYOCOOLER/DEWAR SYSTEM DESIGN
TOPIC# 2 OFFICE: IDENT#: 30155

ONE-SHOT CRYOCOOLERS IN TACTICAL MISSILES HAVE ONLY A SHORT OPERATIONAL LIFETIME, AND THEIR SIZE AND COOL DOWN TIME ARE THE MOST IMPORTANT DESIGN PARAMETERS. A CRYOCOOLER GENERALLY IS A SEPARATE STRUCTURE THAT FITS INTO A DEWAR THAT PROVIDES BOTH THERMAL INSULATION AND MECHANICAL SUPPORT FOR THE INFRARED SENSOR. THE FEASIBILITY IS BEING INVESTIGATED OF AN INTEGRATED CRYOCOOLER/DEWAR SYSTEM THAT IS BASED ON THE LINDE-HAMPSON CYCLE WHICH IS COMPOSED OF A HEAT EXCHANGER AND A JOULE-THOMPSON EXPANDER INTEGRATED INTO A SINGLE MONOLITHIC SYSTEM. ELIMINATION OF THE SEPARATE DEWAR COULD LEAD TO AN EVEN GREATER VOLUME REDUCTION, WHILE INCREASING THE STRUCTURAL RIGIDITY OF THE INTEGRATED SYSTEM. THUS, THE INTEGRATED UNIT IS EXPECTED TO BE SUBSTANTIALLY SMALLER IN VOLUME AND TO HAVE BETTER OVERALL PERFORMANCE THAN EXISTING TECHNOLOGY. SENSOR SYSTEMS ARE BEING DEFINED THAT ARE CANDIDATES FOR USE WITH THE CRYOCOOLER. CONTINUOUSLY COOLED ELECTRICAL LEADS ARE BEING STUDIED THAT COULD MINIMIZE THE REQUIRED REFRIGERATOR LOAD. MATERIALS ARE BEING SURVEYED THAT ARE SUITABLE FOR

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A COOLED ELECTRICAL LEAD SYSTEM AND THAT MUST HAVE MATCHED THERMAL EXPANSIONS. A PRELIMINARY DESIGN STUDY IS BEING UNDERTAKEN OF THE ELECTRICAL LEAD SYSTEM, END CONNECTIONS, DEWAR ASSEMBLY, AND REQUIRED COLD STOPS AND COLD FILTERS TO BE USED IN THE INTEGRATED ASSEMBLY. A CRYOCOOLER/DEWAR SYSTEM IS BEING DESIGNED THAT MEETS THE BASELINE REQUIREMENTS DEVELOPED.

ALPHATECH INC
111 MIDDLESEX TURNPIKE
BURLINGTON, MA 01803
CONTRACT NUMBER:
DR JOHN J SHAW
TITLE:
WEAPON-TARGET ASSIGNMENT ALGORITHMS FOR PARALLEL PROCESSING
TOPIC# 10 OFFICE: IDENT#: 30397

WEAPON-TARGET ASSIGNMENT (WTA) IN A BALLISTIC MISSILE DEFENSE (BMD) SYSTEM IS INTENDED TO DETERMINE HOW DEFENSIVE WEAPONS SHOULD BE ASSIGNED TO BOOSTERS AND RE-ENTRY VEHICLES TO MAXIMIZE THE SURVIVAL OF ASSETS. ALMOST ALL INSTANCES OF THE WTA PROBLEM REDUCE TO THE SOLUTION OF A RECURRING SET OF OPTIMIZATION PROBLEMS WHICH ARE AMONG THE MOST COMPLEX ENCOUNTERED IN MATHEMATICAL PROGRAMMING. TO DATE NO SOLUTION ALGORITHMS HAVE EMERGED THAT CAN GUARANTEE OPTICAL SOLUTIONS WITHIN THE REAL-TIME DEADLINES IMPOSED FOR BMD BATTLE MANAGEMENT. THE FEASIBILITY IS BEING DEMONSTRATED OF REAL-TIME EXECUTION OF ADVANCED WTA ALGORITHMS FOR THE TARGET-ORIENTED PROBLEM CLASS FOR NEAR-OPTICAL, BOOST-PHASE BATTLE MANAGEMENT. THIS IS BEING ACHIEVED BY APPROPRIATE MODIFICATION AND FURTHER DEVELOPMENT AND IMPLEMENTATION OF SEVERAL PARALLEL VERSIONS OF A PROPRIETARY ITERATIVE LINEAR NETWORK FLOW ALGORITHM (ORIGINALLY DEVELOPED FOR A SERIAL PROCESSOR) FOR MULTIPLE-INSTRUCTION/MULTIPLE-DATA (MIMD) PARALLEL PROCESSING ARCHITECTURES. THIS IS BEING ACCOMPLISHED BY DESIGN OF ALGORITHM MAPPINGS ONTO A PARALLEL PROCESSOR ARCHITECTURE, IMPLEMENTATION ON AN NCUBE HYPERCUBE, AND ANALYSIS OF THE RESULTING SYSTEM. SUCCESSFUL COMPLETION OF THIS EFFORT WOULD POINT TO PROMISING DIRECTIONS IN DATA STRUCTURES, ALGORITHM STRUCTURES, MATHEMATICAL PROGRAMMING, AND COMPUTING ARCHITECTURES FOR THE ASSET-ORIENTED PROBLEM CLASS APPROPRIATE TO MIDCOURSE, TERMINAL, AND MUTUAL ANTISATELLITE DEFENSE WTA.

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AMERICAN RESEARCH CORP OF VA

PO BOX 3406

RADFORD, VA 24143

CONTRACT NUMBER:

DR RUSSELL J CHURCHILL

TITLE:

LASER ALLOYING OF PLASMA-DEPOSITED COATINGS FOR PROTECTION AGAINST
ATOMIC OXYGEN

TOPIC# 13

OFFICE:

IDENT#: 30304

ATOMIC OXYGEN-INDUCED DEGRADATION OF MATERIALS IN LOW EARTH ORBIT IS A PROBLEM OF GREAT CONCERN IN THE DEPLOYMENT OF SATELLITES, REFLECTORS AND MIRROR AND ANTENNA STRUCTURES. IN PARTICULAR, THE DEGRADATION OF THIN CARBON-CARBON COMPOSITE MATERIALS BY ATOMIC OXYGEN RESTRICTS THE OPERATIONAL LIFE AND BATTLE-READINESS OF THIS OTHERWISE STRUCTURALLY ADVANTAGEOUS MATERIAL. ALTHOUGH SEVERAL METHODS ARE BEING DEVELOPED TO PROTECT THIN CARBON-CARBON COMPOSITE MATERIALS FROM ATOMIC OXYGEN ATTACK, NO METHOD HAS PROVEN SUCCESSFUL, IN PART BECAUSE OF THE DIFFERENTIAL THERMAL EXPANSION EXPERIENCED BY COATINGS AND IN PART BECAUSE OF LOW BONDING ENERGIES BETWEEN A COATING AND THE CARBON-CARBON SURFACE. A TWO STEP PROCESS IS BEING INVESTIGATED FOR DEPOSITING A GRADED OXIDATION-RESISTANT COATING ONTO CARBON-CARBON COMPOSITE MATERIALS USING PLASMA SPRAY TECHNIQUES FOLLOWED BY LASER SURFACE ALLOYING. THE INNOVATION OF THIS SYSTEM INVOLVES THE VERSATILITY OF THE COATING METHOD, THE PROVEN ABILITY OF PLASMA SPRAY TECHNOLOGIES TO LAY DOWN EXTREMELY THIN COATINGS ON CARBON-CARBON COMPOSITE MATERIALS, AND THE CONTROL OVER COMPOSITION AND MICROSTRUCTURE AFFORDED BY LASER SURFACE ALLOYING. PLASMA-SPRAY MATERIALS ARE BEING EVALUATED; OPTIMAL PLASMA DEPOSITION AND LASER ALLOYING PARAMETERS DETERMINED; AND MATERIALS FABRICATED AND TESTED UNDER CYCLIC CONDITIONS.

ANTROPIX CORP

30 MEADOWFAIR CT

THE WOODLANDS, TX 77381

CONTRACT NUMBER:

DR MICHAEL BERRY

TITLE:

DIAGNOSTIC INSTRUMENTATION FOR WAVELENGTH SCALING OF COUPLING
COEFFICIENTS

TOPIC# 9

OFFICE:

IDENT#: 30217

SUBMITTED BY

TIME RESOLVED AND WAVELENGTH DEPENDENT COUPLING COEFFICIENTS ARE BEING OBTAINED DURING LASER IRRADIATION AT REALISTIC ABLATION CREATED USING A WELL-CHARACTERIZED CONTINUOUS WAVE CO₂ LASER. TARGET SURFACE ABSORPTANCES ARE BEING DETERMINED WITH INTEGRATING SPHERE DEVICES PLUS PROBE LASER BEAMS (AT INFRARED, NEAR INFRATED, VISIBLE, AND ULTRAVIOLET WAVELENGTS) AND FAST DETECTORS. PLUME BLOCKAGES DUE TO ABSORPTION AND/OR SCATTERING BY ATOMIC, MOLECULAR, PARTICULAR, AND PLASMA SPECIES ARE BEING DETERMINED, USING ATTENUATION OF LASER PROBE BEAMS THAT MATCH THE IRRADIATION WAVELENGTHS OF PERTINENT LTH-1 AND LTH-9 LASERS. A SELECTION OF MODEL, STATE-OF-THE-ART, AND DEVELOPMENTAL MATERIALS IS BEING INVESTIGATED TO OBTAIN WAVELENGTH SCALING INFORMATION THAT PERMITS EXTRAPOLATION OF LASER EFFECTS AND TARGET RESPONSES TO NEW LASER INTERACTION CONDITIONS. SYSTEMATIC STUDIES OF WAVELENGTH DEPENDENT COUPLING COEFFICIENTS ARE BEING COMPLETED AS A FUNCTION OF LASER AND INTERACTION PARAMETERS TO PROVIDE MECHANISTIC UNDERSTANDING OF THE PHENOMENOLOGY OF LASER/MATERIALS INTERACTIONS, WITH PARTICULAR EMPHASIS ON LETHALITY AND TARGET HARDENING ISSUES. WHEN SUCCESSFUL, WAVELENGTH DEPENDENT COUPLING COEFFICIENT MERASUREMENTS WOULD LEAD TO THE DEVELOPMENT OF CUSTOM DIAGNOSTIC INSTRUMENTATION.

APA OPTICS INC
2950 NE 84TH LN
BLAINE, MN 55432
CONTRACT NUMBER:
DR M ASIF KHAN

TITLE:

YBaCuO-BASED SUPERCONDUCTOR-INSULATOR-SUPERCONDUCTOR DETECTOR FOR LONG-WAVELENGTH INFRARED APPLICATIONS

TOPIC# 15 OFFICE: IDENT#: 30586

SUPERCONDUCTOR-INSULATOR-SUPERCONDUCTOR (SIS) JUNCTIONS OF HIGH T_c, YBaCuO-TYPE MATERIALS FOR LONG WAVELENGTH INFRARED (LWIR) DETECTION ARE BEING INVESTIGATED. THE FEASIBILITY IS BEING DETERMINED OF USING GALLIUM-ARSENIDE AS THE SUBSTRATE MATERIAL FOR THE HIGH T_c SUPERCONDUCTING MATERIALS OF THE YBaCuO TYPE. A DETERMINATION IS BEING MADE IF PROCESSING STEPS SUCH AS PHOTOLITHOGRAPHY, CONTACT METALLIZATION OR CHEMICAL ETCHING ADVERSELY EFFECT THE SUPERCONDUCTING PROPERTIES OF

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SINGLE LAYERS. THE FABRICATION OF THE SIS STRUCTURE AND THE MEASUREMENT OF ITS SUPERCONDUCTIVE TRANSITION IS BEING UNDERTAKEN TO DETERMINE IF SPUTTERING AN INSULATOR ON THE HIGH T_c SUPERCONDUCTORS POISONS THE SURFACE RENDERING THEM UNUSABLE FOR SENSOR FABRICATION. $YBaCuO$ SIS JUNCTIONS ARE BEING RADIO FREQUENCY-SPUTTERED AND THEN ANNEALED INSITU IN AN OXYGEN ATMOSPHERE. WHEN SUCCESSFUL, THESE JUNCTIONS ARE EXPECTED TO YIELD SUPERCONDUCTORS WITH TRANSITION TEMPERATURES LARGER THAN 77K. THE CURRENT VOLTAGE CHARACTERISTICS OF SUCH A JUNCTION ARE BEING MODULATED BY INCIDENT LWIR RADIATION. THE SIS JUNCTION WOULD, THEREFORE, FUNCTION AS A VOLTAGE CONTROLLED SENSOR. LWIR SENSING IS THE BASIS OF SEVERAL DEFENSE AND COMMERCIAL APPLICATIONS, INCLUDING DETECTION AND TRACKING OF INCOMING MISSILE AND INFRARED SPECTROSCOPY FOR WEATHER FORECASTING.

APA OPTICS INC
2950 NE 84TH LN
BLAINE, MN 55432
CONTRACT NUMBER:
DR M ASIF KHAN
TITLE:
HIGH SPEED GaAs/AlGaAs LASER DIODE MODULATOR
TOPIC# 3 OFFICE: IDENT#: 30587

KEY REQUIREMENTS REMAIN IN THE DEVELOPMENT OF GALLIUM ARSENIDE (GaAs) MONOLITHIC MICROWAVE INTEGRATED CIRCUITS (MMICS) TO BE USED IN COMMUNICATION SYSTEMS, PARTICULARLY IN THE FREQUENCIES OF THE KA BAND OR HIGHER. SIGNAL DISTRIBUTION FOR CONTROLLING AND FEEDING SIGNALS TO EACH ELEMENT CAN BE QUITE COMPLEX FOR LARGE NUMBERS OF MMIC'S. FIBER OPTICS SHOW A LOT OF PROMISE FOR RELIEVING THE PROBLEMS ASSOCIATED WITH USING STANDARD TECHNIQUES SUCH AS MICROWAVE WAVEGUIDES AND COATED CABLES. INTEGRATED OPTIC TRAVELING WAVE MODULATORS HAVE BEEN DEVELOPED FOR HIGH SPEED LASER DIODE MODULATION BUT HAVE BEEN LIMITED IN MODULATION SPEED DUE TO OPTICAL AND MICROWAVE VELOCITY MISMATCH. THE APPROACH OF AN INDIRECT MODULATION OF LASER DIODES IS BEING USED TO MATCH THE OPTICAL AND MICROWAVE PHASE VELOCITIES IN A GaAs/AlGaAs INTEGRATED OPTIC STRUCTURE. THE TECHNIQUE IS A MODIFIED DIRECTIONAL COUPLER TRAVELING WAVE STRUCTURE THAT MATCHES THE MICROWAVE AND OPTICAL PHASE VELOCITIES SUFFICIENT TO ACHIEVE MODULATION SPEEDS UP TO 100 GHz AND WOULD BE COMPATIBLE WITH MONOLITHIC INTEGRATION. WHEN

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SUCCESSFUL, COMMERCIAL APPLICATIONS EXIST IN COMPUTING, DATA PROCESSING AND SENSING WHERE HIGH SPEED OPTOELECTRONIC INTERFACES ARE NEEDED, INCLUDING VERY LARGE SCALE INTEGRATED/VERY HIGH SPEED INTEGRATED CIRCUIT BASED SYSTEMS.

APPLIED RESEARCH ASSOCS INC
6404 FALLS OF NEUSE RD - STE 200
RALEIGH, NC 27615
CONTRACT NUMBER:
DR WILLIAM L DUNN
TITLE:
MOMENTUM-RICH BEAMS INTERACTION WITH CYLINDRICAL TARGETS
TOPIC# 1 OFFICE: IDENT#: 30390

A MOMENTUM-RICH NEUTRAL PARTICLE BEAM (NPB) IS ONE MEANS FOR TARGET DISCRIMINATION BETWEEN REENTRY VEHICLES (RVS) AND DECOYS IN A BALLISTIC MISSILE DEFENSE CONTEXT. AN ASSESSMENT OF THE INTERACTION OF SUCH BEAMS WITH POTENTIAL TARGETS WOULD PROVIDE USEFUL INFORMATION ON THE BEAM'S CHARACTERISTICS THAT WOULD BE REQUIRED TO INDUCE MEASURABLE CHANGES IN TARGETS (E.G., IN VELOCITY, VIBRATION STATES, HEATING AND COOLING RATES). A MODEL IS BEING DEVELOPED TO EVALUATE THESE EFFECTS. WHILE A COMPLETE CHARACTERIZATION OF THIS INTERACTION IS NOT POSSIBLE IN THIS EFFORT, THE INCORPORATION OF STANDARD INTERACTION AND EFFECTS MODELS ON BOTH MICROSCOPIC AND MACROSCOPIC SCALES IS BEING ACCOMPLISHED. THE MODEL IS EXPECTED TO ALLOW SCOPING CALCULATIONS TO PREDICT THE REQUIRED BEAM CHARACTERISTICS IN ORDER TO PERFORM RV/DECOY DISCRIMINATION. THE DEPENDENCE OF MECHANICAL (TARGET DEFLECTION AND VIBRATION) AS WELL AS THERMAL (HEAT BUILD UP AND DISSIPATION) EFFECTS ON SEVERAL BEAM AND TARGET VARIABLES IS BEING INVESTIGATED. THIS INVESTIGATION, WHEN SUCCESSFUL, WOULD HELD DEFINE THE DISCRIMINATION IN A BALLISTIC MISSILE DEFENSE CONTEXT. THIS RESEARCH WILL FORM THE BASIS FOR DISCRIMINATION ANALYSIS, IF MOMENTUM-RICH BEAMS CAN BE PRODUCED THAT MEET THESE REQUIREMENTS.

APPLIED RESEARCH CORP
8201 CORPORATE DR - STE 920
LANDOVER, MD 20785
CONTRACT NUMBER:
DR A K DRUKIER
TITLE:
COMPUTER ORIENTED MULTICHANNEL DIRECT-CURRENT SUPERCONDUCTING QUANTUM INTERFERENCE DEVICE
TOPIC# 15 OFFICE: IDENT#: 30589

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SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES (SQUID'S) ARE ULTRA-SENSITIVE ELECTRONIC DEVICES USED IN MAGNETIC FIELD SENSING. THEIR UNPRECEDENTED SENSITIVITY TO A CHANGE OF MAGNETIC FIELD PERMITS MEASUREMENTS WITH PRECISION APPROACHING THE QUANTUM LIMIT. THEY ARE OFTEN USED AS ZERO SENSORS IN BRIDGE CONFIGURATIONS AND ARE USED INCREASINGLY IN ALL TYPES OF ELECTRONIC APPLICATIONS, E.G., CURRENT/VOLTAGE MEASUREMENT. A PORTABLE, COMPUTER-ORIENTED MULTICHANNEL SQUID SYSTEM OPERATING AT LIQUID NITROGEN TEMPERATURE IS BEING INVESTIGATED. SPECIFICALLY, IMPROVEMENTS ARE BEING MADE IN AN EXISTING SQUID SYSTEM BASED ON Tc SUPERCONDUCTORS; AND LOW-COST MULTICHANNEL ELECTRONICS ARE BEING DEVELOPED FOR SQUID SIGNAL CONDITIONING AND DIGITIZATION. AT A LATER PHASE, A THIN FILM DIRECT CURRENT-SQUID BASED ON HIGH TEMPERATURE SUPERCONDUCTORS WOULD BE DEVELOPED WITH AN OPTIMIZED SLEW RATE AND NOISE LEVEL EXPECTED. THE ELECTRONIC READOUT WOULD BE MINIA-TURIZED AND IMPROVED, AND A PORTABLE/RUGGED CRYOSTAT MULTI-SQUID SENSORS ARRAY DESIGNED AND IMPLEMENTED. TODAY, SQUID'S ARE TOP-OF-THE-LINE, ULTRASENSITIVE DEVICES; TOMORROW, MULTICHANNEL SYSTEM-ORIENTED APPLICATIONS ARE EXPECTED TO BECOME MORE AND MORE IMPORTANT. WHEN SUCCESSFUL, THE LIQUID NITROGEN-OPERATED, ECONOMICAL, MULTICHANNEL SQUID'S WILL EXTEND APPLICATIONS TO BIOMAGNETISM, REMOTE SENSING, AND CRYOGENIC PARTICLE/RADIATION DETECTORS.

APPLIED RESEARCH CORP
8201 CORPORATE DR - STE 920
LANDOVER, MD 20785

CONTRACT NUMBER:
DR ANTHONY C DANKS

TITLE:

SHIELDING OF CRITICAL COMPONENTS FROM ELECTROMAGNETIC PULSE
EFFECTS USING HIGH T SUPERCONDUCTORS

TOPIC# 15

OFFICE:

IDENT#: 30590

HIGH TEMPERATURE SUPERCONDUCTING MATERIALS ARE INCREASINGLY BECOMING AVAILABLE AND THE POSSIBILITY EXISTS OF BUILDING SUPERCONDUCTING SHIELDS AT LIQUID NITROGEN TEMPERATURES WHICH ARE INEXPENSIVE, LIGHT AND ROBUST, AND WOULD ENABLE A VOLUME LARGE ENOUGH TO CONTAIN AN IMPORTANT AMOUNT OF CIRCUITRY. IN ADDITION, FIBER OPTIC TECHNOLOGY IS AVAILABLE TO INTERCONNECT SHIELDED DEVICES WITHOUT SUSCEPTIBILITY TO

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ELECTROMAGNETIC PULSES (EMPS). THE FEASIBILITY IS BEING INVESTIGATED OF USING ELECTROMAGNETIC SHIELDS BASED ON HIGH TEMPERATURE CERAMIC SUPERCONDUCTORS. SPECIFICALLY, FABRICATION TECHNOLOGIES OF CERAMIC SUPERCONDUCTORS ARE BEING STUDIED AS ARE THEIR USE IN FARADAY CAGES TO ATTENUATE ELECTROMAGNETIC BURSTS SUCH AS THOSE RESULTING FROM THE DETONATION OF TACTICAL NUCLEAR WEAPONS. THE PRODUCED FARADAY CAGES ARE BEING TESTED IN FREQUENCY RANGE FROM 1 Hz TO 0.1 MHz USING LIQUID NITROGEN SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES. MORE MATURE LOW Tc SUPERCONDUCTING MATERIALS SUCH AS NIOBIUM AND LEAD ARE BEING COMBINED TO CONSTRUCT A 100dB BROADBAND ELECTROMAGNETIC PULSE SHIELD OPERATING AT LIQUID NITROGEN TEMPERATURES, WITH FIBER-OPTIC INTERFACING BETWEEN DEVICES. WHEN SUCCESSFUL, THIS NEW CLASS OF SUPERCONDUCTING SHIELD WOULD HAVE IMPORTANCE IN RADIO FREQUENCY-NOISE ENVIRONMENTS AND SOME MEDICAL APPLICATIONS, E.G. BIO-MAGNETISM.

APPLIED SCIENCES CONSULTANTS INC

1977 CONCOURSE DR
SAN JOSE, CA 95131

CONTRACT NUMBER:

DR AHMAD WALEH

TITLE:

HIGH-TEMPERATURE SUPERCONDUCTING MAGNETIC SHIELDS FOR SPACE-BASED SYSTEMS

TOPIC# 15

OFFICE:

IDENT#: 30593

THE NEED EXISTS FOR DEVELOPMENT OF LARGE, LOW-MASS, SPACE-BASED MAGNETIC SHIELDS, WHERE SHIELDING OF THE CRITICAL COMPONENTS OF A SYSTEM FROM EITHER INTENSE FRINGE MAGNETIC FIELDS OR FROM ELECTROMAGNETIC PULSE EFFECTS IS NECESSARY. THE FEASIBILITY IS BEING DETERMINED OF USING HIGH-TEMPERATURE SUPERCONDUCTORS IN A CONCEPTUAL DESIGN OF A SUPERCONDUCTING SHIELD THAT MEETS STRATEGIC DEFENSE NEEDS. LABORATORY SAMPLES OF YBaCuO ARE BEING SYNTHESIZED AND EXAMINED FOR THEIR THERMAL, ELECTRICAL, AND MAGNETIC PROPERTIES IN ORDER TO ASSESS THEIR POTENTIAL AND LIMITATIONS FOR USE IN MAGNETIC SHIELDING. EXPLORATORY FABRICATION TECHNIQUES FOR IMPLEMENTING THE USE OF THE CERAMIC MATERIALS IN A SHIELD DESIGN ARE BEING EXAMINED, AND THE RESULTS ARE BEING USED TO DETERMINE THE FEASIBILITY OF MANUFACTURING LARGE SCALE SUPERCONDUCTING MAGNETIC SHIELDS. FINALLY, THE RESULTS OF THIS EFFORT ARE BEING COMPARED WITH THAT OF A FEASIBILITY STUDY PREVIOUSLY PERFORMED

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FOR CONVENTIONAL, HIGH FIELD, TYPE II SUPERCONDUCTORS. WHEN SUCCESSFUL, THESE SHIELDS WOULD BE THINNER, LIGHTER, MORE EFFECTIVE, AND HENCE LESS EXPENSIVE THAN CONVENTIONAL SHIELDING TECHNIQUES. WITH MORE AND MORE INTENSE MAGNETS BEING DESIGNED, HIGH TEMPERATURE SUPERCONDUCTING MAGNETIC SHIELDS ALSO WOULD FIND IMPORTANT COMMERCIAL APPLICATIONS.

APPLIED SCIENCES INC
PO BOX 186 - 800 LIVERMORE ST
YELLOW SPRINGS, OH 45387

CONTRACT NUMBER:

MAT L LAKE

TITLE:

VAPOR GROWN CARBON FIBER COMPOSITES FOR SPACE THERMAL MANAGEMENT SYSTEMS

TOPIC# 7

OFFICE:

IDENT#: 30405

PROPOSED STRATEGIC DEFENSE SYSTEMS IMPOSE DEMANDING CRITERIA FOR THERMAL ENERGY MANAGEMENT, COUPLED WITH SEVERE CONSTRAINTS ON WEIGHT AND COST. PRESENT MATERIALS USEFUL FOR THIS PURPOSE INCLUDE COPPER, WITH A THERMAL CONDUCTIVITY OF ABOUT 400 W/M-K, AND ALUMINUM, WITH A THERMAL CONDUCTIVITY OF ABOUT 240 W/M-K. CARBON COMPOSITES OFFER ATTRACTIVE ALTERNATIVES, SINCE COMMERCIALY AVAILABLE CARBON FIBERS OFFER THERMAL CONDUCTIVITIES WHICH EXCEED THAT OF COPPER (520 W/M-K), AND SINGLE CRYSTAL GRAPHITE IS SEVERAL TIMES THAT OF COPPER. A VAPOR GROWN CARBON FIBER (VGCF) RECENTLY HAS BEEN DEVELOPED WHICH HAS PHYSICAL PROPERTIES VERY CLOSE TO SINGLE CRYSTAL GRAPHITE, AND THERMAL CONDUCTIVITY OF 3000 W/M-K. IN THIS INVESTIGATION, THIS UNIQUE FIBER IS BEING USED IN THE FABRICATION OF SEVERAL TYPES OF CARBON COMPOSITES, AND THERMAL PROPERTIES OF THE RESULTING COMPOSITES ARE BEING EVALUATED. IN ADDITION TO SPACE STRATEGIC SYSTEMS, OTHER POTENTIAL APPLICATIONS EXIST IN LEADING EDGES FOR RE-ENTRY VEHICLES AND HIGH PERFORMANCE COMPOSITES FOR TERRESTRIAL AND AEROSPACE APPLICATIONS.

ASTROSYSTEMS INC
30 LOVETT AVE

NEWARK, DE 19711

CONTRACT NUMBER:

GERALD H NEGLEY

TITLE:

ALUMINUM-GALLIUM-ARSENIDE TOP SOLAR CELL FOR MECHANICAL ATTACHMENT TO A SILICON CONCENTRATOR WITH IMPROVED AMO EFFICIENCY

TOPIC# 5

OFFICE:

IDENT#: 30742

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INCREASES IN SOLAR CELL EFFICIENCY CAN BE ACHIEVED WITH TANDEM MULTI-JUNCTION STRUCTURES TO IMPROVE THE PERFORMANCE AND SCALE OF SPACE PHOTOVOLTAIC CONCENTRATORS. THE "TOP SOLAR CELL" TANDEM APPROACH COULD INCREASE ENERGY CONVERSION EFFICIENCY BY AS MUCH AS 100%. A SELF-SUPPORTING ALUMINUM-GALLIUM-ARSENIDE (AlGaAs) TOP SOLAR CELL IS BEING DEVELOPED FOR MECHANICAL ATTACHMENT TO A SILICON CONCENTRATOR SOLAR CELL. A 1.93EV ALGaAs COMPOSITION IS BEING INVESTIGATED FOR A FOUR-THERMAL WIRING CONFIGURATION, WHILE A 1.76 EV ALGaAs COMPOSITION IS BEING CONSIDERED FOR A TWO-TERMINAL CONFIGURATION. TO AVOID MATERIAL RELATED PROBLEMS, LIQUID PHASE EPITAXY IS BEING USED. THE TWO DIFFERENT DESIGN STRUCTURES TAKE ADVANTAGE OF EXISTING LIGHT EMITTING DIODE TECHNOLOGIES. PRACTICAL EFFICIENCIES IN EXCESS OF 30% ARE EXPECTED UNDER 100X CONCENTRATION. TWO AND FOUR-TERMINAL ALGaAs/Si MECHANICALLY STACKED PROTOTYPES ARE EXPECTED TO BE FABRICATED AT THE END OF THE RESEARCH EFFORT. ALTHOUGH PROPOSED FOR A CONCENTRATOR SYSTEM, THE ALGaAs TOP SOLAR CELL IS EASILY ADAPTABLE TO A FLAT PANEL ARRAY. WHEN SUCCESSFUL, THIS APPROACH WILL HAVE A LARGE NUMBER OF HIGH PERFORMANCE OF SPACE AND TERRESTRIAL POWER APPLICATIONS.

ASTROSYSTEMS INC
30 LOVETT AVE
NEWARK, DE 19711
CONTRACT NUMBER:
NANCY E TERRANOVA
TITLE:

LARGE AREA INDIUM-PHOSPHORUS ON SILICON FOR OPTOELECTRONIC DEVICE
TOPIC# 14 OFFICE: IDENT#: 30743

THE GROWTH OF DEVICE QUALITY, LARGE AREA, INDIUM PHOSPHIDE (InP) EPITAXIAL LAYERS ON SILICON (Si) SUBSTRATES IS RECOGNIZED AS AN IMPORTANT TECHNOLOGICAL DEVELOPMENT. THE QUALITY OF InP HETEROEPITAXIAL LAYERS ON SILICON IS LIMITED BY InP-Si LATTICE MISMATCH AND THERMAL COEFFICIENT OF EXPANSION. THE DEFECT DENSITY OF THE InP EPILAYER IS DIRECTLY RELATED TO THE INTERFACE AREA. A VIABLE InP-Si GROWTH TECHNIQUE, SELECTIVE LIQUID PHASE EPITAXY (SLPE), PREVIOUSLY HAS BEEN DEMONSTRATED IN THE LABORATORY. SLPE GROWTH ENHANCES THE EPILAYER QUALITY SINCE THE LATERAL OVERGROWTH REGION IS SHIELDED FROM DEFECTS ORIGINATING AT THE INTERFACE. THE NEED EXISTS TO DETERMINE THE MOST

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APPROPRIATE SUBSTRATE ORIENTATION AND INTERLAYER AND TO CHARACTERIZE THE RESULTING FILM AND VERIFY ITS QUALITY AS PART OF A DEVICE. SLPE GROWTH OF LARGE AREA, DEVICE QUALITY, InP-Si SUBSTRATES IS BEING UNDERTAKEN, USING NUCLEATION, LATERAL OVERGROWTH, AND HOMOEPITAXIAL GROWTH. InP FILM IS BEING CHARACTERIZED FOR MORPHOLOGY, GROSS IMPURITIES, AND DISLOCATION DENSITY USING OPTICAL MICROSCOPY, SCANNING ELECTRON MICROSCOPY, EDAX, AND PHOTOLUMINESCENCE. FABRICATION, TESTING, AND ANALYSIS IS BEING UNDERTAKEN OF BASIC OPTOELECTRONIC DEVICES ON THE InP/GaP/Si. WHEN SUCCESSFUL, THE AVAILABILITY OF LARGE DIAMETER InP/Si SUBSTRATES WOULD PERMIT MEDIUM OR LARGE SCALE INTEGRATION WITH MICROWAVE OR PHOTONIC TECHNOLOGIES.

ASTROSYSTEMS INC
30 LOVETT AVE
NEWARK, DE 19711
CONTRACT NUMBER:
JAMES B McNEELY

TITLE:
HIGH TEMPERATURE SURVIVABLE CONTACTS FOR GALLIUM ARSENIDE SPACE
SOLAR CELLS
TOPIC# 5 OFFICE: IDENT#: 30753

EXISTING METALLIC-TYPE CONTACTS ON GALLIUM ARSENIDE (GaAs) HAVE NOT BEEN STABLE AT HIGH TEMPERATURES BECAUSE OF INTERDIFFUSION AND/OR ALLOYING OF THE GaAs TOP LAYER. HIGH TEMPERATURE CONTACTS TO GaAs SPACE PHOTOLTAIC CELLS ARE BEING DEVELOPED BASED ON THE FORMATION OF A HIGHLY-STABLE INTERMEDIATE DEGENERATE SEMICONDUCTOR LAYER BETWEEN THE GaAs AND A HIGH TEMPERATURE METAL ALLOY. THE INTERMEDIATE SEMICONDUCTOR APPROACH LEADS TO THE BEST HIGH TEMPERATURE PERFORMANCE BECAUSE IT USES A METAL WHICH IS A SEMICONDUCTOR RATHER THAN ALLOYING WITH THE GaAs. UNDER THIS APPROACH, BOTH THE INTERMEDIATE SEMICONDUCTOR LAYER AND THE CONTACT METAL ARE EXPECTED TO REMAIN STABLE AT TEMPERATURES IN EXCESS OF 600 DEGREES C. THIS CONTACT WILL MAKE POSSIBLE NEW, HIGHER CONCENTRATION SOLAR CONCENTRATOR DESIGNS BOTH FOR SPACE AND TERRESTRIAL USE INCLUDING OTHER SEMICONDUCTOR DEVICES AND ADVANCED OPTOELECTRONIC DEVICES.

AUTONOMOUS TECHNOLOGIES CORP
520 N SEMORAN BLVD - STE 180
ORLANDO, FL 32807
CONTRACT NUMBER:
RANDY W FREY

TITLE:
DEEP SPACE LADAR
TOPIC# 3 OFFICE: IDENT#: 30597

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A PSEUDO-RANGING LASER RADAR (PRLADAR) CONCEPT IS BEING DEVELOPED TO PROVIDE EXTENDED RANGE CAPABILITY TO TRACKING LASER RADAR (LADAR) SYSTEMS MEETING THE LONG-RANGE REQUIREMENTS OF STRATEGIC DEFENSE MISSIONS SUCH AS THE MIDCOURSE INTERCEPTOR ENGAGEMENT PROGRAM. THE CONCEPT HAS THE POTENTIAL FOR REDUCING THE LASER POWER AND/OR OPTICAL APERTURE REQUIRED. THE FEASIBILITY OF A NEW RECEIVER CONCEPT CALLED THE PHASE MULTIPLEXED CORRELATOR (PMC) IS BEING DEMONSTRATED. THE OVERALL OBJECTIVE OF THIS EFFORT IS TO DEMONSTRATE THE SIGNIFICANT SIGNAL-TO-NOISE ENHANCEMENT THAT IS EXPECTED TO OCCUR FROM A PSEUDO-RANDOM CODE (PRC) MODULATION/DEMULATION TECHNIQUES AND TO DEVELOP A QUANTITATIVE METHOD FOR DETERMINING THE MERITS OF PROCEEDING WITH A PRLADAR APPROACH TO DEEP SPACE RANGING. SPECIFICALLY, PSEUDO-NOISE (PN) CODE PARAMETERS OPTIMIZED FOR STRATEGIC DEFENSE TRACKING MISSIONS IS BEING DETERMINED. THE ANALYTIC SIGNAL PROCESSING GAIN FOR THE PRLADAR APPROACH COMPARED TO INCOHERENT AVERAGING OF A MATCHED INTER-MEDIATE FREQUENCY FILTER IS BEING DETERMINED. BREADBOARD PRC ELECTRONICS ARE BEING FABRICATED AND TESTED AS A LABORATORY DEMONSTRATION OF A SIMPLIFIED PN TRANSMITTER MODULATION TECHNIQUE. THE NEW PMC RECEIVER CONCEPT IS BEING INVESTIGATED. DATA IS BEING MEASURED AND RESULTS ANALYZED TO ALLOW SCALING UP OF THE CONCEPT IN A LATER PHASE.

BATTERY ENGINEERING INC
1636 HYDE PARK AVE
HYDE PARK, MA 02138
CONTRACT NUMBER:
DR CARL SCHLAIKIER

TITLE:

LITHIUM/THIONYL CHLORIDE PRIMARY CELLS USING A HOMOGENEOUS CATALY
TO INCREASE RUNNING POTENTIAL AND CAPACITY

TOPIC# 5

OFFICE:

IDENT#: 30308

CATALYSTS CURRENTLY AVAILABLE FOR INCREASING THE CAPACITY AND RUNNING POTENTIAL OF LITHIUM/THIONYL CHLORIDE CELLS ARE ORGANIC MACROCYCLIC COMPLEXES OF TRANSITION METALS. THE STARTING MATERIALS ARE OFTEN DIFFICULT TO PREPARE, THE PROCEDURES FOR THE INCORPORATION OF THE CATALYSTS INTO THE CATHODES ARE OFTEN INVOLVED, AND SHELF LIFE AND VOLTAGE DELAY ON STARTUP AFTER STORAGE OFTEN DEPEND UPON WHETHER THE

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COMPLEX AND ITS BONDING TO THE CARBON ARE STABLE. WHILE LITHIUM/THIONYL CHLORIDE CELLS OFFER THE BEST PROMISE FOR SUPERIOR ENERGY AND POWER DENSITY, THEIR POWER DENSITY IS LIMITED PARTLY BY KINETIC PROCESSES AT THE CARBON ELECTRODE. AN INORGANIC NONMETALLIC COMPLEX IN A TETRACHLOROALUMINATE/THIONYL CHLORIDE ELECTROLYTE IS BEING INVESTIGATED TO DETERMINE WHETHER IT WOULD BE CAPABLE OF ACTING AS A SOLUBLE OR HOMOGENEOUS CATALYST FOR THE REDUCTION OF THIONYL CHLORIDE DURING DISCHARGE OF LITHIUM/THIONYL CHLORIDE CELLS. CELLS PREPARED WITH LABORATORY GLASSWARE OR 13/16 INCH IN DIAMETER TIMES 1/16 INCH THICK BUTTON CELLS ARE BEING USED AS THE EXPERIMENTAL VEHICLES. WHEN SUCCESSFUL, THE NEW CATALYST WOULD BE EASILY PREPARED FROM READILY AVAILABLE MATERIALS, EASILY INCORPORATED INTO CELLS, AND WOULD NOT INCREASE VOLTAGE DELAY.

BRIMROSE CORP OF AMERICA
7720 BELAIR RD
BALTIMORE, MD 21236
CONTRACT NUMBER:
DR S B TRIVEDI

TITLE:

HIGH ENERGY DENSITY SOLID PROPELLANTS QUALITY CONTROL DIAGNOSTICS
TOPIC# 6 OFFICE: IDENT#: 30756

COST EFFECTIVE, RELIABLE, AND REPRODUCIBLE PRODUCTION OF SOLID PROPELLANT MATERIAL WITH HIGH DENSITY AND HIGH MOLECULAR STRAIN IS CRITICAL FOR REDUCING LAUNCH COSTS. A RAPID-QUALITY CONTROL SYSTEM IS BEING DEVELOPED FOR THOSE PROPELLANTS USING NON-DESTRUCTIVE AND NON-INTRUSIVE X-RAY DIFFRACTION TECHNIQUES. THIS WILL AID BUILDING LOW COST, LOW WEIGHT PROPULSION/LAUNCH SYSTEMS IN AN EFFICIENT AND RELIABLE MANNER. TWO REPRESENTATIVE PROPELLANT MATERIAL SYSTEMS ARE BEING INVESTIGATED: HYDROX/L/AMMONIUM PERCHLORATE (HAP)/BERYLLIUM AND HAP/BERYLLIUM HYDRIDE. CORRELATION IS BEING OBTAINED BETWEEN X-RAY DIFFRACTION CHARACTERISTICS OF PROPELLANTS (AS RECEIVED, WITH APPLIED EXTERNAL STRESS AND THERMALLY ANNEALED) AND IMPACT TEST RESULTS. THIS IS ALLOWING TRANSLATION OF X-RAY DIFFRACTION CHARACTERISTICS OF THESE MATERIALS IN TERMS OF SHOCK SENSITIVITY. SHOCK SENSITIVITY IS AN IMPORTANT PROPERTY OF PROPELLANTS, KNOWLEDGE OF WHICH IS CRITICAL FOR THEIR SAFE HANDLING AND SUCCESSFUL END APPLICATIONS. WHEN SUCCESSFUL, DEVELOP A UNIQUE ON-LINE QUALITY CONTROL TOOL FOR THE PRODUCTION OF

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HIGH ENERGY DENSITY PROPELLANTS WILL ALLOW RELIABLE, GOOD QUALITY PRODUCTION OF THESE AS WELL AS SIMILAR PROPELLANT MATERIALS.

CASTLE TECHNOLOGY CORP
262 W CUMMINGS PK
WOBURN, MA 01801
CONTRACT NUMBER:
DR J PAUL PEMSLER
TITLE:
NET SHAPE PEROVSKITE SUPERCONDUCTOR FABRICATION BY
ELECTRODEPOSITION
TOPIC# 15 OFFICE: IDENT#: 30313

MAJOR ADVANCES IN HIGH TEMPERATURE SUPERCONDUCTORS HAVE POSED THE CHALLENGE OF FABRICATING THESE CERAMIC OXIDES INTO USEFUL SHAPES WITH DESIRED PHYSICAL AND ELECTRICAL CHARACTERISTICS. ALTHOUGH OPTIMUM ELEMENTAL COMPOSITIONS MAY NOT HAVE BEEN ESTABLISHED, IT IS REASONABLE TO ASSUME THAT, IN THE NEAR TERM, PEROVSKITE STRUCTURES BASED ON YBaCuO ARE AVAILBLE COMPOSITION TO USE IN DEVELOPING FABRICATION TECHNOLOGIES. THE FEASIBILITY IS BEING ASSESSED OF USING ELECTROCHEMICAL CODEPOSITION TO FABRICATE AND SYNTHESIZE NET SHAPE COPPER OXIDE PEROVSKITE SUPERCONDUCTORS. DURING ELECTRODEPOSITION, A COMPOSITE IS ANTICIPATED TO RESULTS THAT WOULD CONTAIN SUFFICIENT PARTICULATES EMBEDDED IN A MATRIX TO PRODUCE A METAL RATIO OF Y:Ba:Cu OF 1:2:3. THE ELECTRODEPOSITE IS EXPECTED TO BE CAPABLE OF BEING FORMED AS A WIRE, THIN FILM, ROPE AND ANY OTHER COMPOSITE, WHICH SHOULD BE HIGHLY UNIFORM IN COMPOSITION, IS THEN BEING OXIDIZED UNDER CONTROLLED CONDITIONS TO FORM THE 123 COMPOUND, YBaCuO_{7-x} . THOSE SAMPLES WHICH SHOW, BY METALLOGRAPHIC EXAMINATION AND X-RAY DIFFRACTION, THE DESIRED COMPOSITION AND STRUCTURE ARE BEING EXAMINED FOR THEIR SUPERCONDUCTING PROPERTIES. WHEN SUCCESSFULLY DEMONSTRATED, THE ABILITY WOULD EXIST TO PRODUCE PEROVSKITE HIGH TEMPERATURE SUPERCONDUCTORS INEXPENSIVELY IN DESIRED NET SHAPES.

CERAMATEC INC
2425 S 900RD W
SALT LAKE CITY, UT 84119
CONTRACT NUMBER:
DR ASHOK JOSHI
TITLE:
HYDROGEN THERMOELECTRIC GENERATOR
TOPIC# 4 OFFICE: IDENT#: 30458

SUBMITTED BY

FUTURE SPACE POWER STATION NEEDS ARE SEVERAL TIMES HIGHER THAN WHAT CAN BE EFFICIENTLY DELIVERED BY CURRENT PHOTOVOLTAIC POWER GENERATION SYSTEMS. THE CHALLENGE IS TO EXPLORE NEW POWER TECHNOLOGIES THAT WILL MEET PROJECTED POWER NEEDS. A POTENTIAL SOLUTION CAN BE THE USE OF SOLAR OR NUCLEAR POWER BASED ELECTROCHEMICAL HEAT ENGINES SUCH AS THE HYDROGEN HEAT ENGINE. THE HYDROGEN THERMOELECTRIC GENERATOR BASED ON NEWLY DEVELOPED PROTON-CONDUCTING SOLID ELECTROLYTES IS A PROMISING THERMOELECTRIC ENERGY CONVERSION CONCEPT. THE DEVICE PROMISES VERY HIGH SPECIFIC POWER ON BOTH A VOLUME AND WEIGHT BASIS, HIGH CONVERSION EFFICIENCY WHICH IS INDEPENDENT OF SIZE, AND NO MOVING PARTS WITH POTENTIALLY HIGH RELIABILITY. THESE ARE ATTRACTIVE ATTRIBUTES FOR SPACE PLATFORM AND SATELLITE APPLICATIONS. A THEORETICAL AND EXPERIMENTAL FOUNDATION IS BEING ESTABLISHED TO ASSESS FEASIBILITY OF THIS CONCEPT FOR POTENTIAL APPLICATION TO SPACE POWER SYSTEMS. ELECTROLYTE/ELECTRODE COMBINATIONS FOR BOTH HIGH AND LOW TEMPERATURE CELLS ARE BEING SELECTED. METHODS OF ELECTRODE APPLICATION TO BOTH HIGH AND LOW TEMPERATURE SOLID ELECTROLYTES ARE BEING DEVELOPED. BIELEMENT THERMOELECTRIC CELL IS BEING DESIGNED AND FABRICATED. SINGLE BIELEMENT THERMOELECTRIC DEVICE IS BEING TESTED AND EVALUATED.

CERAMATEC INC
2425 S 900RD W
SALT LAKE CITY, UT 84119
CONTRACT NUMBER:
DR ASHOK JOSHI
TITLE:
SOLID STATE PROTON CONDUCTING ELECTROLYTES FOR MODERATE
TEMPERATURE FUEL CELL/ELECTROLYZER
TOPIC# 5 OFFICE: IDENT#: 30460

SOLID STATE PROTON CONDUCTING ELECTROLYTES ARE BEING USED FOR MODERATE TEMPERATURE FUEL CELL/ELECTROLYZERS. THE ADVANTAGES OF THIS CONCEPT OVER EXISTING SYSTEMS ARE HIGH EFFICIENCY OF OPERATION, HIGH POWER DENSITY, SOLID STATE CONSTRUCTION, AND INTEGRATION OF FUEL CELL AND ELECTROLYZER. HIGH EFFICIENCY OF OPERATION IS EXPECTED TO BE REALIZED THROUGH THE CONVERSION OF CHEMICAL ENERGY INTO ELECTRICAL ENERGY VIA AN ISOTHERMAL ELECTROCHEMICAL PROCESS, THUS AVOIDING THE CARNOT CYCLE LIMITATIONS OF OTHER CONVERSION DEVICES. BY COMBINING ELECTRICITY AND

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HEAT, EFFICIENCIES APPROACHING 90% MAY BE REALIZED. HIGH POWER DENSITY IS ANTICIPATED TO BE REALIZED BY OPERATING THE DEVICE AT TEMPERATURES HIGHER THAN USED IN EXISTING SYSTEMS, ALLOWING RAPID ELECTRODE/ELECTROLYTE INTERFACE KINETICS. THROUGH SOLID STATE CONSTRUCTION, THE PROBLEMS ENCOUNTERED WITH ELECTROLYTE MANAGEMENT AND CORROSION ARE EXPECTED TO BE AVOIDED AND GREATER FLEXIBILITY IN DESIGN REALIZED. DEVELOPMENT, FABRICATION, AND TESTING/EVALUATION OF A PROTOTYPE DEVICE IS BEING ACCOMPLISHED TO PROVIDE PROOF OF CONCEPT FOR THE PROPOSED DEVICE. WHEN SUCCESSFUL, THE PROPOSED DEVICE IS EXPECTED TO PRODUCE POWER EFFICIENTLY REGARDLESS OF SIZE, THUS ALLOWING GREAT FLEXIBILITY IN DESIGN AND CONFIGURATION FOR SUCH APPLICATION AS ON BOARD SPACE CRAFT AND SUBMERSIBLE VEHICLE POWER PLANTS.

CERAMATEC INC
2425 S 900RD W
SALT LAKE CITY, UT 84119
CONTRACT NUMBER:

DR ASHOK C KHANDKAR

TITLE:

INTEGRATED HIGH EFFICIENCY HIGH POWER DENSITY SOLID COMPOSITE
ELECTROLYTE FUEL CELL/ELECTROLYZER

TOPIC# 5

OFFICE:

IDENT#: 30605

SPACE APPLICATIONS OF FUEL CELL BASED POWER SYSTEMS ENCOUNTER PROBLEMS WHEN, IN AN EFFORT TO OBTAIN HIGHER PERFORMANCE, CELL TEMPERATURES AND PRESSURES ARE INCREASED. A HIGH POWER DENSITY REVERSIBLE FUEL CELL/ELECTROLYZER IS BEING DEVELOPED TO ADDRESS THIS ISSUE. THE CONCEPT UTILIZES A COMPOSITE SOLID ELECTROLYTE MEMBRANE WHICH OFFERS HIGH CONDUCTIVITY AT MODERATE TEMPERATURES OF 650-800 DEGREES C. THE DESIGN IS OF PLANAR THIN BIPOLAR CONSTRUCTION WHICH SHOULD EXHIBIT LOW IR AND THUS OPERATE AT HIGH CURRENT DENSITIES. IN THE REVERSIBLE MODE, A HIGH EFFICIENCY MAY BE OBTAINED DUE TO THE THERMODYNAMIC ADVANTAGE OFFERED BY MUCH HIGHER OPERATING TEMPERATURES COMPARED TO EXISTING STATE OF THE ART. COMPARED TO EXISTING ALKALINE FUEL CELL SOLID POLYMER ELECTROLYTE ELECTROLYZER TECHNOLOGY, THE SOLID ELECTROLYTE FUEL CELL ELECTROLYZER IS EXPECTED TO GIVE AT LEAST TWICE THE POWER DENSITY. KEY ISSUES RELATING TO MATERIALS AND FABRICATION OF THIS ADVANCED DEVICE ARE BEING ADDRESSED THAT, WHEN SUCCESSFUL, WOULD DEMONSTRATE PROOF OF CONCEPT UNDER FUEL CELL AND ELECTROLYZER MODES.

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THE PLANAR SOLID STATE DEVICE SHOULD ALLOW FLEXIBLE CONFIGURATION TO SUIT THERMAL MANAGEMENT REQUIREMENTS AND SHOULD BE EASILY INTEGRATED INTO ONBOARD SPACE CRAFT APPLICATIONS. THE TECHNOLOGY ADVANCES COULD BE USED FOR FUEL CELLS FOR STATIONARY POWER PLANTS AS WELL AS OXYGEN PUMPS FOR MEDICAL/ELECTRONICS PROCESSING APPLICATIONS.

CHRONOS RESEARCH LABS INC
4186 SORRENTO VALLEY BLVD - STE H
SAN DIEGO, CA 92121
CONTRACT NUMBER:
DR RANDALL B OLSEN
TITLE:
ENHANCED SUPERCONDUCTORS
TOPIC# 15 OFFICE: IDENT#: 30115

ONE OF THE MAJOR CHALLENGES FACING HIGH TEMPERATURE SUPERCONDUCTORS IS THE MAKING OF NON-BRITTLE MATERIALS. BASED ON THE SUCCESSFUL DISCOVERY OF HIGH TEMPERATURE PEROVSKITE SUPERCONDUCTORS, A NEW CLASS OF SUPERCONDUCTING MATERIALS IS BEING INVESTIGATED THAT IS ANTICIPATED TO BE MECHANICALLY TOUGH, HAVE HIGH CRITICAL TEMPERATURES, BE INEXPENSIVE TO MANUFACTURE, AND BE EASILY FORMED INTO WIRES AND BANDS. IN THIS INVESTIGATION, THE MEISSNER EFFECT IS BEING USED TO DETECT A SUPERCONDUCTING TRANSITION IN A SPECIFIC MATERIAL WITHIN THIS PROPOSED NEW CLASS. THE SPECIFIC MATERIAL IS BEING SYNTHESIZED AND CHEMICALLY MODIFIED AND THE MAGNETIC SUSCEPTIBILITY OF SPECIMEN MEASURED. A LATER EFFORT WOULD FOLLOW THIS DETECTION MEASUREMENT WITH OTHER MEASUREMENTS TO FIRMLY ESTABLISH THIS MATERIAL AS A HIGH TEMPERATURE SUPERCONDUCTOR. AFTER THE SUPERCONDUCTING PROPERTIES ARE FIRMLY ESTABLISHED, A SPECIMEN WHICH IS SEVERAL METERS LONG WOULD BE PRODUCED. POWER APPLICATIONS INCLUDE TRANSMISSION, CONDITIONING, STORAGE, AND MOTORS. OTHER APPLICATIONS INCLUDE MAGNETIC SHIELDING, SUPERCONDUCTING CAVITIES, AND ELECTRONIC DEVICES.

CHRONOS RESEARCH LABS INC
4186 SORRENTO VALLEY BLVD - STE H
SAN DIEGO, CA 92121
CONTRACT NUMBER:
DAVID A BRUNO
TITLE:
LIGHTWEIGHT LOW COST FLEXIBLE SENSORS/ACTUATORS FOR LARGE SPACE
STRUCTURE CONTROL
TOPIC# 12 OFFICE: IDENT#: 30116

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TRANSPORTATION COST LIMITATIONS WILL TEND TO IMPOSE RESTRICTIONS ON THE MASS AND HENCE MECHANICAL STIFFNESS OF VERY LARGE STRUCTURES FOR FUTURE SPACE MISSIONS. TECHNIQUES FOR BOTH PASSIVE AND ACTIVE CONTROL OF THE STRUCTURAL DYNAMICS AND STATICS ARE NEEDED. POLYMER PIEZOELECTRIC BIMORPHS HAVE THE POTENTIAL FOR PROVIDING THE NEEDED CONTROL. THE FEASIBILITY IS BEING INVESTIGATED THAT A POLYMER PIEZOELECTRIC BIMORPH CAN EFFECTIVELY DETECT AND CORRECT LOW FREQUENCY STRUCTURAL VIBRATION AND MAINTAIN A DESIRED SHAPE CONFIGURATION. SUCH A BIMORPH IS BEING FABRICATED AND TESTED TO DETERMINE ITS CAPABILITY A LABORATORY-SCALE THIN METALLIC BAND APPLICATION. ANALYTICAL WORK IS BEING UNDERTAKEN TO ESTABLISH A SET OF DESIGN EQUATIONS FOR FUTURE SPACE STRUCTURES AND TO DESIGN A SCALED-UP EXPERIMENT. PIEZOELECTRIC POLYMER BIMORPHS, WHEN SUCCESSFULLY DEMONSTRATED, WOULD BE INEXPENSIVE, LIGHTWEIGHT, EASILY DEPLOYABLE AND ABLE TO CONTROL VERY LARGE STRUCTURES BOTH ACTIVELY AND PASSIVELY. IN ADDITION TO DEFENSE AND SPACE USES TO CONTROL LARGE SPACE STRUCTURES, ADVANCES IN PIEZOELECTRIC DETECTORS/ACTUATORS HAVE A WIDE RANGE OF COMMERCIAL APPLICABILITY. EXAMPLES RANGE FROM ULTRASONIC MEDICAL IMAGING OF INTERNAL HUMAN ORGANS, BIOMEDICAL DETECTION OF MUSCULAR MOTION TO AID HANDICAPPED PERSONS, DISTORTION-FREE MECHANICAL SIGNAL DETECTION FOR MUSICAL INSTRUMENTS, AND HIGH-FIDELITY SOUND PRODUCTION FROM RECORDED MUSIC.

COLEMAN RESEARCH CORP
5950 LAKEHURST DR
ORLANDO, FL 32819
CONTRACT NUMBER:
JOEL GREENSTEIN
TITLE:

HARDENED ELECTRONICS FOR ELECTROMAGNETICALLY LAUNCHED PROJECTILES
TOPIC# 2 OFFICE: IDENT#: 30120

THE ELECTRONICS DESIGN PROBLEM ASSOCIATED WITH ULTRA-HIGH G PHYSICAL ENVIRONMENTS IS BEING ADDRESSED, USING AS A BASIS THE DEVELOPMENT OF CRYSTALS FOR USE IN CRYSTAL OSCILLATORS SUITABLE FOR ELECTROMAGNETICALLY LAUNCHED (RAIL GUN) PROJECTILE APPLICATIONS. THE STUDY IS FOCUSING ON THE STRUCTURAL DESIGN PROBLEM OF RESONANT CRYSTALS SO AS TO PRECEDE THE ELECTRONICS DESIGN PHASE. THIS TASK IS EXAMINING

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VARIOUS CRYSTAL COMPONENTS, THEIR SIZE, SHAPE, RESONANT MODES, MATERIALS, OLD AND NEW MOUNTING PROCEDURES, AND MECHANICAL TUNING CAPABILITIES OF MOUNT CONFIGURATIONS, IN AN ATTEMPT TO DEVELOP DESIGNS AND APPROACHES COMPATIBLE WITH THE ONE HUNDRED THOUSAND TO ONE MILLION G RAIL GUN ENVIRONMENT. THESE FINDINGS MAY BE ABLE TO BE EXTENDED TO OTHER ELECTRONIC COMPONENTS. THE APPLICATION FOR AN ULTRA-HARD CRYSTAL IS IN PORTABLE ELECTRONIC DEVICES THAT ARE SUBJECT TO ROUGH USAGE (E.G., INTENSE SHOCK). WRIST WATCHES, WALKIE-TALKIE, AND SMALL RADIOS ARE EXAMPLES. THESE DEVICES, AND OTHERS LIKE THEM, CURRENTLY MAKE USE OF THE HARDEST CRYSTALS AVAILABLE, THAT OFTEN ARE FURTHER PROTECTED BY MECHANICAL SHOCK AND VIBRATION ISOLATION SCHEMES REQUIRING RELATIVELY LARGE VOLUME (SWAY SPACE). AN ULTRA-HARD CRYSTAL WOULD ELIMINATE THE NEED FOR THE ISOLATORS AND THE ADDITIONAL VOLUME.

CREARE INC

PO BOX 71 - ETNA RD

HANOVER, NH 03755

CONTRACT NUMBER:

DR HERBERT SIXSMITH

TITLE:

ELECTROMAGNETIC BEARINGS FOR MINIATURE HIGH SPEED TURBOEXPANDERS

SPACE-BORNE CRYOCOOLERS

TOPIC# 3

OFFICE:

IDENT#: 30228

CRYOGENIC COOLING OF ADVANCED SENSORS IS BEING INVESTIGATED, PARTICULARLY CRYOCOOLERS THAT USE MINIATURE HIGH-SPEED TURBOEXPANDERS. A MINATURE ELECTROMAGNETIC BEARING (EMB) DESIGN FOR CRYOGENIC TURBINES IS BEING UNDERTAKEN TO OVERCOME THE LIMITATIONS OF GAS BEARINGS. THE PROPOSED EMB, BECAUSE IT IS NON-CONTACTING, IS EXPECTED TO SHOW ULTRA-HIGH RELIABILITY OVER EXTENDED PERIODS OF CRYOCOOLER OPERATION. BECAUSE THE EMB OPERATES AT CRYOGENIC TEMPERATURES, IT ALLOWS A SUBSTANTIAL REDUCTION IN THE TURBOEXPANDER HEAT LEAK ASSOCIATED WITH THE WARMER TEMPERATURES NEEDED BY GAS BEARINGS. THIS REDUCTION IN TURBOEXPANDER HEAT LEAK IS ANTICIPATED TO RESULT IN A SUBSTANTIAL LOWERING OF CRYOCOOLER INPUT POWER THAT CAN LEAD TO MAJOR REDUCTIONS IN SPACECRAFT POWER AND WEIGHT. IN ADDITION TO MAJOR ADVANCES IN SPACE-BORNE CRYOCOOLER PERFORMANCE, THIS PROGRAM, WHEN SUCCESSFUL, WILL ADVANCE EMB TECHNOLOGY TO FAR HIGHER LEVELS OF

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MINIATURIZATION AND SPEED THAN HAVE BEEN ACHIEVED TO DATE. THIS TECHNOLOGY ALSO WILL BENEFIT EARTH-BOUND APPLICATIONS WHERE GOALS OF ULTRA-LOW TEMPERATURES ARE HINDERED BY HEAT LEAKS IN TURBINES, INCLUDING REFRIGERATORS FOR SUPERCONDUCTING MAGNETS IN PARTICLE ACCELERATORS AND MAGNETIC RESONANCE IMAGING SYSTEMS.

CREARE INC
PO BOX 71 - ETNA RD
HANOVER, NH 03755
CONTRACT NUMBER:
W DODD STACY
TITLE:
SUPERCONDUCTING MEISNER EFFECT BEARINGS FOR CRYOGENIC TURBOMACHIN
TOPIC# 15 OFFICE: IDENT#: 30230

STATE-OF-THE-ART MINIATURE EXPANSION TURBINES AND CENTRIFUGAL COMPRESSORS USED IN SPACEBORNE SENSOR CRYOCOOLERS EMPLOY SELF-ACTING AS BEARINGS TO ACHIEVE HIGH RELIABILITY AND LONG OPERATING LIFE. RUNNING RELATIVELY WARM TO ACHIEVE ADEQUATE STIFFNESS AND STABILITY, THESE BEARINGS CONSTITUTE AN UNAVOIDABLE SOURCE OF HEAT LEAK TO THE EXPANSION TURBINE. THE VIABILITY IS BEING ESTABLISHED OF EMPLOYING HIGHLY RELIABLE PASSIVE BEARINGS USING MEISSNER EFFECT OF SUPERCONDUCTING MATERIALS TO PROVIDE STABLE PASSIVE MAGNETIC LEVITATION OF A HIGH SPEED ROTATING SHAFT. OPERATING BELOW THEIR SUPERCONDUCTING TRANSITION TEMPERATURE, SUCH BEARINGS ARE ANTICIPATED TO REDUCE OR ELIMINATE HEAT LEAK AND THEREBY SIGNIFICANTLY TRIM CRYOCOOLER SYSTEM INPUT POWER REQUIREMENTS. THIS EFFORT IS AIMED AT PRODUCING A BEARING SYSTEM DESIGN FOR FABRICATION AND TESTING IN A LATER PHASE. INTER-RELATED ISSUES OF PERFORMANCE, GEOMETRY, MATERIALS SELECTION AND FABRICATION TECHNIQUES ARE BEING IDENTIFIED AND RESOLVED. WHEN SUCCESSFUL, THIS INNOVATION IS SMALL TURBOEXPANDERS IN CRYOCOOLERS FOR SPACEBORNE SURVEILLANCE SENSORS WOULD REDUCE SIGNIFICANTLY INPUT POWER AND SYSTEM LAUNCH WEIGHT WITHOUT RELIABILITY PENALTY. POTENTIAL COMMERCIAL APPLICATIONS INCLUDE ROTATING MACHINERY WHICH REQUIRE LONG LIFE, HIGH RELIABILITY AND FREEDOM FROM LUBRICANTS WHICH MAY CONTAMINATE THE WORKING FLUID.

CREE RESEARCH INC
2100 WESTPARK DR
RSCH TRIANGLE PK, NC 27713
CONTRACT NUMBER:
DR CALVIN H CARTER JR
TITLE:
SUBLIMATION GROWTH OF LARGE SINGLE CRYSTALS OF BETA SILICON CARBI
TOPIC# 14 OFFICE: IDENT#: 30317

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BETA SILICON CARBIDE (B-SiC) POSSESSES A UNIQUE COMBINATION OF PROPERTIES IMPORTANT FOR APPLICATION IN HIGH FREQUENCY ELECTRONIC DEVICES CAPABLE OF OPERATING AT HIGH POWER. THE COMBINATION OF ITS WIDE BANDGAP, HIGH SATURATED ELECTRON DRIFT VELOCITY, HIGH BREAKDOWN ELECTRIC FIELD, LOW DIELECTRIC CONSTANT, AND HIGH THERMAL CONDUCTIVITY GIVE IT A FIGURE OF MERIT FOR HIGH POWER MICROWAVE APPLICATIONS THAT IS 1100 TIMES BETTER THAN THAT OF SILICON AND 183 TIMES BETTER THAN THAT OF GALLIUM-ARSENIDE. RECENT RESEARCH ON SiC HAS RESULTED IN THE FABRICATION OF VARIETY OF ELECTRONIC DEVICES FROM BOTH A ALPHA- AND BETA-SiC. THE RECENT PRODUCTION OF LARGE 6H-SiC CRYSTALS AND THEIR USE AS SUBSTRATES FOR SUBSEQUENT CHEMICAL VAPOR DEPOSITION (CVD) HAS RESULTED IN A DRAMATIC DECREASE IN THE DEFECT DENSITY IN THE CVD GROWN 6H-SiC FILMS AND AN INCREASE IN DEVICE PERFORMANCE. CURRENTLY, THERE IS NO SOURCE OF B-SiC CRYSTALS LARGER THAN 2 MM IN DIAMETER. THE FEASIBILITY IS BEING INVESTIGATED OF GROWING LARGE SINGLE CRYSTALS OF B-SiC SUITABLE FOR USE AS SUBSTRATES FOR CVD GROWTH OF B-SiC THIN FILMS, USING A SUBLIMATION TECHNIQUE SIMILAR TO THAT DEVELOPED FOR GROWING LARGE 6H-SiC SINGLE CRYSTALS. WHEN SUCCESSFULLY DEMONSTRATED, PRODUCTION OF LARGE SINGLE CRYSTALS OF B-SiC WOULD MAKE POSSIBLE THE DEVELOPMENT OF SOLID STATE HIGH POWER MICROWAVE DEVICES FROM THIS MATERIAL.

CREE RESEARCH INC
2100 WESTPARK DR
RSCH TRIANGLE PK, NC 27713
CONTRACT NUMBER:
DR JOHN A EDMOND

TITLE:

RADIATION AND ELECTROMAGNETIC PULSE EFFECTS ON SILICON CARBIDE
BASED ELECTRONICS

TOPIC# 8

OFFICE:

IDENT#: 30620

SILICON CARBIDE (SiC) IS A SEMICONDUCTOR THAT POSSESSES A UNIQUE COMBINATION OF PHYSICAL AND ELECTRONIC PROPERTIES THAT MAKE DEVICES PRODUCED FROM THIS MATERIAL INTRINSICALLY RADIATION AND ELECTROMAGNETIC PULSE (EMP) RESISTANT. IN ADDITION, SiC DEVICES CAN OPERATE AT VERY HIGH TEMPERATURES AND FREQUENCIES AT HIGH POWER. RECENT RESEARCH ON SiC HAS RESULTED IN THE FABRICATION OF METAL-OXIDE-SEMICONDUCTOR

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FIELD-EFFECT TRANSISTORS (FETS) WITH VERY GOOD CURRENT-VOLTAGE CHARACTERISTICS AT TEMPERATURES AS HIGH AS 650 DEGREES C. VERY GOOD QUALITY METAL-SEMICONDUCTORS FETS & P-N JUNCTION DIODES ALSO HAVE BEEN PRODUCED RECENTLY FOR SiC. PAST LIMITED RESEARCH CONCERNING RADIATION RESISTANCE OF SiC DEVICES PRODUCED RATHER POOR QUALITY RESULTS. NEVERTHELESS, THE SiC DEVICES WERE MORE RADIATION RESISTANT THAN SIMILAR Si DEVICES BY A FACTOR OF 4 TO 100 (DEPENDING ON THE DEVICE AND RADIATION SOURCE). IN THIS INVESTIGATION, HIGH QUALITY SiC-BASED ELECTRONIC DEVICES ARE BEING DEVELOPED THAT ARE AT LEAST OR MORE RADIATION RESISTANT THAN THE EARLY DEVICES. PRELIMINARY EMP (VOLTAGE PULSE) AND RADIATION (TOTAL GAMMA DOSE) EXPERIMENTS ARE BEING PERFORMED. DESIGN AND PROCESSING PARAMETERS ARE BEING INVESTIGATED TO INCREASE THE HARDNESS OF SiC DEVICES LIMITED BY INTERFACES WITH OTHER MATERIALS (E.G. SILICON DIOXIDE).

CSA ENGINEERING INC
560 SAN ANTONIO RD - STE 101
PALO ALTO, CA 94306
CONTRACT NUMBER:

ERIC M AUSTIN

TITLE:

ACTIVELY TUNED THERMALLY CONTROLLED TUNED-MASS DAMPERS

TOPIC# 12 OFFICE: IDENT#: 30172

SCENARIOS FOR STRATEGIC DEFENSE SYSTEMS WILL REQUIRE THAT THE EFFECTS OF STRUCTURAL DYNAMICS BE REDUCED. QUITE OFTEN ONE VIBRATIONAL MODE PLAYS A DOMINANT ROLE IN THE DYNAMIC RESPONSE. PASSIVE DAMPING USING TUNED-MASS DAMPERS (TMDS) IS A WELL-KNOWN APPROACH TO SUPPRESS VIBRATION. TMDS HAVE MANY ADVANTAGES, INCLUDING BEING LIGHT-WEIGHT AND HAVING MINIMAL SIDE EFFECTS ON PRIMARY STRUCTURE DESIGN. HOWEVER, TMDS MUST BE TUNED TO THE FREQUENCY OF THE OFFENDING MODE. AN ACTIVE CONTROL SYSTEM FOR TMDS, WHERE ACCELEROMETERS ARE BEING USED TO SENSE THE DYNAMICS AND A THERMAL SYSTEM USED TO CONTROL THE TEMPERATURE (AND THEREBY STIFFNESS) OF A VISCOELASTIC MATERIAL IN THE TMD, IS BEING DESIGNED AND TESTED. IT IS ANTICIPATED THAT THE CONTROL SYSTEM WOULD KEEP THE TMD TUNED TO THE MODE AND ALSO MAINTAIN THE THERMAL ENVIRONMENT FOR SPACE APPLICATIONS. SINCE ONLY A SMALL AMOUNT OF VISCO-ELASTIC MATERIAL IS USED, VERY LITTLE POWER IS EXPECTED TO BE REQUIRED TO MAINTAIN A LARGE INCREASE IN DAMPING. ACTIVE THERMAL CONTROL OF

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TUNED-MASS DAMPERS, WHEN SUCCESSFUL, WOULD ALLOW THIS TYPE OF PASSIVE DAMPING TO BE USED IN A THERMALLY UNCONTROLLED SPACE ENVIRONMENT SUCH AS ON A LARGE SPACE TRUSS. POTENTIAL COMMERCIAL APPLICATIONS INCLUDE SITUATIONS WHERE TUNED-MASS DAMPERS CANNOT BE PRESENTLY USED, I.E., WHERE BOTH THE THERMAL ENVIRONMENT AND/OR THE DYNAMIC OF A STRUCTURE ARE CHANGING.

CSA ENGINEERING INC
560 SAN ANTONIO RD - STE 101
PALO ALTO, CA 94306
CONTRACT NUMBER:
DR DAVID A KIENHOLZ
TITLE:
DYNAMIC ANALYZER FOR VISCOELASTIC DAMPING MATERIALS
TOPIC# 13 OFFICE: IDENT#: 30173

MOST SUCCESSFUL DESIGNS FOR DAMPED STRUCTURES FOR SPACE APPLICATIONS DO NOT ATTEMPT TO USE THE SAME MATERIAL FOR LOAD BEARING AND ENERGY DISSIPATION. RATHER, THE FUNCTIONS ARE SEPARATED WITH DAMPING BEING PROVIDED BY A HIGH-LOSS VISCOELASTIC MATERIAL LOCATED OFF THE MAIN LOAD PATH. A CRITICAL ELEMENT IN THE DESIGN OF SUCH INTEGRALLY DAMPED STRUCTURES IS KNOWLEDGE OF THE STORAGE AND LOSS MODULI OF THE DAMPING MATERIAL. THERE IS A CURRENT NEED FOR AN ACCURATE, RELIABLE, PRACTICAL MEANS FOR EXPERIMENTAL CHARACTERIZATION OF VISCOELASTIC DAMPING MATERIALS. TO FILL THAT NEED, AN ADVANCED MATERIAL TEST SYSTEM IS BEING DESIGNED AND PARTIALLY PROTOTYPED. THE SYSTEM REQUIREMENTS ARE BEING DEFINED FOR THE RANGES OF FREQUENCY, TEMPERATURE, STORAGE MODULUS, AND LOSS FACTOR THAT ARE MOST IMPORTANT IN SPACE-BASED DEFENSE STRUCTURES. THE MOST CRITICAL SUBSYSTEMS (FIXTURING, EXCITATION, SENSING, AND TEMPERATURE CONTROL) ARE BEING FULLY DESIGNED, PROTOTYPED, AND TESTED. PROCEDURES ARE BEING DEVELOPED AND APPLIED FOR CHARACTERIZING TYPICAL VISCOELASTIC DAMPING MATERIALS. SOFTWARE IS BEING DESIGNED FOR A DATA ACQUISITION AND PROCESSING SYSTEM OPTIMIZED FOR VISCOELASTIC MATERIALS TESTING. THE RESULT OF THE WORK, WHEN SUCCESSFUL, WOULD LEAD TO AN ADVANCED SYSTEM FOR MEASURING THE DYNAMIC MECHANICAL PROPERTIES (COMPLEX MODULUS) OF VISCOELASTIC MATERIALS USED FOR VIBRATION DAMPING.

DAMASKOS INC
PO BOX 469
CONCORDVILLE, PA 19331
CONTRACT NUMBER:
DR WILLIAM J BITER
TITLE:
SUPERCONDUCTING INFRARED DETECTORS
TOPIC# 15 OFFICE: IDENT#: 30124

SUBMITTED BY

AN INFRARED DETECTOR IS BEING INVESTIGATED WHICH COMBINES RECENT ADVANCES IN HIGH Tc SUPERCONDUCTORS WITH A NOVEL DESIGN OF THESE ABSORBING ELEMENTS TO DEVELOP A RADIATION DETECTOR FOR THE 8-12 MICRONS REGION COMPATIBLE WITH ARRAY PROCESSING. THE SELECTED STRUCTURE INCORPORATES SUPERCONDUCTING STRIPS ARRANGED IN A PERIODIC ARRAY TO FUNCTION AS ANTENNA-LIKE ELEMENTS. THIS FILMS OF YBaCuOx ARE BEING PATTERNED AND BOUNDARY TYPE JOSEPHSON JUNCTIONS ARE BEING FABRICATED. CURRENT-VOLTAGE CURVES, WITH AND WITHOUT RADIATION, ARE BEING USED TO VERIFY THE EXISTENCE OF THE JUNCTIONS AND MEASURE THEIR SENSITIVITY TO RADIATION. OPTICAL CONSTANTS OF THE YBaCuOx ARE BEING USED TO CALCULATE THE PERFORMANCE OF THESE FILMS WHEN FABRICATED AS MORE CONVENTIONAL STRUCTURES AND ALLOW A COMPARISON TO THE PERFORMANCE OF THE TUNED STRUCTURE. LIMITED MODELING IS BEING DONE ON OPTIMIZING THE DETECTORS AS TO THE SIZE AND SHAPE OF THE ELEMENTS. WHEN SUCCESSFUL, THE ADVANTAGES OF THE SUPERCONDUCTING INFRARED DETECTOR INCLUDE MAXIMUM WAVELENGTH DEFINED BY PHOTOLITHOGRAPHY, POTENTIALLY HIGHER DETECTABILITY, AND USE OF THIN PROCESSING AND FABRICATION TECHNIQUES WITH THEIR INHERENTLY LOW COST AND COMPATIBILITY WITH ALREADY EXISTING ARRAY PROCESSING TECHNIQUES.

DEACON RESEARCH
900 WELCH RD - STE 203
PALO ALTO, CA 94304
CONTRACT NUMBER:
DR ANTHONY O'KEEFE
TITLE:
LASER ASSISTED DIAMOND FILM DEPOSITION
TOPIC# 14 OFFICE: IDENT#: 30125

THE GROWTH OF SYNTHETIC DIAMOND FILMS IS ANTICIPATED TO HAVE A SIGNIFICANT IMPACT IN THE FIELD OF ADVANCED ELECTRONIC DEVICE DEVELOPMENT. THE UNIQUE ELECTRONIC AND PHYSICAL PROPERTIES OF DIAMOND MAKE IT ATTRACTIVE AS A POTENTIAL SUBSTRATE FOR DENSE LARGE SCALE INTEGRATED CIRCUITS, DIODE LASER DEVELOPMENT, AND OTHER ADVANCED ELECTRONIC APPLICATIONS. A CHEMICAL RECIPE FOR PRODUCING SUCH FILMS HAS BEEN DEVELOPED IN RECENT YEARS THAT IS NOT SUITABLE FOR SOME OF THE PROJECTED APPLICATIONS OF DIAMOND FILMS DUE TO THE FREQUENT OCCURRENCE OF GRAPHITIC INCLUSIONS. IMPROVEMENT IN THE CONTROL OF DIAMOND

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GROWTH RATE AND DEPOSITION PURITY IS REQUIRED BEFORE THESE POTENTIAL APPLICATIONS CAN BE REALIZED. A FABRICATION APPROACH UTILIZING SELECTIVE LASER PRODUCTION OF THE METHYL RADICAL IS EXPECTED TO RESULT IN A FILM PURITY UNMATCHED BY OTHER METHODS. A PREDICTIVE MODEL IS BEING DEVELOPED OF THE GAS PHASE PROCESSES RESULTING IN DIAMOND FILM GROWTH AND A LASER BASED PROGRAM IS BEING DESIGNED TO GROW GRAPHITE-FREE DIAMOND FILMS IN A LATER EFFORT. WHEN SUCCESSFUL, THIS EFFORT WOULD RESULT IN THE DEVELOPMENT OF HIGH PURITY DIAMOND FILMS FOR ELECTRONIC DEVICE APPLICATIONS. APPLICATIONS INCLUDE NOVEL DIAMOND BASED SEMICONDUCTORS, THIN FILMS FOR PROTECTION AGAINST HOSTILE ENVIRONMENTS AND DEVELOPMENT OF EFFICIENT INSULATING HEAT SINKS FOR ADVANCED ELECTRONIC AND DIODE LASER DEVELOPMENT.

DEACON RESEARCH
900 WELCH RD - STE 203
PALO ALTO, CA 94304
CONTRACT NUMBER:
DR DAVID DEACON
TITLE:
LONG LIFETIME HIGH BRIGHTNESS PHOTOCATHODES
TOPIC# 1 OFFICE: IDENT#: 30621

THE FREE ELECTRON LASER (FEL) REQUIRES A HIGH BRIGHTNESS, HIGH DUTY CYCLE ELECTRON BEAM. USE OF A PHOTOCATHODE, WHICH ELIMINATES BOTH GRID AND BUNCHER AND ALLOWS HIGH GRADIENT RADIO FREQUENCY FIELDS AT THE ELECTRON SOURCE, CAN SUBSTANTIALLY IMPROVE THE BEAM BRIGHTNESS. FEL PHOTOCATHODES INVESTIGATED TO DATE (PRIMARILY CS:F:GaAs AND CS3SB) HAVE A SHORT EMISSION LIFETIME WHEN DRIVEN TO HIGH CURRENT AND CANNOT BE SCALED TO HIGH AVERAGE POWER. A LONG LIFETIME ALTERNATIVE TO CS3SB WHICH IS SCALEABLE IS BEING DEVELOPED AND ITS OPERATION IN AN OPERATING FEL IS BEING DEMONSTRATED. IN THIS STUDY, THE LASERS AND ULTRA HIGH VACUUM CHAMBER, THE QUANTUM EFFICIENCY IS BEING MEASURED OF A RANGE OF CANDIDATE MATERIALS SUCH AS LAB6, WHICH HAS EXCELLENT SCALING CHARACTERISTICS, AS A FUNCTION OF WAVELENGTH AND TEMPERATURE. IN A LATER EFFORT, A LASER DRIVEN PHOTOCATHODE SYSTEM COULD BE CONSTRUCTED AND TESTED ON AN OPERATING FEL. WHEN SUCCESSFUL, THE IDENTIFICATION AND DEMONSTRATION OF A NEW PHOTOCATHODE FOR HIGH BRIGHTNESS ACCELERATORS WOULD BE ACHIEVED WITH HIGH POWER CAPABILITY AND RESISTANCE TO POISONING WITH APPLICATIONS IN FREE ELECTRON LASERS,

SUBMITTED BY

LITHOGRAPHY, AND HIGH ENERGY ACCELERATORS.

DEFENSE RESEARCH TECHNOLOGIES INC
354 HUNGERFORD DR
ROCKVILLE, MD 20850
CONTRACT NUMBER:
DR T M DRZEWIECKI

TITLE:

ELECTRO-OPTICAL/FLUIDIC GUIDANCE FOR KINETIC ENERGY PROJECTILES
TOPIC# 2 OFFICE: IDENT#: 30622

ONE APPROACH TO COMMANDING KINETIC ENERGY PROJECTILES IS TO GUIDE THE PROJECTILE TO THE TARGET VICINITY BY A CODED LASER BEAM. A RELATIVELY NARROW FIELD-OF-VIEW STRAPPED-DOWN SEEKER THEN ACQUIRES THE TARGET AND CLOSES IN FOR THE KILL. A LIGHTWEIGHT, ELECTROMAGNETIC INTERFERENCE (EMI)/NUCLEAR INSENSITIVE, ULTRA-RUGGED, NO-MOVING PARTS, NON-ELECTRONIC, FLUIDIC ELECTRO-OPTICAL ENERGY CONVERSION DEVICE IS BEING DESIGNED, CONSTRUCTED, AND TESTED THAT IS EXPECTED TO BE CAPABLE OF CONVERTING A LASER GUIDANCE SIGNAL DIRECTLY INTO PROPULSIVE THRUST WITHOUT NEED FOR ELECTRONIC INTERFACES. THE DEVICE USES THE PHOTO-ACOUSTIC EFFORT TO CONVERT ELECTRO-OPTICAL ENERGY INTO AN ACOUSTIC WAVE THAT IS PROCESSED WITH FLUIDICS. THE DEVICE SENSES AND PROCESSES ENCODED LASER SIGNALS AND CONVERTS THEM INTO FLUID POWER SIGNALS THAT COULD DIRECTLY DRIVE CONVENTIONAL (MECHANICAL/PNEUMATIC) OR ADVANCED (FLUIDIC, NO-MOVING-PARTS) THE THRUSTER ATTITUDE AND DIRECTIONAL CONTROL SYSTEMS. THIS FLUIDIC DEVICE MIGHT ALSO BE ABLE TO OPERATE ON OPTICALLY ENCODED SEEKER COMMANDS, RESULTING IN AN ESSENTIALLY NO-MOVING-PARTS PROJECTILE. A DUAL-AXIS, HIGH EFFICIENCY (>90% DIVERTOR/THRUSTER IS BEING DESIGNED THAT CAN BE DIRECTLY OPERATED BY THE PROCESSED PHOTO-ACOUSTIC SIGNALS. BY ELIMINATING MOVING PARTS AND MOST OF THE ELECTRONICS FROM THE PROJECTILE, IT WOULD BE VERY LIGHT WEIGHT AND HARDENED AGAINST ALMOST ALL EMI AND NUCLEAR TREATS. IT WOULD BE EXTREMELY RUGGED IN HIGH G ENVIRONMENTS, RELIABLE AND COST EFFECTIVE DUE TO THE LOW-COST FLUIDIC TECHNOLOGIES USED.

DIAMOND MATERIALS INSTITUTE INC
2820 E COLLEGE AVE
STATE COLLEGE, PA 16801
CONTRACT NUMBER:
DR RICHARD KOBAYASHI

TITLE:

SCALEABLE PROCESS FOR CHEMICAL VAPOR DEPOSITION OF LARGE AREA HETEROEPITAXIAL BETA-SiC ON TiC USING GASES WITH 1:1 Si:C STOICHIOMETRY
TOPIC# 14 OFFICE: IDENT#: 30627

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A PROCESS IS BEING DEVELOPED TO GROW HETEROEPITAXIAL BETA-SILICON CARBIDE, A.K.A 3C-SiC, ON TITANIUM CARBIDE SINGLE CRYSTALS USING NOVEL SOURCE GASES. TWO GASES ARE BEING TESTED IN THIS INVESTIGATION THAT CONTAIN SILICON AND CARBON IN A 1:1 RATIO. A CHEMICAL VAPOR DEPOSITION (CVD) PROCESS IS BEING DEVELOPED TO GROW SINGLE CRYSTAL 3C-SiC USING EACH GAS. A BASELINE CVD REACTOR AND PROCESS IS BEING ESTABLISHED FOR PRODUCTION OF HIGH QUALITY 3C-SiC. MATERIAL QUALITY IS BEING MEASURED TO VERIFY THE BASELINE PROCESS AND CORRELATE RESULTS WITH PROCESS SEQUENCES THAT CONSISTENTLY PROVIDE THE BEST MATERIALS. THIS REACTOR PLUS INFORMATION COLLECTED FROM THE PROCESS RUNS IS FORMING THE BASIS FOR A DEVELOPMENT EFFORT BEING UNDERTAKEN IN LATER EFFORT TO INCREASE THE GROWTH RATE AND YIELD OF THE CVD PROCESS WITHOUT DEGRADING THE QUALITY OF 3C-SiC CRYSTALS. WHEN SUCCESSFUL, THIS RESEARCH COULD LEAD TO A PROCESS WHICH WILL MAKE FEASIBLE MASS PRODUCTION OF HIGH QUALITY 3C-SiC SINGLE CRYSTALS SUITABLE FOR THE FABRICATION OF HIGH PERFORMANCE SEMICONDUCTOR DEVICES. THE COMMERCIAL AVAILABILITY OF SEMICONDUCTOR DEVICE GRADE 3C-SiC COULD REVOLUTIONIZE SOLID STATE ELECTRONICS AND LEAD TO THE CREATION OF ULTRAFAST, HIGH TEMPERATURE FIELD EFFECT TRANSISTORS WHICH ARE EXTREMELY RADIATION HARD.

DIRECTED ENERGY INC
2301 RESEARCH BLVD - STE 101
FORT COLLINS, CO 80526
CONTRACT NUMBER:
GEORGE KRAUSSE
TITLE:
MULTI-MEGAHERTZ THYRATRON/OPENING SWITCH
TOPIC# 5 OFFICE: IDENT#: 30321

THE FEASIBILITY IS BEING DETERMINED OF CONTROLLING THE CONDUCTING PLASMA IN A HYDROGEN THYRATRON WITH A TRANSVERSE MAGNETIC FIELD CREATED BY A DEVICE CALLED A PLASMA SHUTTER. CONDUCTING PLASMA IS THE CORE TECHNOLOGY IN A WIDE RANGE OF ELECTRONIC DEVICES AND SYSTEMS, INCLUDING LASERS. HIGH POWER, HIGH FREQUENCY APPLICATIONS OF PLASMA BASED TECHNOLOGY HAVE BEEN LIMITED DUE TO THE DIFFICULTY IN CONTROLLING THE RECOVERY OR DE-IONIZATION TIME OF THE PLASMA WITH THE RESULT THAT PULSE RATES FOR CONVENTIONAL PULSED POWER TECHNOLOGY RARELY EX-

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CEED 10KHZ. OVER THE PAST 20 YEARS, SEVERAL ATTEMPTS HAVE BEEN MADE TO QUENCH A CONDUCTING PLASMA WITH A MAGNETIC FIELD ORIGINATING FROM SOURCES EXTERIOR TO THE PLASMA. THESE EFFORTS HAVE YIELDED MARGINAL RESULTS DUE TO A NUMBER OF FACTORS. THEORETICALLY, THE PLASMA SHUTTER SHOULD OVERCOME THESE PREVIOUS LIMITATIONS BY RESIDING INSIDE THE PLASMA ITSELF. WHEN SUCCESSFUL, THE PLASMA SHUTTER COULD BE APPLIED TO ANY PLASMA WITH ELECTRON DENSITIES IN THE RANGE OF $10E13$ TO $10E16$ PARTICLES PER CM^3 . A HIGH POWER THYRATRON MIGHT BE ABLE TO OPERATE AT FREQUENCIES APPROACHING 1-10MHZ. IN THYRATRON APPLICATION, THE PLASMA SHUTTER WOULD ENABLE A FLAT TOP CURRENT PULSE IN RADAR SYSTEMS AND A LINEAR CURRENT PULSE FOR IMPROVED FIDELITY AND RESOLUTION OF THE RADIO FREQUENCY PULSES. IT WOULD INCREASE THE POWER AND REDUCE THE TIME REQUIRED TO DELIVER THE POWER IN LASER SYSTEMS.

DWA COMPOSITE SPECIALTIES INC
21119 SUPERIOR ST
CHATSWORTH, CA 91311
CONTRACT NUMBER:
TIMOTHY A LOFTIN
TITLE:
GRAPHITE COPPER STRUCTURAL ELEMENTS
TOPIC# 13 OFFICE: IDENT#: 30126

GRAPHITE-ALUMINUM STRUCTURAL ELEMENTS CURRENTLY ARE BEING DEVELOPED FOR USE IN SPACE STRUCTURES AND OTHER APPLICATIONS DEMANDING HIGH SPECIFIC STIFFNESS AND THERMAL STABILITY. THESE APPLICATIONS ARE RESTRICTED BY THE USE TEMPERATURE OF THE ALUMINUM MATRIX, ELEVATED SOMEWHAT BY THE PRESENCE OF THE GRAPHITE FIBER. THE TECHNOLOGY HAS BEEN UNDER DEVELOPMENT FOR PRODUCING GRAPHITE-REINFORCED COMPOSITES WITH COPPER MATRICES FOR USE AT TEMPERATURES BEYOND THOSE ACCEPTABLE FOR ALUMINUM-MATRIX MATERIALS. TO DATE, THESE MATERIALS HAVE BEEN AVAILABLE IN PLATE FORM ONLY. THE TECHNOLOGY FOR FABRICATING ALUMINUM-BASED STRUCTURAL ELEMENTS IS BEING TRANSLATED TO THE FABRICATION OF COPPER-MATRIX COMPOSITE TUBES. EXISTING TUBE-FABRICATION TOOLING IS BEING MODIFIED TO ADAPT THE TECHNIQUES TO THE HIGHER TEMPERATURE NEEDED. PROTOTYPE GRAPHITE-COPPER TUBES ARE BEING FABRICATED AND SUBJECTED TO DESTRUCTIVE TESTING. TEST SAMPLES ARE BEING MEASURED FOR MECHANICAL PROPERTIES REQUIRED. THE INCREASED OPERATING TEMPERATURE, MODERATE DENSITY AND HIGH THERMAL CONDUCTIVITY OF THE COPPER

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COMPOSITE, WHEN SUCCESSFULLY FABRICATED, WOULD FIND APPLICATION IN SEVERAL AREAS REQUIRING HIGH PERFORMANCE STRUCTURAL MATERIALS FOR HARSH THERMAL ENVIRONMENTS, INCLUDING SPACE-POWER SYSTEMS AND AEROSPACE PLANE COMPONENTS.

E-O PRODUCTS CORP
23101 MOULTON PKWY - STE 210
LAGUNA HILLS, CA 92653
CONTRACT NUMBER:
DIETER H POMMERRENIG
TITLE:
SUPERCONDUCTING FOCAL PLANE ARRAY
TOPIC# 15 OFFICE: IDENT#: 30049

WITH THE DISCOVERY OF HIGH TEMPERATURE CERAMIC SUPERCONDUCTORS, GREAT ADVANCEMENTS IN FOCAL PLAN ARRAY (FPA) TECHNOLOGY ARE ANTICIPATED. A PRELIMINARY PERFORMACNE ANALYSIS INDICATES THAT BOTH THE DETECTIVITY OF FPAS, DUE TO REDUCTION IN NOISE, AS WELL AS THEIR IMAGE ACQUISITION SPEED, DUE TO LOW LOSS TRANSMISSION, CAN BE SIGNIFICANTLY ENCHANCED AND REACH THE GIGAHERTZ RANGE. SUPERCONDUCTIVE CIRCUIT ELEMENTS SUIT-ABLE FOR APPLICATIONS IN INFRARED (IR) FPAS ARE BEING INVESTIGATED. SUPERCONDUCTOR DETECTION MECHANISMS AS WELL AS SUPERCONDUCTOR MULTI- PLEXOR TECHNOLOGY ARE BEING STUDIED. AN ANALYSIS AND TRADE STUDY IS BEING PERFORMED WHICH COMPARES THE PERFORMANCE AND TECHNOLOGY RISKS OF A SUPERCONDUCTING READOUT WITH A CHARGE COUPLED DEVICE OR SWITCH ARRAY. A READOUT UNIT CELL IS BEING DESIGNED AS IS A SUPERCONDUCTING DETECTOR INTEGRATED WITH THE OPTIMUM READOUT, ESSENTIALLY A FPA UNIT CELL. A PERFORMANCE MODEL IS BEING MADE OF THE FPA UNIT CELL. AN EVALUATION AND A CIRCUIT ANALYSIS OF THE SELECTED DETECTOR AND READOUT PERFORMANCE MODEL IS BEING UNDERTAKEN TO PROVIDE FIVE PROJECTED OPERATING CHARACTERISTICS. SUPERCONDUCTING INFRARED FOCAL PLANES HAVE THE POTENTIAL OF ACHIEVING A HUNDRED FOLD PERFORMANCE INCREASED OVER CONVENTIONAL IR ARRAYS.

EIC LABS INC
111 DOWNEY ST
NORWOOD, MA 02062
CONTRACT NUMBER:
DR DAVID RAUH
TITLE:
ULTRATHIN BIPOLAR ELECTRODES FOR PULSE POWER BATTERY CAPACITORS
TOPIC# 5 OFFICE: IDENT#: 30130

SUBMITTED BY

SPACE-BASED MISSILE DEFENSE SYSTEMS REQUIRE EXTREMELY COMPACT SOURCES OF PULSE POWER TO OPERATE PROSPECTIVE LASER AND ELECTROMAGNETIC DEFENSIVE WEAPONS. IN PRINCIPLE, AN ELECTROCHEMICAL POWER SOURCE CAN PROVIDE POWER AT A MUCH LOWER WEIGHT AND VOLUME THAN CAPACITORS OR INDUCTORS, BUT HIGH POWER DENSITY BATTERY CONFIGURATIONS AND MATERIALS MUST FIRST BE DEVELOPED. ULTRATHIN BIPOLAR ELECTRODE STRUCTURES ARE BEING DEVELOPED THAT CAN BE USED AS BUILDING BLOCKS FOR SUCH BATTERIES. THE ELECTRODES BEING INVESTIGATED CONSIST OF VACUUM METALLIZED POROUS SEPARATORS, TYPICALLY LESS THAN 100 MICRONS THICK, THAT FIRST CAN BE ASSEMBLED INTO MULTILAYER BIPOLAR STRUCTURES IN THE DRY STATE, THEN IMPREGNATED WITH ELECTROLYTE AND ACTIVE MATERIALS, AND FINALLY SEALED. THE FEASIBILITY OF SUCH A BIMETALLIZED SEPARATOR/ELECTRODE IS BEING DEMONSTRATED. IN ADDITION, THE BATTERY AND CAPACITOR FIGURES OF MERIT FOR THE STRUCTURE CONTAINING EACH OF TWO ELECTRODE MATERIALS ARE BEING CHARACTERIZED. WHEN SUCCESSFUL, IT IS ANTICIPATED THAT THIS TECHNOLOGY WOULD PROVIDE A NEW BATTERY-CAPACITOR HYBRID, WITH POWER DENSITIES EQUALLING THAT OF SOME CAPACITORS WHILE ACHIEVING A 100-FOLD INCREASE IN ENERGY DENSITY. COMMERCIAL USES INCLUDE PHOTOFLASH DEVICES, HIGHLY PORTABLE LASER EQUIPMENT FOR SURGERY, SURVEYING AND WELDING, TOOLS REQUIRING HIGH POWER BURSTS, AND ENGINE STARTERS.

EIC LABS INC
111 DOWNEY ST
NORWOOD, MA 02062

CONTRACT NUMBER:

DR G L HOLLECK

TITLE:

BIPOLAR LEAD/FLUOROBORIC ACID BATTERY FOR PULSE POWER

TOPIC# 5

OFFICE:

IDENT#: 30234

SPACE-BASED MISSILE DEFENSE SYSTEMS REQUIRE SOURCES OF PULSED POWER TO OPERATE PROSPECTIVE DIRECTED ENERGY WEAPONS. POWER MUST BE AVAILABLE INSTANTANEOUSLY AND SEQUENTIAL POWER PULSES MUST HAVE MINIMAL INTER-PULSE DELAYS. TO ACHIEVE THIS EFFICIENTLY, A RECHARGEABLE HIGH POWER BIPOLAR BATTERY IS BEING DEVELOPED BASED ON THE PB/HBF4/PBO2 SYSTEM. SUCH A BATTERY IS UNIQUE IN THAT THE DISCHARGE PRODUCT OF BOTH ELECTRODES IS A COMMON SALT WHICH IS HIGHLY SOLUBLE IN THE ELECTROLYTE. ON

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EACH CHARGE THE ACTIVE MATERIALS ARE NEWLY DEPOSITED ON THE BIPOLAR SUBSTRATES. SPECIFIC ADVANTAGES OF THE PROPOSED BATTERY ARE EXPECTED TO INCLUDE INVARIANT ELECTRODES, HIGH RATE CAPABILITY, COMPLETE USE OF ACTIVE MATERIALS AS WELL AS SIMPLE AND INEXPENSIVE BATTERY CONSTRUCTION. ELECTROCHEMICAL CAPACITIES UNDER PULSED CONDITIONS ARE BEING INVESTIGATED AS A FUNCTION OF ELECTROLYTE COMPOSITION FOR SEVERAL ELECTRODE SUBSTRATE MATERIALS. IT IS ANTICIPATED THAT THE CELL WOULD BE CAPABLE OF DELIVERING MORE THAN 100 SEQUENTIAL PULSES OF ABOUT 0.001 SEC DURATION BEFORE RECHARGE, EACH PULSE WITH A POWER DENSITY OF GREATER THAN 200 W/CM³. FULL MULTILAYER BIPOLAR BATTERIES OF 10,000 W/KG PULSE COULD BE CONSTRUCTED BASED ON THE PERFORMANCE. IN ADDITION TO SPACE APPLICATIONS WHERE WEIGHT AND POWER DENSITY ARE CRITICAL, IT WOULD ALSO BE USEFUL IN MOBILE TERRESTRIAL APPLICATIONS AND IN ELECTRONICS WHERE IT COULD REPLACE CAPACITOR-BATTERY COMBINATIONS.

ELECTRO TECHNOLOGY CORP
11180 ROSELLE ST - STE G
SAN DIEGO, CA 92121

CONTRACT NUMBER:
NORBERT B ELSNER

TITLE:

ELECTRICAL CONDUCTORS FOR 1000-2000 DEGREES K OPERATION
TOPIC# 4 OFFICE: IDENT#: 30438

BETTER HIGH TEMPERATURE (1000-2000K) ELECTRICAL CONDUCTORS ARE NEEDED TO MINIMIZE THE TRANSMISSION (I^2R) LOSSES ASSOCIATED WITH SPACE-BASED POWER SUPPLIES AND RAIL GUNS FOR BOTH SPACE AND TERRESTRIAL APPLICATIONS. WITH THE AVAILABILITY OF MORE CONDUCTIVE LIGHT-WEIGHT MATERIALS, A SYSTEM'S WEIGHT CAN BE REDUCED AND MORE EFFICIENT DESIGNS CAN BE PURSUED. IN THIS INVESTIGATION, BORIDE ELECTRICAL CONDUCTORS ARE BEING DEVELOPED THAT ARE EXPECTED TO BE EQUAL TO OR BETTER THAN MOLYBDENUM. BORIDES OF CERTAIN METALS SUCH AS TITANIUM AND LANTHANUM ARE A UNIQUE GROUP OF COMPOUNDS: THEY ARE MUCH BETTER CONDUCTORS THAN THE METALS THEMSELVES. ELECTRICAL CONDUCTIVITIES OF THE BORIDE COMPOUNDS POTENTIALLY CAN BE FURTHER IMPROVED THROUGH ALLOY MODIFICATION. HIGH-TEMPERATURE ELECTRICAL CONDUCTIVITY AND OTHER RELATED PROPERTIES OF HOT PRESSED BORIDE COMPOUNDS ARE BEING DETERMINED. ELECTRICAL CONDUCTIVITY IS BEING DETERMINED OF SELECTED BORIDES THAT EXHIBIT AN

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ANISTROPIC CRYSTAL STRUCTURE. A MODEL IS BEING DEVELOPED TO BETTER UNDERSTAND THE CHEMICAL AND ELECTRONIC PROPERTIES OF THESE BORIDES. ALLOY ADDITIONS (DOPANTS) ARE BEING IDENTIFIED FOR SELECTED BORIDE COMPOUNDS THAT WILL IMPROVE THEIR CONDUCTIVITY AND SUCH BORIDES ARE BEING PREPARED AND EVALUATED. BORIDE CONDUCTORS COULD BE USEFUL IN MANY COMMERCIAL AREAS SUCH AS IN HIGH-TEMPERATURE ELECTROLYTIC REFINING OF METALS SUCH AS ALUMINUM.

ELECTRO TECHNOLOGY CORP
11180 ROSELLE ST - STE G
SAN DIEGO, CA 92121
CONTRACT NUMBER:
R J CAMPANA
TITLE:
LOW-MASS AND ENHANCED SURVIVABILITY SPACE HEAT PIPES
TOPIC# 7 OFFICE: IDENT#: 30439

ALL TYPES OF BALLISTIC MISSILE DEFENSE CONTINUOUS-POWER SYSTEMS UNDER DEVELOPMENT USE HEAT PIPES IN THEIR WASTE-HEAT RADIATORS. SOME CONCEPTS ALSO USE HEAT PIPE RADIATORS WITH THE HEAT SOURCE. SINCE RADIATORS ARE MAJOR WEIGHT COMPONENTS OF THESE SYSTEMS, THERE IS A SIGNIFICANT OPPORTUNITY TO REDUCE RADIATOR MASS AS WELL AS ENHANCE RADIATOR SURVIVABILITY BY DEVELOPING A LOW-MASS, HIGH-TEMPERATURE-CAPABILITY HEAT PIPE CONSISTING OF GRAPHITE OR CARBON-CARBON COMPOSITES AND HEAT TRANSPORT FLUIDS. THE MASS OF HEAT PIPES PER UNIT OF HEAT TRANSPORTED IS EXPECTED TO BE REDUCED BY FACTORS OF 2 TO 5 TIMES THAT OF CURRENT METALLIC SYSTEMS. THE FEASIBILITY OF SUCH HEAT PIPES IS BEING INVESTIGATED IN THIS STUDY, AND THEIR PERFORMANCE IS BEING ESTIMATED FOR COMPARISON WITH CURRENT DESIGNS. PREFERRED MATERIALS ARE BEING EVALUATED AND SELECTED AMONG NUMEROUS CANDIDATES. WHEN SUCCESSFUL, MUCH LIGHTER HEAT PIPES WOULD BE AVAILABLE FOR SPACE APPLICATION WITH ENHANCED SURVIVABILITY AND POTENTIALLY LOW MATERIAL COSTS.

ELECTRO-OPTEK CORP
3152 KASHIWA ST
TORRANCE, CA 90505
CONTRACT NUMBER:
DR WILLIAM S CHAN
TITLE:
MOLECULAR BEAM EPITAXY FOR FABRICATING LONG WAVELENGTH INFRARED DETECTORS USING InAsSb ON Si SUBSTRATE
TOPIC# 14 OFFICE: IDENT#: 30128

SUBMITTED BY

MIDCOURSE SURVEILLANCE AND MISSILE SURVEILLANCE SYSTEMS REQUIRE LONG WAVELENGTH INFRARED (LWIR) AND MEDIUM WAVELENGTH INFRARED (MWIR) DETECTOR ARRAYS, REPECTIVELY. CURRENT IRREPRODUCIBILITY OF HgCdTe TECHNOLOGY FOR THE LWIR SPECTRAL REGION HAS FORCED A REAPPRAISAL OF DEVELOPING InAsSb AS AN ALTERNATE HAVING HIGHER PRODUCIBILITY, STRONG BONDING, AND BETTER UNIFORMITY WHILE PROCESSING HIGHER OR COMPARABLE PERFORMANCE. RECENT PROGRESS MADE IN MOLECULAR BEAM EPITAXY (MBE) OF InAsSb AND STRAINED SUPERLATTICE (SSL) OF III-V COMPOUNDS HAS OPENED THE POSSIBILITY OF USING InAsSb SSL MATERIAL AS AN ALTERNATIVE TO HgCdTe TECHNOLOGY. ION-BEAM EPITAXY (IBE) AND MBE CONFIGURATIONS AND REQUIREMENTS FOR GROWING InAsSb SSL ARE BEING INVESTIGATED AND DESIGNED. A SPECIAL BUFFERED SILICON SUBSTRATE IS BEING USED FOR THE InAsSb EPITAXY, AIMED AT ACHIEVING UNIFORM EPILAYER HAVING A CUTOFF WAVELENGTH OF 12 MICRONS AS 77K. THE BUFFERED SUBSTRATE IS FORMED BY AN INNOVATIVE IBE TECHNIQUE. SPECIAL IBE - MBE FIXTURES ARE BEING DESIGNED AND MBE PROCESSES ARE BEING DELINEATED. WHEN SUCCESSFULLY DEMONSTRATED, THIS APPROACH COULD LEAD TO MORE REPRODUCIBLE, UNIFORM AND SENSITIVE DETECTORS THAN THOSE OF LWIR HgCdTe TECHNOLOGY.

ELECTRO-OPTIK CORP
3152 KASHIWA ST
TORRANCE, CA 90505
CONTRACT NUMBER:
DR WILLIAM S CHAN

TITLE:
SUPERLATTICE FORMATION OF HIGH-T SUPERCONDUCTING FILM
TOPIC# 15 OFFICE: IDENT#: 30129

THE TECHNIQUE AND PHYSICS OF SUPERLATTICE FORMATION HAVE ADVANCED TO SUCH A DEGREE IN RECENT YEARS THAT BANDGAP TAILORING AND ULTRA-THIN STRUCTURE ENGINEERING ARE WELL-ACCEPTED TOOLS FOR SYNTHESIS OF NEW AND INNOVATIVE ELECTRONIC MATERIALS AND DEVICES. THE FEASIBILITY IS BEING EXPLORED OF USING AN INNOVATIVE MOLECULAR BEAM EPITAXY (MBE) APPROACH TO FABRICATE SUPERLATTICE OF HIGH-Tc SUPERCONDUCTOR YBaCuO. THE CONTROLLED EPITAXY OF ALTERNATING ULTRA-THIN LAYERS OF CuO AND YO/BaO ON A BUFFERED SAPPHIRE SUBSTRATE IS BEING INVESTIGATED TO FORM A SUPERLATTICE WHICH APPROXIMATES CLOSELY THE LAYERED STRUCTURE OF THE YBaCuO SUPERDUCTOR. THE GROWTH OF THE SUPERLATTICE IS BEING CARRIED OUT BY

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USING HIGHLY-REACTIVE ATOMIC OXYGEN GENERATED BY A SPECIAL ION BEAM GUN ALONG WITH MOLECULAR BEAMS OF Y, Ba AND Cu GENERATED BY HIGH-TEMPERATUR MBE GUNS. FAST RESPONSE COMPUTER-CONTROLLED SHUTTERS ARE BEING USED TO PERFORM THE EPITAXY OF THE ALTERNATING LAYERS WITH SHARP INTERFACES. THE GROWTH OF SINGLE CRYSTAL SUPERLATTICE FILMS OF YBaCuO ARE BEIN ESTABLISHED THAT ARE EXPECTED TO SUPERCONDUCT AT HIGH TEMPERATURES AND SUSTAIN A CRITICAL CURRENT DENSITY $> 10^6$ A/CME². WHEN SUCCESSFULLY DEMONSTRATED, APPLICATIONS OF THE THIN FILM FORM OF THE SUPERLATTICE WOULD EXIST IN ELECTRONIC DEVICES AND MICROELECTRONIC CHIP FABRICATIONS AS WELL AS IN DIGITAL AND INFRARED DETECTORS AND SUPERCONDUCTING CABLES.

ELECTROSTATIC TECHNOLOGY INC
80 HAMILTON ST
NEW HAVEN, CT 06511
CONTRACT NUMBER:
ANTHONY GREENE

TITLE:
SUPERCONDUCTING STRUCTURES FABRICATION BY ELECTROSTATIC FLUIDIZED
BED DEPOSITION
TOPIC# 15 OFFICE: IDENT#: 30631

ALTHOUGH THE DISCOVERY OF SUPERCONDUCTIVITY IN CERAMIC MATERIALS AT EASILY ACCESSIBLE TEMPERATURES HOLD MUCH PROMISE, THERE REMAIN MANY TECHNICAL QUESTIONS BEFORE APPLICATIONS CAN BE REALIZED, INCLUDING THE FABRICATION OF THESE MATERIALS INTO USEFUL FORMS. THE FEASIBILITY IS BEING STUDIED OF APPLYING POWDER COATINGS OF HIGH TEMPERATURE SUPERCONDUCTING MATERIALS TO PLATES AND SHAPED OBJECTS BY THE ELECTROSTATIC FLUIDIZED BED DEPOSITION PROCESS. THE MOST PROMISING OF THESE MATERIALS IS BEING DEPOSITED ON VARIOUS SUBSTRATES, AND THEIR ELECTRICAL PROPERTIES MEASURED, PARTICULARILY, TEMPERATURE VARIATION OF THE SPECIMENS' RESISTANCE AND THEIR CURRENT CARRYING CAPACITY. THE EFFECTS OF PERTINENT PROCESS PARAMETERS ON THE QUALITY OF THE SUPERCONDUCTIVE COATINGS ARE BEING STUDIED. THE DATA FOR POWDERS DEPOSITED BY THIS PROCESS IS BEING COMPARED WITH DATA REPORTED FOR ALTERNATE METHODS OF FABRICATION OF THESE MATERIALS. WHEN SUCCESSFUL, A COMMERCIAL SUPERCONDUCTING FABRICATION FACILITY USING THE ELECTROSTATIC FLUIDIZED BED/VORTEX GENERATOR DEPOSITION METHOD WOULD BE ESTABLISHED.

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SUBMITTED BY

EMCORE CORP
35 ELIZABETH AVE
SOMERSET, NJ 08873

CONTRACT NUMBER:

DR PETER NORRIS

TITLE:

ATOMIC LAYER EPITAXY OF GALLIUM-ARSENIDE IN A ROTATING-DISK REACT

TOPIC# 14

OFFICE:

IDENT#: 30434

ATOMIC LAYER EPITAXY (ALE) IS A PROMISING GROWTH TECHNIQUE. THE ATTRACTIVENESS OF ALE FOR FUTURE DEVICE AND INTEGRATED CIRCUIT APPLICATIONS CAN BE UNDERSTOOD BY CONSIDERING SEVERAL DESIRABLE ATTRIBUTES FOR EPITAXIAL GROWTH TECHNIQUES. THESE INCLUDE LOWER DEFECT DENSITY, IMPROVED UNIFORMITY OF THICKNESS AND DOPING, IMPROVED THICKNESS CONTROL, AND THE POSSIBILITY OF CONFORMAL EPITAXY. A MAJOR PROBLEM WITH PRESENT ALE METHODS IS LOW GROWTH RATE, WHICH IS SUBSTANTIALLY LESS THAN A MONOLAYER PER SECOND. THE FEASIBILITY IS BEING DEMONSTRATED OF ALE GROWTH OF GALLIUM-ARSENIDE IN A ROTATING DISK GEOMETRY METALORGANIC CHEMICAL VAPOR DEPOSITION (MOCVD) REACTOR. THE PROPORTIONALITY OF GROWTH RATE TO ROTATION RATE IS BEING DEMONSTRATED. IT IS ANTICIPATED THAT THIS WOULD ALLOW THE FABRICATION OF STRUCTURES WHICH REQUIRE BOTH HIGH AND LOW GROWTH RATES IN A SINGLE SYSTEM WITHOUT MAJOR PERTURBATIONS DURING GROWTH. THIS IS PARTICULARLY IMPORTANT FOR STRUCTURES WHERE ABRUPT INTERFACES ARE NECESSARY AND YET HAVE SUBSTANTIAL TOTAL EPITAXIAL THICKNESS. THE DEMONSTRATION OF A SIGNIFICANT ENHANCED GROWTH RATE IS A REQUIREMENT FOR THE DEVELOPMENT OF PRACTICAL ALE-BASED MATERIALS AND DEVICE TECHNOLOGIES. SUCCESSFUL DEVELOPMENT OF THE TECHNIQUES FOR REPRODUCIBLE GROWING DEVICE-QUALITY GALLIUM-ARSENIDE BY ALE WOULD HAVE MAJOR IMPLICATIONS FOR A BROAD RANGE OF DEVICE APPLICATIONS INCLUDING SENSORS, HIGH-SPEED ELECTRONIC DEVICES AND INTEGRATED CIRCUIT DEVELOPMENT.

ENERGY COMPRESSION RESEARCH CORP
910 CAMINO DEL MAR - STE A
DEL MAR, CA 92014

CONTRACT NUMBER:

OVED ZUCKER

TITLE:

HIGH PERFORMANCE SOLID STATE ARMATURE USING COMPOSITE TAMPING

TOPIC# 2

OFFICE:

IDENT#: 30440

SUBMITTED BY

THE APPLICABILITY OF THE RAILGUN IN THE 1.5-5 KM/SEC RANGE HAS BEEN LIMITED BY THE ARMATURE WHICH MUST CARRY THE ENTIRE RAILGUN CURRENT AND CONVERT THE MAGNETIC FIELD PRESSURE TO A PROPULSIVE FORCE ON THE PROJECTILE. AT THE SAME TIME, IT NEEDS TO MAKE A LOSSLESS SLIDING CONTACT TO THE RAILS WHILE HAVING THE SMALLEST POSSIBLE PARASITIC MASS. SOLID STATE ARMATURES APPEAR TO FULFILL THESE REQUIREMENTS IN THEORY; IN PRACTICE THIS PROMISE HAS NOT YET BEEN FULLY REALIZED. THE FEASIBILITY IS BEING INVESTIGATED OF USING A NEW APPROACH TO THE SOLID ARMATURE THAT IS DESIGNED TO ADDRESS SIMULTANEOUSLY ALL OF THE MAJOR ISSUES. THE CONCEPT IS BASED ON AN ORIENTED COMPOSITE MATERIAL OF FINE COPPER WIRES CLAD WITH A THIN LAYER OF HIGH-STRENGTH PYROLYTIC GRAPHITE. THE COPPER ACTS AS THE CURRENT CARRYING ELEMENT AND THE PYROLYTIC GRAPHITE ACTS AS A HIGH STRENGTH CONTAINMENT VESSEL AND ELECTRICAL INSULATOR. THE ENTIRE ASSEMBLY IS CONTAINED IN A CERAMIC OR GRAPHITE MATRIX. A MODEL FOR THE CURRENT CONTACT AREA IS BEING DEVELOPED AS IS A MODEL FOR THE CURRENT DISTRIBUTION OF THE SOLID ARMATURE. THE THERMODYNAMIC AND MECHANICAL PERFORMANCE OF THE GRAPHITE COATED FILAMENTS ARE BEING ANALYZED. FABRICATION TECHNIQUES FOR THE GRAPHITE COATED COPPER FILAMENTS AND ASSEMBLY TECHNIQUES FOR THE ARMATURE ARE BEING INVESTIGATED. A PROGRAM IS BEING PREPARED FOR THE FABRICATION OF SMALL SCALE ARMATURES AND TESTING IN A SMALL RAILGUN FACILITY IN A LATER PHASE.

ENERGY COMPRESSION RESEARCH CORP
910 CAMINO DEL MAR - STE A
DEL MAR, CA 92014
CONTRACT NUMBER:
OVED ZUCKER
TITLE:
MEGA-AMP OPENING SWITCH
TOPIC# 5 OFFICE: IDENT#: 30443

THE REQUIREMENTS FOR BOTH INDUCTIVE STORES AND PULSE-SHAPING ELEMENTS ARE EXTREMELY DIFFICULT TO MEET IN A SINGLE SWITCH DESIGN, PARTICULARLY IF IT IS TO BE IMPLEMENTED AS A SUPERCONDUCTING SWITCH OR A STANDARD (OR NORMAL-CONDUCTOR) SWITCH. A REPRATED MEGA-AMP OPENING SWITCH IS BEING DEVELOPED TO ADDRESS THIS PROBLEM. THE CONCEPT UTILIZE MACHINE GUN STYLE FED CYLINDRICAL FOIL WHOSE PRESSURE INDUCED

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RUPTURE PRODUCES A CRACK WHICH PROPAGATES AT THE SPEED OF SOUND. THE CRACK REDIRECTS THE CURRENT TO A LONGER PATH WHOSE THERMALLY INDUCED RESISTNCE EXCURSION COMMUTES THE CURRENT TO A WATER COOLED METAL OXIDE VARISTOR FOR THE DISSIPATION OF THE COMMUTATION ENERGY. A MATHEMATICAL MODEL OF THE SWITCH IS BEING GENERATED AND CRITICAL PARAMETERS ANALYZED. A MEANS OF REPRATING THE SWITCH IS BEING EXAMINED AND THE MECHANICAL FEASIBILITY OF MANUFACTURING THE SWITCHES ASSESSED. IN ADDITION TO APPLICATION TO DRIVE ELECTRO-THERMAL, ELECTRO-MAGNETIC, AND COIL GUNS, THE SWITCH CAN BE DESIGNED TO CARRY VERY HIGH CURRENTS FOR ESSENTIALLY UNLIMITED TIME IN A SUPERCONDUCTING ENERGY STORAGE SYSTEM.

EXCEL TECHNOLOGY INC
20 WESTFIELD RD
CORAM, NY 11727
CONTRACT NUMBER:
DR RAMA RAO

TITLE:
GIGA-HERTZ REPETITION RATE EXCIMER LASER FOR CUMULATIVE IMPULSE
LOADING
TOPIC# 1 OFFICE: IDENT#: 30452

IN BALLISTIC MISSILE DEFENSE, MECHANICAL DAMAGE AND DISCRIMINATION CAPABILITY OF PULSED LASER CAN BE ENHANCED SIGNIFICANTLY BY INCREASING THE REPETITION RATE OF THE BEAM. THE FEASIBILITY IS BEING INVESTIGATED OF DEVELOPING A HIGH REPETITION RATE AND HIGH POWER TITANIUM DOPED SAPPHIRE (Ti:SAPPHIRE) LASER, TUNABLE IN A WIDE SPECTRAL REGION (300-1200 NM). Ti:SAPPHIRE IS EXTREMELY IMPORTANT SINCE IT CAN BE PUMPED IN THE GREEN (532 NM), HAS A BROAD TUNING RANGE (600-900 NM) AND HAS RELATIVELY LARGE GAIN CROSS-SECTION (50% OF Nd:YAG). INDICATIONS ARE THAT THE LASING RANGE OF THE CRYSTAL MAY BE EXTENDED FURTHER INFRARED UP TO 120 NM. THE PUMP LASER BEING UTILIZED IS APULSED, Q-SWITCHED, FREQUENCY-DOUBLED Nd:YAG LASER OPERATING AT 532 NM WITH PULSE DURATION OF 20 NSEC AND PULSE ENERGY OF 30 MJ AT 1 KHZ REPETITION RATE. A RING LASER CAVITY IS BEING CONSTRUCTED TO OBTAIN SINGLE FREQUENCY OPERATION THROUGHOUT THE EXPECTED GAIN BANDWIDTH (600-1200 NM). THIS RADIATION IS EXPECTED TO BE SUBSEQUENTLY FREQUENCY DOUBLED TO GENERATE TUNABLE RADIATION IN THE 300-600 NM RANGE. THE COMBINATION OF HIGHLY EFFICIENT Ti:SAPPHIRE AND HIGH REPETITION RATE OF PUMP LASER IS EXPECTED TO

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OFFER SEVERAL MEGAWATT OF PEAK POWER AT KHZ REPETITION RATE COVERING THE ENTIRE SPECTRAL RANGE FROM ULTRAVIOLET TO INFRARED. APPLICATIONS INCLUDE VARIOUS SCIENTIFIC (SPECTROSCOPY), MEDICAL (LASER SURGERY AND DIAGNOSTIC), AND INDUSTRIAL (MATERIAL PROCESSING) USES.

FELTECH
639 ROMERO CANYON RD
MONTECITO, CA 93108
CONTRACT NUMBER:
DR LUIS R ELIAS
TITLE:
HIGH EFFICIENCY MILLIMETER WAVE CONTINUOUS WAVE FREE-ELECTRON LASER
TOPIC# 3 OFFICE: IDENT#: 30241

A FREE-ELECTRON LASER (FEL) DRIVEN BY A VERY COMPACT ELECTROSTATIC ACCELERATOR AND CAPABLE OF OPERATING CONTINUOUS WAVE (CW) WITH HIGH EFFICIENCY IS BEING INVESTIGATED. AFTER PASSING THROUGH UNDULATOR, THE CURRENT DRIVING THE FEL IS RECOVERED IN AN ELECTRON COLLECTOR. THE ELECTRON BEAM-LINE IS BEING DESIGNED IN SUCH A WAY AS TO MAXIMIZE THE CURRENT RECOVERY WHICH IS EXPECTED TO BE HIGHER THAN 99.5%. THE SMALL AMOUNT OF CURRENT LOST IS BEING REPLACED BY A POWER SUPPLY. WITH A CAREFUL DESIGN OF THE SYSTEM COMPONENTS, THE OVERALL EFFICIENCY IS ANTICIPATED TO BE BETTER THAN 50%. THIS FIRST-EVER CW FEL IS BEING OPERATED IN THE 5MM RANGE WITHH 10KW OF CONTINUOUS POWER, WITH AN EASY CONTINUOUS TUNABILITY OVER ITS OPERATION RANGE. EXTENSIONS OF THE CONCEPT TOWARDS FELS CAPABLE OF OPERATING CW AT SHORTER WAVELENGTHS AND HIGHER POWERS ALSO ARE BEING CONSIDERED. THE CW FEL, WHEN SUCCESSFUL, WOULD OPERATE AT A SINGLE MODE WITH A HIGH DEGREE OF COHERENCE. NEW CONCEPTS IN RADAR, OR MORE GENERALLY, SENSOR TECHNOLOGY ARE LIKELY TO MAKE BETTER USE OF THE COHERENCE PROPERTIES OF THE RADAR BEAMS. FOR THAT TYPE OF TECHNOLOGY THE CW FEL WOULD PROVE TO BE A MUCH WELCOMED SOURCE OF RADIATION.

FIBERTEK INC
510-A HERNDON PKWY
HERNDON, VA 22070
CONTRACT NUMBER:
DR RALPH BURNHAM
TITLE:
DIODE-ARRAY-PUMPED NIOBIUM-DOPED BERYLLIUM LANTHANATE
TOPIC# 1 OFFICE: IDENT#: 30052

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RECENT DEVELOPMENTS IN THE FIELDS OF ELECTRO-OPTICS AND LASERS HAVE THE POTENTIAL TO DEMONSTRATE AN ADVANCED TRANSMITTER COMPONENT FOR A SCALABLE EFFICIENT LASER-BASED SENSOR SYSTEM INTENDED FOR SPACE-BASED TARGET DISCRIMINATION AND TRACKING. BASED ON THESE DEVELOPMENTS, AN EXPLORATORY INVESTIGATION IS BEING UNDERTAKEN OF THE TECHNOLOGY FOR BIODE-ARRAY PUMPING OF THE NEODYMIUM DOPED BERYLLIUM LANTHANATE (Nd:BEL) LASER USING OPTICAL COUPLING TECHNIQUES THAT ARE SCALABLE TO LASER SYSTEMS WITH OUTPUT POWERS UP TO 100W. A HIGH-POWER DIODE-ARRAY-PUMPED SOLID STATE LASER-TRANSMITTER, BASED ON Nd:BEL, IS BEING INVESTIGATED EXPERIMENTALLY USING ADVANCED OPTICAL COUPLING TECHNIQUES. AN ENGINEERING DESIGN FOR SUCH DIODE-PUMPED LASER SYSTEM MATCHED TO THE NARROW-BAND CESIUM-THALLIUM (CS-TL) ATOMIC RESONANCE FILTER-RECEIVER IS BEING DEVELOPED. TECHNIQUES ARE BEING ANALYZED FOR OPTICAL COUPLING BETWEEN LINEAR DIODE ARRAYS AND SOLID-STATE LASERS HOSTS AS ARE TECHNIQUES FOR HEAT REMOVAL FROM LASER HOST AND PUMP ARRAYS. A BREADBOARD DIODE-ARRAY-PUMPED Nd:BEL LASER IN A SCALABLE GEOMETRY IS BEING FABRICATED AND CHARACTERIZED. BASED ON THE RESULTS OF THE ABOVE TASKS, A PROTOTYPE LASER IS BEING DESIGNED FOR USE IN A SENSOR SYSTEM TO BE BUILT IN A LATER RESEARCH PHASE. THE LASER SYSTEM, WHEN SUCCESSFUL, WOULD BE AN EXTREMELY RELIABLE, EFFICIENT, AND COMPACT LASER SOURCE TO PROVIDE SUPERIOR SIGNAL-TO-NOISE PROPERTIES IN A DETECTION SYSTEM.

FLUOROCHEM INC
680 S AYON AVE
AZUSA, CA 91702
CONTRACT NUMBER:
DR T ARCHIBALD

TITLE:
SYNTHESIS OF TETRA-FUNCTIONAL CUBANE DERIVATIVES
TOPIC# 6 OFFICE: IDENT#: 30054

AN APPROACH HAS BEEN DEVELOPED TO MEET THE SPECIFIC IMPULSE INTENSIVE NEEDS OF STRATEGIC DEFENSE APPLICATIONS BASED ON THE INTRINSIC ENERGY THAT WOULD BE RELEASED DURING COMBUSTION OF ENERGETIC CUBANE DERIVATIVES. WHILE CUBANE-1,2,4,7-TETRACARBOXYLIC ACID IS AN IMPORTANT SYNTHETIC ENTRY INTO ENERGETIC CUBANE COMPOUNDS, PROCEDURES FOR LARGE-SCALE PRODUCTION OF THIS MATERIAL ARE NOT AVAILABLE. ROUTES FOR

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LARGE SCALE PREPARATION OF THIS TETRA ACID ARE BEING DEVELOPED. THE FEASIBILITY IS BEING INVESTIGATED OF SCALING UP EXISTING ROUTES STARTING WITH CUBANE-1,4-DICARBOXYLIC ACID. NEW ROUTES ARE BEING EXAMINED BASED ON FUNCTIONALIZED CUBANE PRECURSORS IN WHICH THE CUBANE-FORMING STEP IS THE LAST STEP IN THE SEQUENCE. BASED ON THESE STUDIES, A ROUTE IS BEING SELECTED FOR PROCESS DEVELOPMENT DIRECTED AT THE ECONOMICAL AND PRACTICAL SYNTHESIS OF KILOGRAM QUANTITIES OF CUBANE-1,2,4,7-TETRACARBOXYLIC ACID. THE READY AVAILABILITY OF THIS TETRA ACID WOULD ALLOW THE DEVELOPMENT OF NEW PROPELLANTS AND EXPLOSIVES WITH HIGHER PERFORMANCE THERMAL STABILITY AND DENSITY THAN STATE-OF-THE-ART MATERIALS. A READY SOURCE OF THIS TETRA ACID ALSO WOULD BE OF IMMEDIATE USE IN THE AREA OF POLYNITROCUBANES AND CUBYL POLYMERS AND WOULD ENCOURAGE INVESTIGATIONS OF OTHER CUBANE COMPOUNDS IN MANY BIOLOGICAL APPLICATIONS IN PHARMACEUTICALS, INSECTICIDES, AND RELATED APPLICATIONS.

FOSTER-MILLER INC
350 SECOND ST
WALTHAM, MA 02254
CONTRACT NUMBER:
DR JOHN D LENNHOF
TITLE:
HIGH T SUPERCONDUCTORS AS INFRARED DETECTORS
TOPIC# 15 OFFICE: IDENT#: 30137

THE AVAILABILITY OF THE SUPERCONDUCTING OXIDES (SCO'S) IN WELL CONTROLLED THIN-FILM FORM COULD DIRECTLY OFFER THE OPPORTUNITY TO PRODUCE INFRARED DETECTORS WITH WAVELENGTH SENSITIVITY OUT TO 20 MICRONS AND WITH FREQUENCY RESPONSES APPROACHING 100 GHZ. EXTENSIVE RESEARCH IN MATERIALS PROCESSING SHOULD NOT BE REQUIRED FOR THE APPLICATION - CONTROL OF STOICHIOMETRY AND HOMOGENEITY OF COMPOSITION AVAILABLE WITH PRESENT PROCESSES IS ANTICIPATED TO BE OF SUFFICIENT QUALITY TO PRODUCE THESE FAST DETECTORS. POLYCRYSTALLINITY AND A LOW CRITICAL CURRENT DENSITY ARE NOT PROBLEMS. WHEN COMPARED WITH EXISTING TECHNOLOGY, THE PROCESSES BEING USED TO MAKE THESE MATERIALS ARE INHERENTLY SIMPLER, AND COULD LEAD TO IMPROVED FREQUENCY PERFORMANCE AT THESE WAVELENGTHS AT DRAMATICALLY REDUCED COST. IN THIS INVESTIGATION, THE THIN-FILM TECHNOLOGY WHICH SHOWS THE MOST PROMISE FOR USE AS DETECTOR ELEMENTS IS BEING DETERMINED. SEVERAL SAMPLES ARE BEING

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PREPARED AND CHARACTERIZED WITH RESPECT TO PERFORMANCE AS DETECTORS. WHEN SUCCESSFUL, DEVICES WITH THOSE FEATURES WOULD FIND WIDE APPLICATION IN FAST IMAGES, SEEKERS, FORWARD LOOKING INFRARED DEVICES AND IN NOVEL, SECURE COMMUNICATION RECEIVERS.

FOSTER-MILLER INC
350 SECOND ST
WALTHAM, MA 02254
CONTRACT NUMBER:
DR PHILIP STARK
TITLE:
HOOK-AND-LOOP MOUNTED SPACE-BASED DEFENSIVE SHIELDS
TOPIC# 8 OFFICE: IDENT#: 30138

A NEW STRUCTURAL CLOSURE TECHNOLOGY HAS BEEN DEVELOPED WITH POTENTIAL FOR SPACE APPLICATIONS. BASED ON HOOK-AND-LOOP TYPE FASTENING SIMILAR IN FUNCTION TO VELCRO-BRAND FASTENERS, THESE NEW CLOSURES COULD BE USED IN NEW STRUCTURAL APPLICATIONS BECAUSE OF THEIR HIGH STRENGTHS. HOOK-AND-LOOP FASTENERS EXHIBIT A NUMBER OF UNIQUE ADVANTAGES FOR MOUNTING DEFENSIVE SHIELD SYSTEMS TO SPACE ASSETS FOR PROTECTION INCLUDING ACTIVE COOLING POTENTIAL OF THE SHIELD COMPONENTS AND PROTECTION SYSTEMS AGAINST KINETIC ENERGY PROJECTILES. SPECIFIC REQUIREMENTS AND POTENTIALLY PROMISING DESIGN CONFIGURATIONS BEING CONSIDERED FOR STRATEGIC DEFENSIVE SHIELDS ARE BEING IDENTIFIED. EFFECTIVENESS OF THE CONCEPT OF A HOOK-AND-LOOP MOUNTED CERAMIC ARMOR DEFENSIVE SHIELD SYSTEM IS BEING EVALUATED (USING HIGH STRENGTH POLYMER HOOK-AND-LOOP SAMPLES) IN TERMS OF ITS: BALLISTIC PERFORMANCE CHARACTERISTICS WHEN SUBJECTED TO CURRENT THREAT, ADVANCED KINETIC ENERGY PROJECTILES; ATTACHEMENT STRENGTH; CYCLE LIFE; AND RESISTANCE TO THERMAL CYCLING AND THERMAL SHOCK. THE BIGGEST IMPACT OF THE TECHNOLOGY, WHEN SUCCESSFULLY DEMONSTRATED, WOULD BE IN AUTOMATED OR ROBOTIC ASSEMBLY OPERATIONS WHERE FASTENERS WOULD IMPROVE THE RELIABILITY OF THE PROCESS AND THE QUALITY OF THE FINAL PRODUCT. POTENTIAL COMMERCIAL APPLICATIONS INCLUDE ASSEMBLY OF AUTOMOTIVE COMPONENTS, APPLIANCE ASSEMBLY, MOVABLE BUILDING PARTITIONS, AND SCAFFOLDING.

FOSTER-MILLER INC
350 SECOND AVE
WALTHAM, MA 02254
CONTRACT NUMBER:
UDAY KASHALIKAR
TITLE:
PRESSURE CASTING FOR NEAR-NET SHAPE PRODUCTION OF LOW COST GRAPHITE MAGNESIUM SPACE STRUCTURES
TOPIC# 13 OFFICE: IDENT#: 30141

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THE FEASIBILITY IS BEING DETERMINED OF A LOW-COST, METAL MATRIX COMPOSITE (MMC) FABRICATION TECHNIQUE FOR NEAR-NET SHAPE FABRICATION OF SPACE STRUCTURAL JOINTS THAT WOULD INVOLVE FABRICATION OF A CUSTOM-TAILORED FIBER PREFORM AND A SPECIALIZED MOLD FOLLOWED BY INFILTRATION WITH MOLTEN MAGNESIUM ALLOY. INCORPORATION OF LOW-COST MATERIALS, TOOLING, AND PROCESSING WOULD MAKE THE PROCESS ECONOMICAL AS COMPARED TO CONTEMPORARY MMC FABRICATION METHODS. PRESSURIZATION DURING INFILTRATION WOULD ALLOW A HIGHER FIBER CONTENT AND THINNER WALLS THAN CONVENTIONAL VACUUM-ASSISTED LIQUID METAL INFILTRATION. A COMPLEX-SHAPE TRUSS JOINT COMPONENT IS BEING FABRICATED AND EVALUATED SUB-SCALE, WITH FIBER CONTENT ABOVE 55 PERCENT BY VOLUME AND WALL THICKNESS AROUND 0.010 IN. TO 0.020 IN. WHEN SUCCESSFUL, LIGHTWEIGHT SPACE TRUSS JOINTS AND ULTRA HIGH SPECIFIC STIFFNESS AND STRENGTH, ZERO COEFFICIENT OF THERMAL EXPANSION, GOOD HARDNESS AGAINST DIRECTED ENERGY WEAPONS, NO OUTGASSING, AND EXCELLENT RESISTANCE TO SPACE ENVIRONMENT COULD BE PRODUCED ECONOMICALLY. LOWERING THE COST OF HIGH PERFORMANCE GRAPHITE-MAGNETISUM MMCS WOULD PROMOTE SEVERAL COMMERCIAL APPLICATIONS THAT REQUIRE HIGH STRENGTH AND STIFFNESS COMBINED WITH LIGHT WEIGHT AND HIGH TEMPERATURE CAPABILITY, INCLUDING AUTOMOTIVE ENGINE BLOCKS, CONNECTING RODS, FLYWHEELS, AND HELICOPTER JOINTS/FITTINGS.

FOSTER-MILLER INC
350 SECOND ST
WALTHAM, MA 02254
CONTRACT NUMBER:
GERALD AVARBOCK
TITLE:
POWER AND SIGNAL DISTRIBUTION USING SUPERCONDUCTIVITY
TOPIC# 15 OFFICE: IDENT#: 30184

HIGH TEMPERATURE SUPERCONDUCTING OXIDE (SCO) CONDUCTORS HAVING HIGH STRUCTURAL STRENGTH AND GOOD DIELECTRIC PROPERTIES CAN CARRY BOTH DC POWER AND HIGH FREQUENCY AC SIGNALS IN APPLICATIONS SUCH AS MISSILE WIRING HARNESES WHERE WEIGHT AND SIZE ARE AT A PREMIUM AND THE REQUISITE COOLING CAN BE PROVIDED. THE FEASIBILITY IS BEING INVESTIGATED OF IMPROVING THE MECHANICAL UTILITY OF HIGH-TEMPERATURE SCOS BY FORMING WIRES AND RIBBONS COATED WITH HIGH STRENGTH POLYMER DIE-

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LECTRICS. SCO WIRE AND RIBBON CORES ARE BEING FABRICATED USING PROCESSES WHICH PROVIDE SUPERIOR MECHANICAL AND ELECTRICAL PROPERTIES. THE CONDUCTORS ARE BEING PREPARED USING MELT-SPINNING AND EXTRUSION, FOLLOWED BY OXIDATION AND ANNEAL. EVALUATION OF THE RESULTS OF BOTH APPROACHES ARE BEING MADE WITH RESPECT TO MECHANICAL AND SUPERCONDUCTING ELECTRICAL PROPERTIES. THE CORES THAN ARE BEING COATED WITH BOTH LIQUID-CRYSTAL POLYMER AND FLUOROPLASTIC MATERIALS AND CHARACTERIZED AND EVALUATED WITH RESPECT TO MECHANICAL AND ELECTRICAL PROPERTIES AND DAMAGE TO THE CORE. SPECIFIC ATTENTION IS BEING GIVEN TO PRODUCING AND CHARACTERIZING CONDUCTORS FOR DC POWER TRANSMISSION. ASSUMING SUCCESS, A PAIRED CONDUCTOR STRUCTURE WOULD BE FABRICATED AND ITS PERFORMANCE AT RADIO FREQUENCY AC CHARACTERIZED.

GENERAL COHERENT TECHNOLOGY INC

1216 GLEN COVE

RICHARDSON, TX 75080

CONTRACT NUMBER:

DR J F McCOY

TITLE:

GAMMA RAY LASER PUMP DIAGNOSTIC

TOPIC# 1

OFFICE:

IDENT#: 30056

RECENT WORK HAS SHOWN HOW TO MAKE AN ABSOLUTE MEASUREMENT OF THE SPECTRUM OF X-RAYS EMITTED IN AN INTENSE PULSE AT ENERGIES EXCEEDING THOSE WHICH COULD BE CALIBRATED BY PREVIOUS METHODS. A PROBLEM ARISES IN THE EVALUATION OF POTENTIAL PUMP SOURCES FOR A GAMMA RAY LASER, AS WELL AS IN THE SIMULATION OF NUCLEAR WEAPONS AND IN RADIATION THERAPY IN MEDICINE. THE CALIBRATION IS DONE BY EXPOSING LAYERS OF DIFFERENT MATERIALS, EACH OF WHICH IS ABLE TO STORE AS EXCITATIONS OF THE CONSTITUENT NUCLEI A SAMPLE OF THE INTENSITY AT A DIFFERENT ENERGY. THE STORED ENERGIES CAN BE ACCESSED LATER FOR READOUT, BUT THE TECHNIQUE CURRENTLY IS LIMITED TO ENERGIES LESS 1.5 MILLION ELECTRON VOLT (MEV). A MODEL IS BEING DEVELOPED AND VALIDATED OF THE STANDARDIZATION PROCESS THAT IS NECESSARY TO EXTEND THIS NEW METHOD TO 6.0 MEV. THE STANDARDIZATION OF A CALIBRATION TARGET FOR THE RANGE OF 1.5 TO 6.0 MEV NOW BECOMING IMPORTANT IN EFFORTS TO EVALUATE GAMMA RAY LASER MATERIALS WOULD BE IMPLEMENTED AT A LATER STAGE. BENEFITS, WHEN SUCCESSFULLY DEVELOPED AS A DIAGNOSTIC INSTRUMENT, INCLUDE THE ABILITY CALIBRATE SIMPLY THE SPECTRAL OUTPUT OF LARGE SOURCES OF

SUBMITTED BY

PULSED X-RAYS THAT CURRENTLY EXIST, INCLUDING UNCALIBRATED LINACS
FOR RADIATION THERAPY IN MEDICINE.

GENERAL SCIENCES INC
655 S GRAVERS RD
PLYMOUTH MEETING, PA 19462
CONTRACT NUMBER:
DR PETER D ZAVITSANOS
TITLE:
NEW STRUCTURAL MATERIALS
TOPIC# 13 OFFICE:

IDENT#: 30327

NEW HIGH TEMPERATURE STRUCTURES NEED TO BE DEVELOPED THAT ARE BASED ON INTERMETALLIC MATERIALS AND CERAMIC COMPOSITES. HIGH DENSITY BORIDES AND CARBIDES PREVIOUSLY HAVE BEEN SYNTHESIZED BY SELF PROPAGATING HIGH TEMPERATURE SYNTHESIS USING REACTION PRESSING TECHNIQUES IN THE ABSENCE OF EXTERNAL HEATING. BASED ON THIS TECHNIQUE, NEW MATERIALS (DENSE REINFORCED STRUCTURES) ARE BEING SYNTHESIZED USING TITANIUM BORIDE AS A PRIMARY MATRIX, WITH SECOND PHASE BRITTLE COMPONENTS SUCH AS CARBON PARTICLES, CARBON CLOTHS, SILICON AND SILICON CARBIDE FILAMENTS, AS WELL AS DUCTILE SECOND PHASE ADDITIONS, SUCH AS SEVERAL FORMS OF NICKEL. THE EFFECTS OF THE ADDITIONS ON THE MECHANICAL AND PHYSICAL PROPERTIES OF THOSE MATERIALS IS BEING EXAMINED AS A FUNCTION OF TEMPERATURE AND COMPOSITION. THE INTERACTION OF MATRIX/REINFORCEMENT DURING THE EXOTHERMIC FORMATION IS BEING STUDIED AS ARE OXIDATION RATES. A NEW FILLER MATERIAL ALSO IS BEING USED WITH HIGH TEMPERATURE RESINS TO DEMONSTRATE COMPOSITES WITH HIGHER TEMPERATURE CAPABILITIES AND LOW OBSERVABLE PROPERTIES. THE RESULTING MATERIALS ARE EXPECTED TO HAVE IMPROVED TOUGHNESS, OXIDATION RESISTANCE, AND HIGH TEMPERATURE SURVIVABILITY.

HYDROGEN CONSULTANTS INC
12420 N DUMONT WY
LITTLETON, CO 80125
CONTRACT NUMBER:
GREGORY J EGAN
TITLE:
METAL HYDRIDE CONCEPTS FOR EXTENDING STORAGE TIME OF CRYOGENIC HYDROGEN
TOPIC# 6 OFFICE:

IDENT#: 30329

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CRYOGENIC HYDROGEN AND OXYGEN ARE THE HIGHEST SPECIFIC IMPULSE AEROSPACE PROPELLANTS AND THE MOST ACCESSIBLE TECHNOLOGY FOR BALLISTIC MISSILE DEFENSE SYSTEMS. THESE CRYO-PROPELLANTS COULD BE USED UNIVERSALLY FOR LAUNCH TO LOW EARTH ORBIT, ORBIT TRANSFER, ORBIT MANEUVERING AND STATION KEEPING. LIQUID HYDROGEN (AT ABOUT 20 DEGREES K) BOILS OFF BECAUSE OF THE INEVITABLE HEAT LEAK THAT CANNOT BE ELIMINATED BY THE BEST OF CRYOGENIC TANK DESIGNS. THE FEASIBILITY OF EFFICIENT CRYO-PROPULSION LOGISTICS CONCEPT IS BEING INVESTIGATED USING METAL HYDRIDES TO ABSORB HYDROGEN BOILOFF, STORE, COMPRESS AND RELIQUEFY OR SOLIDIFY IT. THE CRYOGENIC SYSTEMS MISSION REQUIREMENTS ARE BEING EXAMINED. ENGINEERING MODELS OF HYDRIDE DEVICES ARE BEING DEVELOPED THAT EXTEND THE STORAGE TIME OF THESE CRYOGENS. A DECISION MATRIX IS BEING BUILT THAT MATCHES SYSTEM PROBLEMS WITH HYDRIDE SOLUTIONS IN A WAY THAT CONSIDERS POWER AND WEIGHT, SURVIVABILITY, TECHNOLOGY RISK AND OTHER FACTORS. SUCCESSFUL DEVELOPMENT OF HYDRIDE TECHNOLOGY FOR SPACE COULD LEAD TO AN INTEGRATED SYSTEM OF COMMON MATERIALS AND FLUIDS FOR PROPULSION, POWER CONVERSION, THERMAL MANAGEMENT, ENVIRONMENTAL CONTROL, LIFE SUPPORT AND RADIATION PROTECTION. COMMERCIAL APPLICATIONS INCLUDE INDUSTRIAL LIQUID HYDROGEN PRODUCTION, CRYOGENIC COOLING FOR SUPERCONDUCTING MAGNETS, ADVANCED INSTRUMENTATION AND HIGH SPEED RAIL TRANSPORT.

IAP

6828 N LA PRESA

SAN GABRIEL, CA 91775

CONTRACT NUMBER:

S SPENCER MERZ

TITLE:

HIGH-POWER FAST DI/DT SOLID-STATE SWITCHES

TOPIC# 5

OFFICE:

IDENT#: 30247

PULSE MODULATORS ARE REQUIRED FOR VARIOUS LASERS, PULSE GENERATORS, AND MICROWAVE SOURCES THAT MUST OPERATE IN A PULSED MODE AND REQUIRE FAST CURRENT RATE-OF-RISE, AND ARE SUSCEPTIBLE TO EXCESSIVE ENERGY LOADING, PARTICULARLY AT HIGH REPETITION RATES. A NEW FAMILY OF MODULATION BEING INVESTIGATED BASED ON A NEW SWITCH CONCEPT. THE SWITCH IS A BACK-LIGHTED THYRATRON THAT CAN BE USED FOR SPARK GAP APPLICATIONS. THE MOST IMPORTANT ISSUES BEING ADDRESSED INCLUDE PERFORMANCE

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AT HIGH VOLTAGE AND HIGH CURRENT, AND HIGH POWER OPERATION AT HIGH REPETITION RATES. MODULATORS BASED ON THIS SWITCH ARE BEING DESIGNED; AND AN ASSESSMENT OF THE VARIOUS MODULATOR PERFORMANCE CHARACTERISTICS OBTAINED. DETERMINATION OF SUITABLE TRIGGERING METHODS ARE BEING MADE FOR DEVELOPING PROTOTYPE MODULATORS. SUCCESS WILL RESULT IN A NEW GENERATION OF MODULATORS FOR APPLICATIONS THAT INCLUDE EXCIMER LASERS, RAILGUNS, POWER PULSE GENERATORS, FREE ELECTRON LASERS, AND PARTICLE BEAMS.

IAP RESEARCH INC
2763 CULVER AVE
DAYTON, OH 45429
CONTRACT NUMBER:
DAVID P BAUER
TITLE:
OVERCOMING RAILGUN PLASMA ARMATURE VELOCITY LIMIT
TOPIC# 2 OFFICE: IDENT#: 30474

ELECTROMAGNETIC RAILGUNS EXPERIENCE A VELOCITY LIMIT AT ABOUT 6 KM/S WITH PLASMA ARMATURES. HIGHER VELOCITIES ARE NOT REGULARLY ACHIEVABLE DUE TO DELETERIOUS ENERGY ABSORPTION PLASMA PHENOMENA. AN APPROACH FOR EMPLOYING A CONFINED PLASMA IS BEING INVESTIGATED THAT IS EXPECTED TO VIRTUALLY EMLIMINATE THE PROBLEMS OF CONVENTIONAL RAILGUN PLASMAS. THE FEASIBILITY IS BEING DETERMINED EMPLOYING A SOLID ARMATURE BODY FOR CONFINING A RAILGUN PLASMA ARAMATURE, TO OVERCOME CONVENTIONAL PLASMA ARMATURE VELOCITY LIMITS. THE KEY PARAMATERS ARE BEING DETERMINED THAT CONTROL PLASMA PROPERTIES WITHIN THE PLASMA CHANNEL. CONCEPTS AND SIZING CRITERIA ARE BEING DETERMINED FOR LOW MASS ARMATURE BODIES CAPABLE OF WITH STANDING THE PLASMA CHANNEL PRESSURES AND THE ACCELERATION STRESSES. DESIGN CRITERIA ARE BEING DEVELOPED FOR THE DIFFUSER NOZZLE. AN ARMATURE BODY IS BEING DESIGNED AND FABRICATED. SEVERAL OF THE CONFINED PLASMA ARMATURE ARE BEING CONDUCTED. THE FEASIBILITY OF THE CONFINED PLASMA ARMATURE CONCEPT IS BEING ASSESSED. WHEN SUCCESSFULLY DEMONSTRATED, HIGHER MUZZLE VELOCITIES WOULD BE ACHIEVABLE AND RAILGUN BORE EROSION WOULD BE SIGIFICANTLY REDUCED.

IMPACT TECHNOLOGIES INC
4542 JOHN MARR DR
ANNANDALE, VA 22003
CONTRACT NUMBER:
CARL W ANDERSON
TITLE:
RADIAL BLEED TOTAL THRUST CONTROL
TOPIC# 6 OFFICE: IDENT#: 30475

SUBMITTED BY

IN SPITE OF SUPERIOR STORABILITY, SOLID ROCKET MOTORS HAVE LONG BEEN PENALIZED, RELATIVE TO OTHER COMPETING SYSTEMS, FOR THEIR INABILITY TO MODULATE ENGINE THRUST. SIMPLE AND COST EFFECTIVE ENGINEERING MEANS TO THROTTLE SOLIDS WOULD ENABLE THE CREATION OF SUPERIOR SOLID PROPELLANT ROCKET MOTORS AND ENHANCE STRATEGIC DEFENSE. A NEW SOLID ROCKET APPROACH IS BEING EXPLORED THAT ENABLES THROTTLING AND SUPPLIES THE ADDED CAPABILITY OF VERY HIGH SIDE FORCES AS WELL. THIS RADIAL BLEED TOTAL THRUST CONTROL CONCEPT IS EXPECTED TO OFFER COMBINED AXIAL THRUST MANAGEMENT, THRUST MODULATION OF GREATER THAN 10/1, AND VERY HIGH SIDE FORCE VALUES, WITH SIDE FORCE ANGLES EXCEEDING 50 DEGREES OF THRUST VECTOR. DESIGN AND PERFORMANCE PARAMETERS ARE BEING DETERMINED AND EXISTING AND NEW HIGH TEMPERATURE MATERIALS FOR SOLID ROCKET MOTOR NOZZLE ENVIRONMENTS ARE BEING IDENTIFIED AND RANKED. WHEN SUCCESSFUL, THE MECHANICAL IMPLEMENTATION OF THIS CONCEPT IN A LATER RESEARCH PHASE WOULD BE ALL ELECTRIC, SPACE STORABLE, SMALL IN SIZE, LOW IN INERT WEIGHT, AND FEW MOVABLE PARTS.

IMPLANT SCIENCES CORP
35 CHERRY HILL DR
DANVERS, MA 01923
CONTRACT NUMBER:
DR STEPHEN N BUNKER
TITLE:
ULTRA-THIN SILICON-ON-INSULATOR BY A BONDED WAFER PROCESS
TOPIC# 14 OFFICE: IDENT#: 30330

BOTH SILICON-ON-SAPPHIRE AND SIMOX (SEPARATION BY IMPLANTATION OF OXYGEN) SILICON-ON-INSULATOR (SOI) MATERIALS PRESENTLY ARE USED AS SUBSTRATES TO FABRICATE RADIATION-HARD MICROCIRCUITS FOR DEFENSE USE. PROOCES IS NOW PRODUCING SOI WAFERS BY IMPLANTATION BY VERY HIGH TEMPEURE ANNEALING. THESE MATERIALS, HOWEVER, ARE VERY EXPENSIVE, AND THEIR ELECTRICAL PROPERTIES ARE INFERIOR TO BULK SILICON. AN SOI SUBSTRATE IS BEING DEVELOPED USING WAFER BONDING WITH AN INNOVATIVE HIGH ENERGY ETCH-STOP ION IMPLANT TECHNIQUE. THIS IS ANTICIPATED TO PROVIDE SUPERIOR QUALITY. THIS NEW TECHNIQUE COULD ALLOW THE SINGLE CRYSTAL DEVICE LAYER TO 1000-2000 ANGSTROMS THICK. PROTOTYPE SUBSTRATES ARE BEING FABRICATED AND THE CRYSTAL QUALITY AND IMPURITY CONCENTRATIONS ARE BEING ASSESSED. WITH FURTHER ENGINEERING SCALE-UP

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DURING A LATER EFFORT, THESE WAFERS COULD BE MANUFACTURED FOR RADIATION-HARD INTEGRATED CIRCUITS (IC'S). WHEN SUCCESSFUL, THIS RESEARCH WOULD GREATLY INCREASE THE PERFORMANCE CAPABILITIES AND AFFORDABILITY OF RADIATION-HARD IC'S. THE INCREASED CRYSTAL QUALITY COULD ALSO PERMIT NEW TYPES OF RADIATION-RESISTANT MICROCIRCUITS.

INTELLIGENT AUTOMATION INC
1715 GLASTONBERRY RD
ROCKVILLE, MD 20854
CONTRACT NUMBER:
LEONARD S HAYNES

TITLE:
PRECISION HIGH-SPEED SIX DEGREE OF FREEDOM POSITIONER
TOPIC# 1 OFFICE: IDENT#: 30058

LARGE DEPLOYABLE SPACE STRUCTURES SUFFER FROM INHERENT MECHANICAL VIBRATIONAL INSTABILITY. THIS INSTABILITY ARISES FROM THE OVERALL MASS REQUIREMENTS OF ANYTHING LAUNCHED INTO SPACE AND THE SOFTNESS EXPERIENCED IN LARGE AREA STRUCTURES. THIS TENDENCY TOWARD MECHANICAL VIBRATION HAS SEVERE ADVERSE AFFECTS ON ANY OPTICAL COMMUNICATION OR WEAPON POINTING SYSTEM WHICH MUST OPERATE OVER LONG DISTANCES. A PRECISION MIRROR POSITIONING SYSTEM IS BEING DEVELOPED WHICH HAS SIX DEGREES OF FREEDOM AND WHICH ALSO HAS LARGE DISPLACEMENT AND HIGH FREQUENCY RESPONSE. THE ADDITIONAL DEGREES OF FREEDOM PROVIDED BY THE SIX AXIS CAPABILITY ARE EXPECTED TO PROVIDE A DEGREE OF CONTROL OVER THE TRANSLATIONAL VIBRATION PARAMETERS FAR GREATER THAN WHAT IS NOW POSSIBLE IN CONVENTIONAL SYSTEMS. SPECIFIC MECHANICAL CONFIGURATIONS, AND SPECIFIC ACTUATOR AND CONTROL STRUCTURES ARE BEING IDENTIFIED, AND EARLY SIMULATIONS ARE VERY ENCOURAGING. A PROTOTYPE EFFORT COULD BE ACCOMPLISHED AT A LATER STAGE TO VERIFY THE THEORETICAL RESULTS. THIS SYSTEM, WHEN SUCCESSFULLY DEVELOPED, WILL GREATLY INCREASE THE OPPORTUNITY TO EXPLOIT ACTIVE DAMPING TO MINIMIZE PROBLEMS DUE TO VIBRATION IN MIRROR POINTING SYSTEMS AND WILL ALSO PROVIDE HIGH SPEED, HIGH ACCURACY SIX AXIS POSITIONING FOR MIRROR POINTING AND POTENTIALLY FOR MANY OTHER APPLICATIONS.

IONIC ATLANTA INC
1347 SPRING ST
ATLANTA, GA 30309
CONTRACT NUMBER:
DR KEITH O LEGG

TITLE:
PLASMA ENHANCEMENT TECHNOLOGY FOR PRODUCTION OF HIGH T
SUPERCONDUCTING THIN FILM SURFACES W/O HIGH TEMPERATURE PROCESSIN
TOPIC# 15 OFFICE: IDENT#: 30644

SUBMITTED BY

AT THE PRESENT TIME, ALL HIGH TEMPERATURE SUPERCONDUCTORS MUST BE SUBJECTED TO A PROLONGED ANNEAL AT HIGH TEMPERATURE IN OXYGEN TO ESTABLISH THE PROPER STRUCTURE AND SUPERCONDUCTING PROPERTIES. IN THE DEPOSITION OF THIN SUPERCONDUCTING FILMS, THIS GIVES RISE TO NUMEROUS PROBLEMS OF INTERDIFFUSION, SURFACE SEGREGATION, AND DAMAGE FROM DIFFERENTIAL THERMAL EXPANSION. A UNIQUE ENHANCED PLASMA DEPOSITION TECHNIQUE HAS BEEN DEVELOPED THAT PERMITS THE FORMATION OF CRYSTALLINE FILMS OF EVENT QUITE COMPLEX CERAMICS BY ROOM TEMPERATURE DEPOSITION. THE FEASIBILITY IS BEING DETERMINED WHETHER THIS TECHNIQUE CAN BE USED TO ELIMINATE OR SUBSTANTIALLY REDUCE THE OXYGEN ANNEAL, WITH ALL ITS ATTENDANT PROBLEMS. A SERIES OF DEPOSITIONS OF YBaCuO FILMS ON DIFFERENT SUBSTRATES IS BEING UNDERTAKEN WITH AND WITHOUT THE ENHANCED PLASMA TECHNIQUE. THE CHEMISTRY, STOICHIOMETRY AND SUPERCONDUCTING PROPERTIES OF THE FILMS IS BEING MEASURED AFTER ANNEALING IN OXYGEN FOR VARIOUS PERIODS OF TIME. THE NEED FOR A HIGH TEMPERATURE ANNEAL IN OXYGEN IS A SERIOUS PROBLEM BECAUSE OF THE DAMAGE WHICH IT WOULD CAUSE TO MANY MATERIALS AND THE SEVERE RESTRICTIONS IT IMPOSES ON THE SUBSTRATES ON WHICH THE SUPERCONDUCTING FILM CAN BE GROWN. ELIMINATING OR EVEN SIGNIFICANTLY REDUCING IT WOULD OPEN THE MATERIAL TO A MUCH WIDER RANGE OF APPLICATIONS, ESPECIALLY IN THE AREAS OF INTEGRATED ELECTRONICS, OPTICS AND SENSORS.

IRVINE SENSORS CORP
3001 REDHILL AVE - BLDG III/STE 208
COSTA MESA, CA 92626
CONTRACT NUMBER:
DAVID F LUDWIG

TITLE:
TARGET SELECTION AND AIM POINT DETERMINATION FOR KINETIC ENERGY WEAPONS
TOPIC# 2 OFFICE: IDENT#: 30338

THE APPLICATION IS BEING DEMONSTRATED OF APPLYING A PROPRIETARY 128 CHANNEL INTEGRATED CIRCUIT INFRARED FOCAL PLANE MOSAIC ARRAY ASSEMBLY MODULE (HYMOSS MODULE) WITH A PROPRIETARY SIGNAL PROCESSING ALGORITHM FOR INFRARED IMAGING TECHNOLOGY (DYMANIC STARE) TO THE IMAGE PROCESSING PROBLEMS OF THE KINETIC ENERGY WEAPON (KEW) EXO-ATMOSPHERIC PROJECTILES. THE PROBLEMS BEING ADDRESSED ARE: TARGET SELECTION AFTER

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HANDOFF, CLOSELY SPACED TARGETS, SMEAR LIMITS ON INTEGRATION TIME, AND AIM POINT DETERMINATION AGAINST BOOSTERS. OPERATING MODES AND EFFICIENCY OF DYNAMIC STARE AGAINST EACH OF THESE PROBLEMS ARE BEING INVESTIGATED. BASED ON THIS INVESTIGATION, A DEMONSTRATION UNIT IS BEING DESIGNED FOR IMPLEMENTATION IN A LATER EFFORT THAT IS EXPECTED TO DEMONSTRATE HOW BEST TO OPTIMIZE AND OPERATE DYNAMIC STARE FOR KEW APPLICATIONS. ON-FOCAL PLANE SIGNAL PROCESSING CAPABILITIES THAT ARE BEING EVALUATED DURING THE PROGRAM INCLUDE VERY LARGE DYNAMIC RANGE, REAL TIME ELECTRONIC DECONFIGURABILITY, ELECTRONIC IMAGE MOTION COMPENSATION, SPATIAL OVERSAMPLING, AND TEMPORAL AND SPATIAL FEATURE EXTRACTION. DEFENSE APPLICATIONS INCLUDE SMART PROJECTILES, INFRARED SEARCH AND TRACK, AND OPTICAL NAVIGATION SYSTEMS WHILE COMMERCIAL BENEFITS ARE FOUND IN PRODUCT INSPECTION, OPTICAL CHARACTER RECOGNITION, SECURITY SYSTEMS, AND ROBOT VISION SYSTEMS.

IRVINE SENSORS CORP
3001 REDHILL AVE - BLDG III/STE 208
COSTA MESA, CA 92626
CONTRACT NUMBER:
DAVID E LUDWIG
TITLE:
STACKED SUPERCONDUCTING ELECTRONICS FOR INFRARED FOCAL PLANE
SIGNAL PROCESSING
TOPIC# 15 OFFICE: IDENT#: 30483

THE FEASIBILITY IS BEING INVESTIGATED OF DEVELOPING AN INFRARED (IR) ON-FOCAL PLANE SIGNAL PROCESSING CAPABILITY BY COMBINING ELECTRONIC REAL ESTATE AFFORDED BY A PROPRIETARY 128 CHANNEL INTEGRATED CIRCUIT FOCAL PLANE MOSAIC ARRAY ASSEMBLY MODULE AND THE SUPERCONDUCTING JOSEPHSON-JUNCTION TECHNOLOGY. THE MODULE HAS BEEN DEVELOPED TO READ OUT AND PROCESS SIGNALS FROM 128 X 128 TWO-DIMENSIONAL ARRAYS OF IR DETECTORS. LOW POWER, HIGH PERFORMANCE CIRCUITS HAVE BEEN DEVELOPED FOR LONG WAVELENGTH INFRARED (LWIR) FOCAL PLANE PROCESSING USING NIOBIUM AT 4 DEGREES KELVIN. NEW HIGHER TEMPERATURE SUPERCONDUCTORS ARE ANTICIPATED TO EXTEND THIS CAPABILITY TO AT LEAST 60 DEGREES KELVIN. OF PARTICULAR INTEREST IS A DEMONSTRATED PROPRIETARY SUPERCONDUCTING ANALOG-DIGITAL CONVERTER CAPABLE OF 13 BIT RESOLUTION AND 10E7 WORDS PER SECOND AT LESS THAN 10 MICROWATTS POWER DISSIPATION. IN ORDER TO PRODUCE HIGH PERFORMANCE LWIR FOCAL PLANE SIGNAL PROCESS-

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ING, THIS EFFORT IS ADDRESSING ELECTRONICS CONFIGURATION TRADES AND CONCEPT DESIGN. A COMPATIBLE INTEGRATED CIRCUIT WOULD BE BUILT AND TESTED IN A LATER PHASE. SUCCESSFUL DEMONSTRATION AT 10 DEGREE KELVIN WOULD LEAD THE WAY TO AN FPA SIGNAL PROCESSING MODULE WHICH COULD PERFORM MOST OF THE FUNCTIONS DESIRED FOR ADVANCED SENSORS FOR SPACE AND GROUND-BASED SURVEILLANCE AND TRACKING SYSTEMS, INCLUDING PRE-AMPLIFICATION, BANDPASS FILTERING, GAMMA EVENT CIRCUMVENTION, TIME DELAY AND INTEGRATION, DIGITIZATION, THRESHOLDING, AND BUFFERING.

J & D SCIENTIFIC INC
2854 S HAVEN DR
ANNAPOLIS, MD 21401
CONTRACT NUMBER:
DR LARRY D McCORMICK

TITLE:

SCANNING TUNNELING MICROSCOPY ETCHING OF NANOMETER SCALE INTEGRATED CIRCUITS

TOPIC# 14

OFFICE:

IDENT#: 30146

PRESENT METHODS UTILIZED FOR THE FABRICATION OF INTEGRATED CIRCUITS ARE BASED ON MICROLITHOGRAPHY, EITHER OPTICAL, X-RAY, ELECTRON BEAM, OR ION BEAM. THESE METHODS ARE SIGNIFICANTLY LIMITED IN THE PRODUCTION OF SMALLER SCALE FEATURES (E.G., NANOLITHOGRAPHY), BY THE WAVELENGTH OF THE RADIATION (OPTICAL AND X-RAY LITHOGRAPHY) AND/OR BY THE COMPLEXITY AND COST OF THE EQUIPMENT (X-RAY AND ELECTRON AND ION BEAM LITHOGRAPHY). THE SCANNING TUNNELING MICROSCOPE (STM), HAS BEEN USED TO IMAGE SURFACES WITH ATOMIC RESOLUTION. THE ABILITY OF STM TO FUNCTION OUTSIDE ULTRA-HIGH VACUUM CONDITIONS RAISES THE POSSIBILITY OF BROADENING THE RANGE OF APPLICATION TO AREAS OTHER THEN IMAGING. THE FEASIBILITY IS BEING INVESTIGATED OF USING STM TO SELECTIVELY MODIFY THE SURFACE OF A SUBSTRATE ON THE NANOMETER LEVEL IN ORDER TO REPLACE BOTH THE MICROLITHOGRAPHY MASKING STEP AND THE CHEMICAL ETCHING SET IN THE FABRICATION PROCESS. SPECIFIC EXPERIMENTS ARE BEING UNDERTAKEN TO ATTEMPT TO ETCH A GaAs SUBSTRATE WITH THE STM IN AN ACIDIC AND IN AN ALKALINE SOLUTION. THE ETCHED PORTION OF THE GaAs IS BEING CHARACTERIZED WITH STM AND SCANNING ELECTRON MICROSCOPY (SEM). SIGNIFICANT POTENTIAL ADVANTAGES OF NANOMETER ETCHING OF GaAs ARE THE INCREASED SPEED (SMALLER FEATURES OF AN INTEGRATED CIRCUIT RESULT IN FASTER DEVICES) AND A DECREASE IN THE AMOUNT OF MATERIAL, AND

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THEREFORE PRICE, REQUIRED FOR THE INTEGRATED CIRCUIT.

JAMAR TECHNOLOGY CO
PO BOX 210529
SAN DIEGO, CA 92121
CONTRACT NUMBER:
DR HARRY SHIELDS

TITLE:

SHORT DURATION ULTRAVIOLET LASER PULSE GENERATION BY RAMAN-INDUCE
CAVITY DUMPING

TOPIC# 3

OFFICE:

IDENT#: 30484

ULTRAVIOLET LASER PULSES OF A FEW NANoseconds (NS) DURATION ARE POTENTIALLY USEFUL IN SEVERAL APPLICATIONS INCLUDING LASER RADAR, REMOTE SENSING AND X-RAY GENERATION. LASER RADAR AND REMOTE SENSING USING RELATIVELY LONG PULSES ARE IMPRECISE AND X-RAY GENERATION IS INEFFICIENT. THE USE OF STIMULATED RAMAN SCATTERING BY MOLECULAR GAS IS BEING INVESTIGATED AS A MEANS TO TEMPORARILY COMPRESS LASER PULSES STORED IN AN OPTICAL RESONATOR. THE TECHNIQUE IS BEING EVALUATED FOR THE PARTICULAR CASE OF GAS DISCHARGE EXCIMER LASERS OF INTERMEDIATE PULSE ENERGY (1-10J) AND INITIAL PULSE DURATION OF 50-100NS. BY PLACING A RAMAN MEDIUM WITHIN THE LASER CAVITY, SUCH THAT THE NOMINAL REFLECTIVITY OF THE CAVITY CHANGES FROM 100% AT THE LASER WAVELENGTH TO 0% AT THE RAMAN-SHIFTED STOKES WAVELENGTH, THE OPTICAL ENERGY MAY BE EXTRACTED IN A PULSE OF A FEW NANoseconds DURATION. THIS WORK IS GENERATING A DATABASE FOR THE DESIGN OF THESE SHORT PULSE SYSTEMS AND IS EXPECTED TO RESULT IN A RECOMMENDED DESIGN FOR LABORATORY DEMONSTRATION. THIS IS BEING ACHIEVED THROUGH DETAILED ANALYTICAL MODEL OF THE CIRCULATING INTENSITIES WITHIN THE LASER/RAMAN RESONATOR. THIS INVESTIGATION COULD LEAD TO DEPLOYMENT WITH MILITARY AND COMMERCIAL APPLICATIONS IN REMOTE SENSING, GAS DETECTION, AND X-RAY GENERATION.

K.E.M.P. CORP
1909 MATTHEW LN
KNOXVILLE, TN 37923
CONTRACT NUMBER:
DR F E LEVERT

TITLE:

IMPROVED DIRECT NEUTRON SENSOR

TOPIC# 3

OFFICE:

IDENT#: 30645

SUBMITTED BY

THE DETECTION OF NEUTRONS NORMALLY IS A PROBLEM BECAUSE OF THEIR LACK OF CHARGE AND THEREFORE WEAK INTERACTION WITH MATTER. NEUTRON INDUCED CONDUCTIVITY CHANGES OFFER THE OPPORTUNITY FOR THE DEVELOPMENT OF A DIRECT MEANS OF MEASURING NEUTRON FLUENCES. DEVELOPMENT OF ORGANIC POLYMER-BASED FAST AND THERMAL NEUTRON IS BEING INVESTIGATED AND IS ANTICIPATED TO BE CAPABLE OF DIRECTLY MEASURING NEUTRON FLUENCES OVER A WIDE RANGE OF NEUTRON FLUXES. NEUTRON ENERGY SENSITIVITY OF SEVERAL ORGANIC POLYMERS IS BEING EXAMINED BY PERFORMING NEUTRON IRRADIATION WITH SEVERAL FILM THICKNESSES DESIGNED TO MATCH THE RANGE OF PROTON REACTION PRODUCTS WITH PARTICULAR RECOIL ENERGIES. THERMAL NEUTRON SENSITIVITY STUDIES ARE BEING PERFORMED BY DOPING SELECTED POLYMER FILMS WITH LARGE CROSS-SECTION THERMAL NEUTRON ABSORBERS. SUCCESSFUL COMPLETION OF THIS EFFORT WOULD LEAD TO THE DEVELOPMENT OF A NOVEL CLASS OF NEUTRON DETECTORS THAT WOULD PROVIDE A DIRECT MEASURE OF NEUTRON FLUXES. THE FILM COULD BE USED TO MAKE DIRECTIONAL, POSITION SENSITIVE AND ISOTROPIC NEUTRON SENSORS AND ALSO COULD BE USED TO MAKE PERSONAL DIRECT READING NEUTRON DOSIMETERS AND VERY LARGE AREA NEUTRON DETECTORS.

KDT INDUSTRIES INC

PO BOX 1787

AUSTIN, TX 78767

CONTRACT NUMBER:

CHARLES H WERNER

TITLE:

LAUNCH SYSTEM PROCESS CONTROL

TOPIC# 6

OFFICE:

IDENT#: 30070

COMPLEX PROCESSES HAVE BEEN MODELED PREDOMINANTLY IN A PIECEMEAL FASHION, WITH EACH GROUP OF RESEARCHERS MODELING A SMALL, BUT MANAGEABLE PART OF THE PROCESS. THIS TYPICALLY RESULTS IN THE DEVELOPMENT OF A NUMBER OF DISJOINT MODELS EACH ACCESSING ITS OWN DEDICATED DATABASE, MAKING END-TO-END ANALYSES OF PROCESSES VERY DIFFICULT. THE PRIMARY OBJECTIVE OF THE RESEARCH IS THE EFFECTIVE INTEGRATION OF DISTINCT MODELING SYSTEMS AND THE INFORMATIONAL CONTENT OF THEIR ASSOCIATED DATABASE ELEMENTS. CURRENT MODELS SPAN MANY FUNCTIONS AND HAVE A MULTIPLICITY OF USER AND DATA INTERFACES, WITHIN SEPARATE HARDWARE AND SOFTWARE ENVIRONMENTS. AN INNOVATIVE COMPUTER ARCHITECTURE

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IS BEING DEVELOPED THAT INTEGRATES EXISTING, DISTINCT COMPUTER MODELS BY PROVIDING APPROPRIATE DATA INTERFACES TO STORE AND MANAGE THE INPUTS, OUTPUT, AND TRANSFER OF DATA. THE RESEARCH IS FOCUSING ON THE INTEGRATION OF SELECTED COMPUTER MODELS SPECIFICALLY ASSOCIATED WITH DIFFERENT ASPECTS OF EARTH-TO-ORBIT LAUNCH SYSTEMS. ALTHOUGH THE RESEARCH IS FOCUSING ON EARTH-TO-ORBIT LAUNCH SYSTEMS AS A PROOF-OF-CONCEPT DEMONSTRATION, THE METHODOLOGY IS BEING DEVELOPED IN A GENERAL NATURE TO ALLOW EASY ADAPTATION TO OTHER MODELING SYSTEMS. THIS METHODOLOGY IS EXPECTED TO HAVE WIDE APPLICATION DUE TO THE SIMILAR STRUCTURE OF MODELS DEVELOPED FOR MANY ENGINEERING AND MANAGEMENT PROCESSES.

KENSAL CONSULTING
5701 E GLENN ST - BLDG 36
TUCSON, AZ 85712
CONTRACT NUMBER:
KENDALL PRESTON JR

TITLE:

THREE-DIMENSIONAL CELLULAR AUTOMATA FOR SUBPIXEL TARGET DETECTION
TOPIC# 10 OFFICE: IDENT#: 30072

A NEED EXISTS IN STRATEGIC DEFENSE SYSTEMS FOR NEW COMPUTER ARCHITECTURES FOR RAPID PROCESSING OF TARGET DATA AND NOVEL NUMERICAL ALGORITHMS FOR ENHANCING THE SPEED OF DATA PROCESSING. THE ARCHITECTURE BEING STUDIED IS THE THREE-DIMENSIONAL CELLULAR AUTOMATA. THE BINARY RANKING TRANSFORM. THE APPLICATION IS IN WEAK, SUBPIXEL TARGET DETECTION WHERE IN HUNDREDS OF THOUSANDS OF POTENTIAL TRACKS MUST BE MONITORED FOR TARGETS AT THE 12dB LEVEL. TASKS BEING PERFORMED ARE INVESTIGATIONS OF: THEORETICAL ASPECTS OF THE BINARY RANKING TRANSFORM FOR WEAK, SUBPIXEL TARGET DETECTION; METHODS FOR IMPLEMENTING THIS TRANSFORM USING THREE-DIMENSIONAL CELLULAR AUTOMATA; AND METHODS FOR REDUCING THE ALGORITHMS AND ARCHITECTURE DEVELOPED TO SILICON, OR ALTERNATELY, GALLIUM ARSENIDE IN VERY LARGE SCALE INTEGRATION STRUCTURES. THE THREE-DIMENSIONAL CELLULAR LOGIC PROCESSOR IS NOT ONLY USEFUL IN WEAK, SUBPIXEL TARGET DETECTION BUT ALSO IN PERFORMING THREE-DIMENSIONAL PATTERN RECOGNITION AND THREE-DIMENSIONAL SHAPED GRAPHICS. INTERACTIVE GRAPHICS IMAGING IS A MAJOR MARKET FOR DIRECT COMMERCIAL APPLICATION OF THE THREE-DIMENSIONAL CELLULAR LOGIC PROCESSOR.

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KOPIN CORP
695 MYLES STANDISH BLVD
TAUNTON, MA 02780
CONTRACT NUMBER:
DR PAUL M ZAVRACKY

TITLE:
COMPOSITIONAL DEFECTS IN THE ELECTRICAL BEHAVIOR OF ZONE-MELTING
RECRYSTALLIZATION FILMS AND THEIR SUBSEQUENT REDUCTION
TOPIC# 14 OFFICE: IDENT#: 30745

THE ZONE-MELTING-RECRYSTALLIZATION (ZMR) TECHNIQUE OFFERS AN ATTRACTIVE, COST-EFFECTIVE APPROACH TO THE FABRICATION OF SOI WAFERS. ALTHOUGH SIGNIFICANT EFFORT HAS BEEN EXPANDED IN CHARACTERIZING ZMR MATERIAL, ONLY RECENTLY HAVE MATERIALS OF EXCEPTIONAL QUALITY BEEN PRODUCED. VERY LOW ($10^5/\text{CM}^2$) DEFECT DENSITY MATERIAL HAS BEEN MANUFACTURED USING THIS PRODUCTION ZMR SYSTEM. ALTHOUGH ZMR TECHNOLOGY HAS PROVIDED SOI MATERIALS WITH ACCEPTABLE ELECTRICAL PROPERTIES, A THOROUGH EXAMINATION OF RECENT HIGH QUALITY ZMR MATERIALS HAS NOT YET BEEN PERFORMED. A CORRELATION BETWEEN CHEMICAL IMPURITIES AND THE ELECTRICAL PARAMETERS OF COMPOSITE METAL-OXIDE SEMICONDUCTOR AND BI-POLAR DEVICES HAS YET TO BE ESTABLISHED. IN THIS INVESTIGATION, THE FEASIBILITY IS BEING EXAMINED OF USING CURRENT MEASUREMENT AND DEVICE TECHNOLOGY TO DETERMINE THE ROLE OF THE REMAINING DEFECTS ON THE ELECTRICAL PROPERTIES OF ZMR MATERIAL. SPECIFICALLY, THE AVAILABILITY OF MEASUREMENT TECHNIQUES IS BEING DETERMINED THAT ARE SUFFICIENTLY SENSITIVE TO PROVIDE INFORMATION RELATING THE COMPOSITIONAL DEFECTS WITHIN THE ELECTRICAL CHARACTERISTICS OF ZMR FILMS. THE FEASIBILITY OF CREATING TEST DEVICES IS BEING EVALUATED THAT CAN BE USED TO ANALYZE THE EFFECT OF COMPOSITIONAL IMPURITIES. A MASK SET IS BEING DESIGNED WITH APPROPRIATE ELECTRICAL STRUCTURES THAT CAN BE USED TO MAP THE ELECTRICAL PROPERTIES OF ZMR FILMS ON A MICROSCOPIC SCALE. ADVANTAGES OVER CONVENTIONAL SILICON BULK WAFERS INCLUDING: RADIATION HARDNESS, VOLTAGE ISOLATION, IMPROVED SPEED PERFORMANCE, GREATER PACKING DENSITY AND COMPOSITE METAL OXIDE SEMICONDUCTOR (CMOS) LATCH-UP IMMUNITY. CURRENT METHODS OF FABRICATING SOI MATERIAL RESULT IN EITHER COST AND/OR QUALITY PROBLEMS. THE ZONE-MELTING-RECRYSTALLIZATION (ZMR) TECHNIQUE OFFERS AN ATTRACTIVE APPROACH TO THE FABRICATION OF SOI WAFERS. ALTHOUGH SIGNIFICANT EFFORT HAS BEEN EXPANDED IN

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CHARACTERIZING ZMR MATERIAL, ONLY RECENTLY HAVE MATERIALS OF EXCEPTIONAL QUALITY BEEN PRODUCED. VERY LOW ($10^5/\text{CM}^2$) DEFECT DENSITY MATERIAL HAS BEEN MANUFACTURED USING THIS PRODUCTION ZMR SYSTEMS.

KOPIN CORP
695 MYLES STANDISH BLVD
TAUNTON, MA 02780
CONTRACT NUMBER:
DR JACK P SALERNO
TITLE:
EPITAXIAL GALLIUM-ARSENIDE ON SILICON-ON-INSULATOR WAFERS
TOPIC# 14 OFFICE: IDENT#: 30746

THE NEED FOR LARGE-AREA GALLIUM-ARSENIDE (GaAs) WAFERS FOR ELECTRONIC AND OPTOELECTRONIC DEVICES IS BEING ADDRESSED THAT ARE SUITABLE FOR MONOLITHIC INTEGRATION OF BOTH GaAs AND SILICON (Si) RADIATION-HARDENED FUNCTIONS. THE GROWTH OF GaAs IS BEING INVESTIGATED BY ORGANO-METALLIC CHEMICAL VAPOR DEPOSITION ON SILICON-ON-INSULATOR (SOI) WAFERS PREPARED BY ZONE MELTING RECRYSTALLIZATION (ZMR). THE USE OF ZMR SOI WAFERS FOR GaAs GROWTH PROVIDES A Si LAYER OF HIGHER PURITY AND CRYSTALLINE QUALITY AT A SIGNIFICANT LOWER COST THAN COMPETING TECHNOLOGIES. THE FEASIBILITY IS BEING INVESTIGATED OF EPITAXIAL GROWTH OF GaAs ON ZMR SOI SUBSTRATES. SEEDING IS BEING USED TO PRODUCE A SLIGHTLY MISORIENTED RECRYSTALLIZED Si FILM THAT WILL BE USED FOR GaAs ON Si GROWTH. THE ELECTRICAL AND STRUCTURAL PROPERTIES OF THE GaAs LAYER ARE BEING COMPARED TO GaAs GROWN ON BULK Si, SIMOX (SEPARATION BY IMPLANTATION OF OXYGEN), AND SILICON-ON-SAPPHIRE SUBSTRATES. RESEARCH IN A LATER PHASE WOULD BE CARRIED OUT TO FURTHER OPTIMIZE GROWTH PROCESS AND TO EVALUATE DEVICE PERFORMANCE. WHEN SUCCESSFUL, THIS APPROACH WOULD MAKE POSSIBLE THE INTEGRATION OF RADIATION-HARDENED Si INTEGRATED CIRCUITS WITH GaAs ELECTRONIC AND OPTOELECTRONIC FUNCTIONS. SUCH WAFERS COULD ALSO BE EXPLOITED FOR THE FABRICATION OF FOCAL PLAN ARRAY DETECTORS BY COMBINING SOI CIRCUITRY WITH GaAs DETECTORS OR HgCdTe DETECTORS EPITAXIALLY GROWN ON THE GaAs LAYER.

MAGMA-SEAL INC
10116 ASPEN ST
AUSTIN, TX 78758
CONTRACT NUMBER:
DR EARL T DUMITRU
TITLE:
SCREWLESS EXTRUDER FOR PLASTIC BINDER PROCESSING OF PROPELLANTS
REPLACING TWIN SCREWS
TOPIC# 6 OFFICE: IDENT#: 30648

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THERMOPLASTIC BINDERS FOR SOLID PROPELLANTS AND PLASTIC BINDER EXPLOSIVES (PBX) CURRENTLY ARE COMPOUNDED WITH TWIN SCREW EXTRUDERS WHICH MINIMIZE THE HEAT HISTORY OF THESE SENSITIVE MATERIALS. NEW POLYETHER BLOCK COPOLYMERS AS ENERGETIC BINDERS MAY PLACE ADDITIONAL DEMANDS ON THE MACHINERY USED FOR MIXING AND EXTRUSION. THE UTILITY OF EXTRUDER DESIGN IS BEING EXPLORED FOR MIXING HIGH-SOLIDS, HEAT-SENSITIVE MATERIALS. THE NEW MACHINE HAS A LARGE ROTOR INSIDE AN ECCENTRIC BARREL WITH CAREFULLY CALCULATED CLEARANCES AT VARIOUS POINTS OF THE ANNULUS. A SHORT AND UNIFORM HEAT HISTORY RESULTS. A GEAR PUMP AND STATIC MIXERS ARE USED DOWNSTREAM AS NEEDED. A SMALL 300 LB/HR LAB-SIZE UNIT IS BEING TESTED IN ORDER TO ESTABLISH ITS POTENTIAL FOR SAFER, MORE UNIFORM, AND MORE ECONOMICAL PREPARATION OF PBX AND SOLID PROPELLANTS. A LOW COST THERMOPLASTIC ELASTOMER IS BEING SELECTED WITH MELT VISCOSITY CLOSE TO THAT EXPECTED FOR NEWER ENERGETIC BINDERS; AND THE SIZE DISTRIBUTION OF A SELECTED FILLER IS BEING OPTIMIZED TO ACHIEVE HIGH SOLIDS CONTENT. THE COMPOUNDED EXTRUDATE IS BEING EXAMINED FOR PARTICLE DISTRIBUTION, UNIFORMITY, DEGRADATION OF MOLECULAR WEIGHT, AND OTHER SIGNS OF DISTRESS.

MAINSTREAM ENGINEERING CORP
268 N BABCOCK ST - STE C
MELBOURNE, FL 32935

CONTRACT NUMBER:

LAWRENCE R GRZYLL

TITLE:

WORKING FLUIDS FOR USE IN SPACECRAFT HEAT PIPES

TOPIC# 5 OFFICE: IDENT#: 30254

IN ORDER TO UTILIZE A WORKING FLUID FOR A SPECIFIC HEAT PIPE APPLICATION, THE WORKING FLUID MUST HAVE A USEFUL TEMPERATURE RANGE THAT SPANS THE TEMPERATURE LIMITS OF THE HEAT PIPE. THE LIQUID TRANSPORT FACTOR HAS A PRONOUNCED EFFECT ON HEAT PIPE DESIGN. AN OVERVIEW OF THE STATUS OF CURRENT HEAT PIPE WORKING FLUIDS SHOWS THAT NONE OF THE CURRENT WORKING FLUIDS CAN BE USED OVER THE 450-700K TEMPERATURE RANGE. BY PREDICTING THE LIQUID TRANSPORT FACTOR OF VARIOUS COMPOUNDS, SEVERAL WORKING FLUIDS HAVE BEEN FOUND THAT CAN BE USED OVER THAT TEMPERATURE RANGE. THE FEASIBILITY IS BEING DEMONSTRATED OF USING SUCH WORKING FLUIDS IN SPACECRAFT HEAT PIPES. THE PROPERTIES

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USED IN THE PREDICTION OF THE LIQUID TRANSPORT FACTOR OF THE NOVEL COMPOUND ARE BEING VERIFIED. THESE PROPERTIES ARE THE LIQUID DENSITY, LIQUID SURFACE TENSION, AND LIQUID VISCOSITY. IN ADDITION, THE THERMAL STABILITY AND CORROSIVE PROPERTIES OF THE NOVEL FLUIDS ARE BEING DETERMINED. THE INVESTIGATION, WHEN SUCCESSFUL, WOULD RESULT IN THE VERIFICATION OF NOVEL COMPOUNDS FOR USE AS WORKING FLUIDS IN HEAT PIPES OVER THE TEMPERATURE RANGE OF 450-700K.

MAINSTREAM ENGINEERING CORP
268 N BABCOCK - STE C
MELBOURNE, FL 32935
CONTRACT NUMBER:

DR ROBERT P SCARINGE

TITLE:

HEAT PUMP THERMAL TRANSPORT LOOP FOR SPACECRAFT APPLICATIONS

TOPIC# 7

OFFICE:

IDENT#: 30344

INCREASINGLY STRINGENT THERMAL REQUIREMENTS ARE PROJECTED FOR FUTURE SPACECRAFT. COMPLIANCE WITH THESE REQUIREMENTS NECESSITATES THE DEVELOPMENT OF THERMAL CONTROL TECHNIQUES WITH CAPABILITIES FAR EXCEEDING THOSE IN CURRENT USE. A FUNDAMENTAL CONSIDERATION IS A HEAT TRANSPORT AND THERMAL REJECTION SYSTEM CAPABLE OF ACCOMODATING LARGE LOADS, HIGH ENERGY DENSITIES, LONG TRANSPORT DISTANCES, VARIABLE DUTY CYCLES, AND VARYING OPERATIONAL PARAMETERS. AN INNOVATIVE, SPACECRAFT THERMAL-MANAGEMENT/THERMAL-TRANSPORT LOOP FOR HIGH POWER APPLICATIONS IS BEING INVESTIGATED THAT UTILIZES A COMPRESSOR RATHER THAN A PUMP TO TRANSPORT THE WORKING FLUID AROUND THE LOOP. USING EXISTING EXPERTISE IN THE THERMAL-DESIGN/HEAT-PUMP AREA TO REFINE THE HEAT PUMP THERMAL TRANSPORT LOOP, AN ANALYSIS OF THE CRITICAL COOLING SYSTEM COMPONENTS IS BEING CONDUCTED FOR A CONCEPTUAL DESIGN. THEORETICAL MODELING OF THE HEAT PUMP THERMAL TRANSPORT LOOP IS BEING PERFORMED. ALTERNATIVE OIL SEPARATION AND ACCUMULATOR TECHNIQUES ARE BEING ANALYZED. OPTIMUM WORKING FLUID IS BEING DETERMINED. COMPARISON OF THE PROPOSED SYSTEM WITH OTHER THERMAL TRANSPORT CONFIGURATIONS IS BEING PERFORMED. CRITICAL COMPONENTS ARE BEING IDENTIFIED THAT REQUIRE TESTING IN A LATER PHASE.

MATERIAL CONCEPTS INC
666 N HAGUE AVE
COLUMBUS, OH 43204
CONTRACT NUMBER:

DR DAVID GODDARD

TITLE:

CAST GRAPHITE/METAL COMPOSITES FOR KINETIC ENERGY WEAPONS

TOPIC# 2

OFFICE:

IDENT#: 30192

SUBMITTED BY

CURRENT CONCEPTS, FOR SPACE-BASED KINETIC ENERGY WEAPONS UTILIZING FILAMENT-WOUND GRAPHITE/EPOXY AS A STRUCTURAL MATERIAL, SUFFER FROM ADDED INSULATION WEIGHT REQUIRED BY THE INABILITY OF THIS MATERIAL TO WITHSTAND HIGH TEMPERATURES. FILAMENT-WOUND GRAPHITE/METAL COMPOSITES, SUCH AS GRAPHITE/ALUMINUM OR GRAPHITE/MAGNESIUM (Gr/Mg), POTENTIALLY CAN PROVIDE GREATLY INCREASED SERVICE TEMPERATURE CAPABILITY WHILE MAINTAINING THE SAME MECHANICAL PROPERTY AND FABRICATION ADVANTAGES AS GRAPHITE/EPOXY. IN ADDITION TO SAVING INSULATION WEIGHT, THE USE OF GRAPHITE/METAL COMPOSITES COULD ALLOW HOTTER PORTIONS OF THE STRUCTURE TO BE FABRICATED AS PART OF THE SAME PIECE, THEREBY SAVING ADDITIONAL WEIGHT AND ELIMINATING THE NEED FOR JOINTS AND ATTACHMENT FITTINGS. IN THIS INVESTIGATION, FABRICATION IN Gr/Mg IS BEING DEMONSTRATED OF A FULL-SCALE PROPELLANT SECTION (CASE) OF THE DIVERT PROPULSION SYSTEM OF THE TERMINALLY GUIDED KINETIC KILL VEHICLE. FIBER POSITIONING IS BEING PERFORMED BY FILAMENT WINDING. CASTING IS BEING USED TO INFILTRATE THE FIBERS WITH THE METAL MATRIX AND PRODUCE THE METAL MATRIX COMPOSITE STRUCTURE. WHEN SUCCESSFUL, APPLICATIONS INCLUDE SYSTEMS WHICH REQUIRE MATERIALS THAT EXHIBIT HIGH STRENGTH AND MODULUS, LOW THERMAL EXPANSION, HIGH THERMAL CONDUCTIVITY, GOOD ELEVATED TEMPERATURE SERVICE CAPABILITY, AND THAT CAN BE ECONOMICALLY FABRICATED INTO COMPLEX SHAPES.

MATERIALS TECHNOLOGIES CORP

57 MARYANNE DR

MONROE, CT 06468

CONTRACT NUMBER:

DR YOGESH MEHROTRA

TITLE:

CALCIUM-ZIRCONIUM-PHOSPHATES FOR SPACE-BORNE OPTICAL AND STRUCTURAL COMPONENTS

TOPIC# 13

OFFICE:

IDENT#: 30653

NEW MATERIALS ARE NEEDED FOR SPACE-BORNE PRECISION OPTICAL COMPONENTS AND THERMO-MECHANICALLY STABLE, LARGE LIGHTWEIGHT STRUCTURES. THE OPPORTUNITY EXISTS FOR FABRICATING BOTH OPTICAL COMPONENTS AND SUPPORTING STRUCTURES WITH MATERIALS OF THE SAME CHEMICAL COMPOSITION. CALCIUM-ZIRCONIUM-PHOSPHATE (CZP) CERAMICS ARE BEING EXPLORED FOR POSSIBLE USE IN THE FABRICATION OF SPACE-BORNE STRUCTURAL AS WELL AS

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OPTICAL COMPONENTS FOR CONSTRUCTING THERMALLY INVARIANT WEAPON SUPPORT ASSEMBLIES. COMPOSITIONS IN THIS FAMILY OF MATERIALS CAN BE SPECIFICALLY FORMULATED TO YIELD NEAR-ZERO THERMAL EXPANSION IN THE SPACE ENVIRONMENT. THESE MATERIALS ARE CHEMICALLY STABLE, MECHANICALLY CRACK-FREE, STRONG AND TOUGH AND THERMALLY INVARIANT. NEAR-NET SHAPE AND SIZE FABRICATION OF CZP CERAMICS FOR PRECISION OPTICAL AND STRUCTURAL COMPONENTS IS BEING DEMONSTRATED. THERMO-MECHANICAL PERFORMANCE OF CZP OPTICAL AND STRUCTURAL COMPONENTS ARE BEING DEFINED FOR GIVEN THERMO-MECHANICAL LOADS. SYSTEMS PERFORMANCE OF CZP CERAMICS IN EXPECTED TO BE SUPERIOR TO CURRENTLY USED MATERIALS WITH REGARDS TO THERMO-MECHANICAL STABILITY, STRUCTURAL DAMPING/JITTER AND MECHANICAL INTEGRITY. WEAPON TRACKING, POINTING, TARGETING AND RE-TARGETING CAPABILITIES ARE EXPECTED TO BE SUPERIOR DUE TO THE ABSENCE OF A THERMAL MISMATCH BETWEEN THE PRECISION OPTICS AND THE SUPPORTING STRUCTURES.

MCR TECHNOLOGY CORP
PO BOX 10084
CHICAGO, IL 60610
CONTRACT NUMBER:
DR KEITH BOYER
TITLE:

HIGH BRIGHTNESS X-RAY SOURCE FOR DIRECTED ENERGY AND HOLOGRAPHIC IMAGING APPLICATIONS
TOPIC# 1 OFFICE: IDENT#: 30193

THE TECHNOLOGIES OF HIGH BRIGHTNESS X-RAY SOURCES AND HOLOGRAPHIC IMAGING INDIVIDUALLY HAVE A LARGE RANGE OF POTENTIAL APPLICATIONS IN DEFENSE, COMMERCIAL, AND SCIENTIFIC SECTORS. THE FEASIBILITY IS BEING DETERMINED OF DEVELOPING A COMMERCIALY VIABLE TECHNOLOGY FOR BIOLOGICAL X-RAY MICROHOLOGRAPHY INTEGRATING BOTH HIGH BRIGHTNESS X-RAY SOURCE AND THE TECHNOLOGY FOR IMAGE RECONSTRUCTION. SPECIFICALLY, AN ESTIMATE IS BEING DEVELOPED OF THE SCALING OF THE PEAK SOURCE BRIGHTNESS AND EFFICIENCY IN X-RAY SOURCE TECHNOLOGY. AN ASSESSMENT IS BEING UNDERTAKEN OF ENERGY DEPOSITION RATES AND, PARTICULARLY, THE SPATIAL CONTROL OF THE ENERGY. IN ADDITION, A GENERAL PROGNOSIS IS DEVELOPED FOR THE TECHNOLOGY OF HOLOGRAPHIC RECONSTRUCTION. AN ASSESSMENT IS BEING UNDERTAKEN OF THE DEVELOPMENT OF FAST ALGORITHMS ALONG WITH A PROJECTION OF THE ASSOCIATED DEVELOPMENTS IN COMPUTER

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HARDWARE AND HOLOGRAPHIC DETECTOR TECHNOLOGY. THIS INFORMATION WOULD ENABLE THE FORMULATION OF DESIRED SCALING RELATIONSHIPS FOR INFORMATION HANDLING CAPABILITY, COMPUTATIONAL SPEED, SYSTEM SIZE, AND SYSTEM COST. NUMEROUS APPLICATIONS TO A BROAD SPECTRUM OF DEFENSE AND COMMERCIAL APPLICATIONS WOULD EXIST INCLUDING MATERIALS SCIENCE AND BIOLOGICAL MICROHOLOGRAPHY.

MEMISTOR CORP
860 LATHROP DR
STANFORD, CA 94305

CONTRACT NUMBER:
MARCIAN E HOFF JR

TITLE:

THOUSAND-OBJECT TRACKING WITH NEURAL NETS

TOPIC# 10

OFFICE:

IDENT#: 30494

NEW COMPUTATIONAL MEANS NEED TO BE DEVELOPED FOR THE PRACTICAL SOLUTION OF REAL-TIME TRACKING OF A THOUSAND OR MORE SPACE-BORNE OBJECTS AT ONE TIME. IT IS ASSUMED THAT, DURING AN ENGAGEMENT, DATA WOULD ARRIVE FROM A NUMBER OF SENSORS WHICH MAY BE LOCATED IN A NUMBER OF PLACES, OBSERVING OBJECTS IN SPACE WITH AND WITHOUT OVERLAPPING COVERAGE. THE SENSOR DATA WOULD BE FED TO COMPUTER EQUIPMENT DEDICATED TO THE TRACKING TASK, AND THE OUTPUT WOULD BE THE TIME HISTORIES OF DETECTED OBJECTS GIVING THEIR TRACK NUMBERS AND POSITIONS VERSUS TIME. CONVENTIONAL COMPUTERS CANNOT PERFORM THE TRACKING FUNCTION AT REAL-TIME RATES WITH A LOAD OF A THOUSAND OR MORE OBJECTS TO TRACK. MANY OF THE FUNCTIONS CAN BE DONE WITH NEURAL NETWORKS THAT CAN BE IMPLEMENTED IN A HIGHLY PARALLEL STRUCTURE. SYSTEM ARCHITECTURE IS BEING DEVELOPED TO IMPLEMENT THIS TRACKING APPROACH. EFFECTS OF SENSOR NOISE AND SENSOR SIGNAL QUANTIZATION ON PROBABILITIES OF FALSE TRACK INITIATION AND LOSING A TRACK ARE BEING DETERMINED. A PRELIMINARY HARDWARE DESIGN IS BEING UNDERTAKEN FOR THE TRACKING APPROACH. WHEN SUCCESSFUL, THIS RESEARCH WOULD LEAD TO THE DESIGN OF A PRACTICAL, RELIABLE, ECONOMICAL SYSTEM FOR REAL-TIME SIMULTANEOUS TRACKING OF A THOUSAND PLUS SPACE-BORNE OBJECTS. SOLUTION OF THIS PROBLEM ALSO WOULD ADDRESS THE NATION'S TRACKING PROBLEM IN THE AIR TRAFFIC CONTROL AREA.

METSAT INC
515 S HOWES ST
FORT COLLINS, CO 80521

CONTRACT NUMBER:
DR EDWARD TOMLINSON

TITLE:

ULTRAFAST ALGORITHMS FOR REAL-TIME DETECTION AND CHARACTERIZATION OF CLOUDS

TOPIC# 1

OFFICE:

IDENT#: 30154

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THE MICROPHYSICAL PROPERTIES OF CLOUDS AND THE MORPHOLOGY OF CLOUD FIELDS CAN HAVE SIGNIFICANT DETRIMENTAL EFFECTS ON THE SUCCESSFUL OPERATION OF A BALLISTIC MISSILE DEFENSE SYSTEM. A DETAILED FEASIBILITY STUDY IS BEING UNDERTAKEN OF DUAL VERY LARGE SCALE AND MEDIUM SCALE INTEGRATED CIRCUIT TECHNOLOGY BASED ULTRAFAST ALGORITHM IMPLEMENTATIONS FOR THE DETECTION AND CHARACTERIZATION OF CLOUDS. THE FEASIBILITY IS BEING DETERMINED OF INTEGRATING THE ABOVE IMPLEMENTATIONS INTO EXISTING COMPUTER ARCHITECTURES FOR STRATEGIC DEFENSE. THE FEASIBILITY IS BEING INVESTIGATED OF AUTOMATING THE DATA INGEST AND DATA ALIGNMENT FROM SENSORS TO ENHANCE THE SENSOR TIME RESPONSE. PRELIMINARY STRATEGIES ARE BEING DEVELOPED FOR VALIDATING AND TESTING SUCH ULTRAFAST ALGORITHM IMPLEMENTATIONS. BENEFITS, WHEN SUCCESSFULLY DEVELOPED, INCLUDE REAL-TIME INFORMATION ABOUT THE LOCATION AND CHARACTER OF CLOUD, SUCH AS OPTICAL THICKNESS. IMAGE PROCESSING APPLICATIONS INVOLVING PATTERN RECOGNITION AND IMAGE UNDERSTANDING WOULD EXIST, INCLUDING APPLICATIONS IN THE AIRCRAFT INDUSTRY FOR CLOUD DEPICTION, THE MEDICAL INDUSTRY, AND COMPUTER AIDED MANUFACTURING.

MICRO-OPTICS TECHNOLOGIES INC
8608 UNIVERSITY GREEN - #5
MIDDLETON, WI 53562
CONTRACT NUMBER:
DR JEFFREY C BUCHHOLZ

TITLE:
CURRENT INJECTION PUMPING OF ORGANIC LIGHT EMITTERS
TOPIC# 11 OFFICE: IDENT#: 30497

THE FEASIBILITY IS BEING DETERMINED OF THIN FILMS OF ORGANIC SEMICONDUCTORS AS POTENTIAL CURRENT PUMPED LIGHT EMITTERS FOR LIGHT EMITTING DIODE AND LASER DIODE APPLICATIONS. THE POTENTIAL IS BEING EXPLORED OF METAL-PHTHALOCYANINE ORGANIC SEMICONDUCTOR MATERIALS FOR LIGHT EMITTERS WITH EMISSION WAVELENGTHS TUNABLE BY CHEMICAL MODIFICATION. THE FILMS ARE BEING PREPARED BY VACUUM SUBLIMATION UNDER ULTRA-HIGH VACUUM CONDITIONS. BECAUSE OF THE MOLECULAR BEAM EPITAXY TYPE DEPOSITION, DEVICES CAN BE FORMED IN WHICH MODULATION OF MATERIALS PROPERTIES ARE ANTICIPATED TO BE INTRODUCED BY VARYING THE TYPE OF METAL-PHTHALOCYANINE (MIXED CENTRAL METAL ATOMS) OR BY INTRODUCING DO-

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PANTS FROM THE GAS PHASE. THE IMPETUS FOR THIS WORK IS THE POTENTIAL FOR AN EXPANSION OF THE TUNABILITY OF THE OPTICAL EMITTERS ELECTRICALLY PUMPED ON THE SIZE SCALE OF A LIGHT EMITTING DIODE OR LASER DIODE AND WITH IMPROVED MATERIALS COMPATIBILITY WITH OTHER INTEGRATED OPTICS MATERIALS. ORGANIC MATERIALS AS LIGHT EMITTING DEVICES ARE ANTICIPATED TO HAVE CHEMICAL TUNABILITY AND TO BE SUITABLE FOR USE ON FOREIGN SUBSTRATES THAT DO NOT TOLERATE HIGH TEMPERATURE PROCESSING. IT IS ANTICIPATED THAT SUCH DEVICES WOULD HAVE APPLICATION AS INTEGRATED OPTICAL COMPONENTS.

MISSION RESEARCH CORP
127 EASTGATE DR - STE 208
LOS ALAMOS, NM 87544

CONTRACT NUMBER:

DR MARK J SCHMITT

TITLE:

FREE-ELECTRON LASER PERFORMANCE ENHANCEMENT WITH HELICAL WIGGLERS

TOPIC# 1

OFFICE:

IDENT#: 30258

FREE ELECTRON LASERS (FEL) EMPLOYING HELICALLY POLARIZED WIGGLERS COULD PROVIDE HIGHER GAIN AND MUCH LOWER HARMONIC RADIATION OUTPUT THAN THOSE EMPLOYING LINEARLY POLARIZED WIGGLERS. THREE-DIMENSIONAL FEL COMPUTER CODES ARE BEING MODIFIED TO PERFORM A SIDE-BY-SIDE COMPARISON OF HELICAL AND LINEARLY POLARIZED FEL CONFIGURATIONS. THIS COMPARISON INCLUDES FUNDAMENTAL CONVERSION EFFICIENCY, GAIN, POWER AT THE HARMONIC FREQUENCIES, AND OTHER PARAMETERS RELEVANT TO HIGH-POWER FEL OPERATION. THE IMPACT IS BEING ASSESSED OF HELICAL WIGGLER GEOMETRY ON WIGGLER LENGTH AND HARMONIC GENERATION FOR HIGH-POWER FEL DESIGNS. EXISTING COMPUTER CODES ARE BEING USED AND MODIFIED AS REQUIRED TO ADDRESS THE HELICAL WIGGLER PROBLEM. FINITE-DIFFERENCE AND CHARGE-SHEET EQUIVALENT MAGNETIC FIELD CODES ARE BEING USED TO EXAMINE NOVEL HELICAL PERMANENT MAGNET GEOMETRIES TO DETERMINE WHAT STRENGTH HELICAL FIELD CAN BE ACHIEVED. WHEN SUCCESSFULLY DEMONSTRATED, THE HELICAL WIGGLER IS EXPECTED TO BE SHORTER THAN A LINEARLY POLARIZED WIGGLER WITH EQUIVALENT GAIN AND, THUS, WOULD PRODUCE A MORE COMPACT FEL AND RELAX VIBRATIONAL AND ALIGNMENT TOLERANCES. ELECTRON AND OPTICAL BEAM SCRAPING INSIDE THE WIGGLER ALSO WOULD RADIATE MUCH LESS HARMONIC POWER; THIS CHARACTERISTIC WOULD ELIMINATE THE NEED FOR HARMONIC SCRUBBING IN HIGH-POWER APPLICATIONS AND REDUCE THE COST

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(AND EXTEND THE LIFETIME) OF THE OPTICAL SYSTEMS IN MEDICAL AND
COMMERCIAL APPLICATIONS.

NORTH STAR RESEARCH CORP
555 ZUNI SE - STE 345
ALBUQUERQUE, NM 87108
CONTRACT NUMBER:
DR RICHARD ADLER
TITLE:
ELECTRON GUN DEVELOPMENT
TOPIC# 1 OFFICE:

IDENT#: 30347

EXISTING ELECTRON GUN TECHNOLOGY CANNOT PROVIDE THE COMBINATION OF
HIGH CURRENT, HIGH BRIGHTNESS AND LONG LIFE THAT IS ESSENTIAL FOR
MAJOR STRATEGIC DEFENSE FREE ELECTRON LASER (FEL) DEMONSTRATIONS. THE
FEASIBILITY OF MEETING THESE REQUIREMENTS IS BEING INVESTIGATED
THROUGH THE DEMONSTRATION OF ADVANCED CATHODES INCLUDING CONTROLLED
POROSITY DISPENSER CATHODES AND M-TYPE, POROUS TUNGSTEN DISPENSER
CATHODES WHICH OFFER HIGH CURRENT DENSITY AND LONG LIFE, AND ADVANCED
ELECTRON GUN DESIGN TECHNIQUES WHICH FACILITATE EXTRACTION OF HIGH
CURRENT, HIGH BRIGHTNESS BEAMS. SCALABLE HIGH CURRENT DENSITY (UP TO
100 A/CM²) CATHODES UP TO 5 CM DIAMETER ARE BEING CONSTRUCTED.
ELECTRON GUN DESIGNS AND CONSTRUCTION TECHNIQUES ARE BEING DEVELOPED
THAT CAN TAKE BEST ADVANTAGE OF THE SUPERIOR EMISSION CHARACTERISTICS
OF HIGH CURRENT DENSITY CATHODES, TO FORM HIGH CURRENT, HIGH BRIGHT-
NESS BEAMS. EXPERIMENTS USING A 1.7 MEV, 2 KA ACCELERATOR TEST BED
ALSO BEING PERFORMED TO TEST AND EVALUATE HIGH BRIGHTNESS ELECTRON GUN
DESIGN CONCEPTS. WHEN SUCCESSFUL, THIS PROGRAM WILL FORM THE BASIS
FOR SUBSTANTIAL IMPROVEMENTS IN DIRECTED ENERGY CONCEPTS INCLUDING
HIGH-BRIGHTNESS INJECTORS FOR FELS, HIGH-CURRENT DENSITY LARGE-AREA
CATHODES FOR EXCIMER LASERS AND RELIABLE HIGH CURRENT ELECTRON GUNS
FOR HIGH POWER CHARGED PARTICLE BEAM DEVICES. INDUSTRIAL APPLICATIONS
INCLUDE INDUCTION AND RADIO FREQUENCY ACCELERATORS, MICROWAVE SOURCES,
AND ADVANCED THYRATRONs.

NSPACE
1049 - N 3RD/STE 602
ABILENE, TX 79601
CONTRACT NUMBER:
DR JIM WILSON
TITLE:
SPACE STRUCTURE VIBRATION CONTROL
TOPIC# 12 OFFICE:

IDENT#: 30079

SUBMITTED BY

CURRENT CONCEPTS FOR THE DESIGN OF LARGE SPACE STRUCTURES GENERALLY INVOLVE LARGE DIMENSION TRUSS STRUCTURES THAT REQUIRE VIBRATION CONTROL SYSTEMS TO SUPPRESS MOTION. SEVERAL OF THE DIFFICULTIES IN THE DESIGN OF ACTIVE/REACTIVE CONTROL SYSTEMS COULD BE AVOIDED IF THE CONTROLLED STRUCTURE PROVIDED DETERMINISTIC REPEATABLE PASSIVE DAMPING AT HIGH LEVELS. THE FEASIBILITY OF DEVELOPING AN OPTIMAL CONTROL APPROACH IS BEING INVESTIGATED. GROUND RULE REQUIREMENTS OF LARGE SPACE STRUCTURES FOR DAMPING ARE BEING ESTABLISHED. VARIOUS CONCEPTS FOR DAMPING TREATMENTS ARE BEING STUDIED. A CONFIGURATION TRADE IS BEING PERFORMED TO SELECT AN INTEGRATED DAMPER/STRUCTURE ELEMENT USING A VISCOUS HYDRAULIC DAMPING ELEMENT. DEVICES OF THIS TYPE PREVIOUSLY HAVE BEEN DEVELOPED AND SPACE QUALIFIED AND HAVE DEMONSTRATED LINEAR DETERMINISTIC DAMPING RATES OVER A WIDE RANGE OF TEMPERATURE AND INPUT AMPLITUDE AND FREQUENCY. VARIOUS IMPLEMENTATIONS OF ACTIVE VIBRATION CONTROL ACTUATORS ARE BEING EVALUATED. AN OPTICAL CONTROL APPROACH FOR THE LARGE SPACE STRUCTURE IS BEING DETERMINED AND AN APPROPRIATE TEST PLAN IS BEING GENERATED. NEAR TERM APPLICATIONS INCLUDE POTENTIALLY THE SPACE STATION, SPACE BASED RADAR, AND VARIOUS COMPONENTS OF A SPACE-BASED STRATEGIC DEFENSE SYSTEM AS WELL AS COMMERCIAL SATELLITES.

ORTEL CORP
2015 W CHESTNUT ST
ALHAMBRA, CA 91803
CONTRACT NUMBER:
DR KAM Y LAU
TITLE:
ULTRA-LOW THRESHOLD LASER DIODES BAND STRUCTURE ENGINEERING
TOPIC# 14 OFFICE: IDENT#: 30662

ULTRA-LOW THRESHOLD LASER DEVICES WITH LASING THRESHOLDS IN THE SUB-MILLIAMPERE, AND PREFERABLY IN THE MICROAMPERE RANGE, ARE VERY IMPORTANT FOR THE IMPLEMENTATION OF INTEGRATED OPTOELECTRONICS AND COMPUTER OPTICAL INTERCONNECTS FOR FUTURE SUPERCOMPUTERS. A MEAN TO ACCOMPLISH MICROAMPERE THRESHOLD LASERS IS THROUGH THE USE OF STRAINED QUANTUM WELL LAYERS TO REDUCE THE EFFECTIVE HOLE MASS THEREBY LEADING TO DESIRABLE PROPERTIES. SUITABLE MATERIALS ARE BEING INVESTIGATED FOR PRODUCING THE DESIRED BAND STRUCTURE LEADING TO SUCH AN ULTRA-LOW

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THRESHOLD LASER. THE BASIC MATERIALS CENTER AROUND THE TERNARY ALLOYS GALLIUM-ALUMINUM-ARSENIDE AND INDIUM-GALLIUM-ARSENIDE. THE MATERIAL MUST BE ABLE TO GROW ON GaAs SUBSTRATE, WITH THE LATTICE CONSTANTS SO ARRANGED THAT WILL PRODUCE STRAIN IN THE CORRECT DIRECTION. BAND STRUCTURE CALCULATIONS ARE BEING UNDERTAKEN FOR THEORETICAL STUDY OF SUITABLE MATERIALS. POSSIBLE MATERIALS ARE BEING IDENTIFIED SO THAT SUBSEQUENT EXPERIMENTAL WORK CAN BE PERFORMED USING A METAL ORGANIC CHEMICAL VAPOR DEPOSITION SYSTEM (MOCVD), WITH THE ULTIMATE GOAL OF ACTUALLY FABRICATING LASERS WITH THRESHOLDS IN THE MICROAMPERE RANGE.

P.E.R.

1120 N PATTERSON AVE
SANTA BARBARA, CA 93111

CONTRACT NUMBER:

DR AVNER AMIR

TITLE:

COMPACT HIGH-POWER COHERENT FAR-INFRARED RADIATION SOURCE

TOPIC# 1

OFFICE:

IDENT#: 30665

A CERENEKOV-TYPE FREE ELECTRONLASER (FEL) DRIVEN BY A LOW-VOLTAGE (1-2 MEV) ACCELERATOR WITH A BEAM RECOVERY SYSTEM HAS THE POTENTIAL TO ADDRESS STRATEGIC DEFENSE NEEDS FOR BROAD-BAND RADAR AND COMMUNICATION TRANSMITTERS. CERENEKOV LASERS SUFFER FROM A TYPICALLY VERY LOW GAIN WHICH HAS RESTRICTED THEIR OPERATION, WHEN USING LOW ENERGY SOURCES, TO THE MILLIMETER OR LONGER WAVELENGTHS RANGE. MECHANISMS FOR ENHANCING THE GAIN OF A CERENEKOV-TYPE FEL AT LOW ENERGIES (LESS THAN 2 NEW) AND SHORT WAVELENGTHS (LONGER THAN 75 MICROMETERS) ARE BEING INVESTIGATED. A COMPACT DEVICE IS BEING DEVELOPED THAT IS EXPECTED TO OPERATE IN THE 75-1000 MICROMETERS RANGE AT OUTPUT POWERS OF 1-400 KW. ELECTROOPTICAL MODULATION OF THE REFRACTIVE INDEX OF THE DIELECTRIC MATERIAL IS BEING USED FOR FAST FREQUENCY TUNING. SPECIFICALLY, THEORETICAL RESEARCH AND COMPUTER SIMULATIONS RELEVANT TO THE DEVICE CONFIGURATION ARE BEING PERFORMED. THE ISSUES OF A 3-DIMENSIONAL OPTICAL MODE STRUCTURE ARE BEING ADDRESSED THAT WILL OPTIMIZE THE GAIN AND REDUCE THE LOSSES. ELECTRON BEAM TRANSPORT, RESONATOR DESIGN AND OUTPUT COUPLING, PERFORMANCE OF ELECTRON BEAM SOURCES, AND ELECTRO-OPTICAL PROPERTIES OF THE SEMICONDUCTOR COMPONENTS ARE BEING EXPLORED. POTENTIAL APPLICATIONS FOR COHERENT HIGH-POWER SOURCES IN THE MILLIMETER AND FAR-INFRARED REGION INCLUDE RADAR AND

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COMMUNICATIONS TRANSMITTERS AND SCIENTIFIC AND MEDICAL
INSTRUMENTATION.

PACIFIC APPLIED RESEARCH
6 CRESTWIND DR
RAN. PALOS VERDES, CA 90274
CONTRACT NUMBER:
DR WALTER R WARREN JR
TITLE:
PULSED HIGH-FREQUENCY OVERTONE CHEMICAL LASER STUDIES
TOPIC# 1 OFFICE: IDENT#: 30747

OPERATION OF HYDROGEN FLUORIDE(HF) CHEMICAL LASERS ON OVERTONE
TRANSITIONS (OTS) HAS THE PROMISE OF LEADING TO EFFICIENT, HIGH POWER
LASER DEVICES AT SHORT WAVELENGTHS. AN OT LASER EXPERIMENTAL STUDY
IN A PHOTOLYTICALLY INITIATED PULSED LASER IS BEING UNDERTAKEN. THIS
APPROACH IS ANTICIPATED TO REMOVE TWO CONTINUOUS WAVE (CW) OT EXPERI-
MENTAL LIMITATIONS: SHORT SINGLE-DEVICE GAIN LENGTH AND MEDIUM NON-
UNIFORMITY. THUS THE APPROACH IS EXPECTED TO ALLOW THE UNAMBIGUOUS
STUDY OF ISSUES ASSOCIATED WITH OT LASERS WITH THEIR LOW ZERO POWER
GAIN. THIS WOULD INCLUDE ACCURATE EXPERIMENTAL COMPARISONS OF THE
PERFORMANCE CHARACTERISTICS (LOW POWER THROUGH HIGHLY SATURATED) OF
A PULSED HF CHAIN REACTION CHEMICAL LASER WHEN OPERATING ONLY ON
FUNDAMENTAL TRANSITIONS ($\Delta V=1$) AND ONLY ON FIRST OVERTONE
TRANSITIONS ($\Delta V=2$), AND EXPERIMENTALLY DETERMINE RESONATOR
LENGTH LIMITATIONS ON OT PULSED LASER OPERATION CAUSED BY SUPER
RADIANT LASING OF THE FUNDAMENTAL TRANSITION MECHANISM. IN THE CUR-
RENT EFFORT, THE DETAILED DEVELOPMENT OF THE TEST CAPABILITIES IS
BEING UNDERTAKEN, INCLUDING IDENTIFICATION OF TEST SERIES GROUPS AND
DESIGN OF THE LASER TEST FACILITY, AND DIAGNOSTIC SYSTEMS,
INSTRUMENTS, AND TECHNIQUES.

PDA ENGINEERING
2975 REDHILL AVE
COSTA MESA, CA 92626
CONTRACT NUMBER:
JOHN M BORDER
TITLE:
PERMANENT LUBRICANTS FOR METALS AND NON-METALS
TOPIC# 13 OFFICE: IDENT#: 30663

SUBMITTED BY

IN MANY APPLICATIONS, PERMANENT LUBRICANTS ARE DESIRABLE THAT ARE CAPABLE OF OPERATING AT HIGH TEMPERATURES AND PRESSURES, WHILE PROVIDING A LOW COEFFICIENT OF FRICTION AND EXHIBITING A HIGH DEGREE OF DURABILITY, THAT IS SUITABLE FOR USE IN SELF-LUBRICATING BEARINGS AND SURFACES. WHILE MANY LUBRICANTS PRODUCE VERY LOW COEFFICIENTS OF FRICTION, BOUNDARY LUBRICANTS GENERALLY HAVE SHORT USABLE LIFETIMES. THE FEASIBILITY IS BEING EXAMINED OF AN APPROACH THAT EFFECTIVELY BONDS THE LUBRICANT TO THE SURFACE. TWO LUBRICANTS ARE BEING INVESTIGATED: ONE DESIGNED FOR USE ON METAL SURFACES; THE OTHER ON NON-METAL SURFACES. BOTH LUBRICANTS ARE BASED ON FLUOROCARBON MATERIALS WHICH ARE BEING MODIFIED SO THAT THE LUBRICANT FORMS A STRONG BOND TO THE SURFACE. PROCESS CONDITIONS ARE BEING DEVELOPED FOR APPLYING EACH LUBRICANT TO THE APPROPRIATE SURFACE, AND THE APPLIED LUBRICANT SPAN A DIVERSE RANGE OF DEFENSE, SPACE, AND COMMERCIAL AREAS. BESIDES DECREASING WEAR, THE LUBRICANT WOULD DECREASE CONTAMINATION FROM LUBRICANTS AND INCREASE THE PRECISION POSSIBLE IN BEARINGS. OTHER APPLICATION INCLUDE LUBRICATION OF DIFFICULT MATERIALS, LUBRICATION OF LARGE AREAS, AND USE AS AN OIL ADDITIVE.

PDA ENGINEERING
2975 REDHILL AVE
COSTA MESA, CA 92626
CONTRACT NUMBER:
DR RONALD E ALLRED
TITLE:
STRUCTURE-PROPERTY RELATIONSHIPS IN CERAMIC COMPOSITES FROM SOL-G
TOPIC# 13 OFFICE: IDENT#: 30664

THE CONSIDERABLE POTENTIAL OF CERAMIC MATRIX COMPOSITES HAS NOT BEEN REALIZED PRIMARILY BECAUSE OF DIFFICULTIES IN PROCESSING THESE MATERIALS INTO HIGH QUALITY STRUCTURES. A VARIATION ON PREVIOUS SOL-GEL APPROACHES IS BEING INVESTIGATED THAT SHOULD RESULT IN MINIMAL SHRINKAGE (NET-SHAPE) PROCESSING AT SIGNIFICANTLY LOWER TEMPERATURES THAN CONVENTIONAL PROCESSES. THE APPROACH IS EXPECTED TO BE APPLICABLE TO MOST GLASS, GLASS-CERAMIC AND CERAMIC MATRIX MATERIALS OF INTEREST WITH ANY FIBER GEOMETRY. BOTH LOW AND HIGH DENSITY MATERIALS WITH HIGH STRENGTH, STIFFNESS AND FRACTURE TOUGHNESS ARE ANTICIPATED TO BE FABRICATED WITH THIS SOL-GEL PROCESS. THE FEASIBILITY OF THE PROCESS

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IS BEING DEMONSTRATED ON TWO MODEL CERAMIC COMPOSITE SYSTEMS: FUSED SILICA FIBERS IN A SILICA MATRIX AND SILICA FIBERS IN A MULLITE MATRIX. THE SILICA-MULLITE SYSTEM IS THE MORE COMPLEX AND REPRESENTATIVE FIBER SURFACE CHEMISTRY FOR STUDYING INTERFACE ADHESION. COMPOSITES ARE BEING FABRICATED WITH BOTH SYSTEMS AND EVALUATED AT VARIOUS STAGES OF THE COMPOSITE AEROGEL-INFILTRATION PROCESS. THERMAL STABILITY, SHRINKAGE, MICROSTRUCTURE, AND MECHANICAL PROPERTIES ARE BEING EVALUATED. SUCCESSFUL DEVELOPMENT OF THIS NET-SHAPE SOL-GEL PROCESS WOULD LEAD TO A VARIETY OF CERAMIC MATRIX COMPOSITE MATERIALS FOR HIGH TEMPERATURE, OXIDATION, CORROSION AND WEAR RESISTANT SPECIALTY APPLICATIONS.

PHOTON RESEARCH ASSOCS INC
1033 MASSACHUSETTS AVE
CAMBRIDGE, MA 02138
CONTRACT NUMBER:
DR JAMES E KEAT
TITLE:
ORDER N ALGORITHMS FOR MULTIBODY DYNAMICS SIMULATIONS
TOPIC# 12 OFFICE: IDENT#: 30667

ORDER "N" ($O(N)$) ALGORITHMS ARE AN IMPORTANT NEW AREA OF RESEARCH IN MULTIBODY DYNAMICS BECAUSE OF THEIR POTENTIAL FOR PRODUCING COMPUTER PROGRAMS OF GREATLY INCREASED RUNNING SPEED. $O(N)$ ALGORITHMS ARE BEING INVESTIGATED IN TWO AREAS. FIRST, A PREVIOUSLY DEVELOPED $O(N)$ ALGORITHM BEING REFINED AND TESTED. THIS ALGORITHM IS APPLICABLE TO SYSTEMS OF RIGID OR FLEXIBLE BODIES WITH OPEN CHAIN, TREE, OR CLOSED-LOOP INTERCONNECTION TOPOLOGY. THE INTERCONNECTION JOINTS CAN HAVE AN ARBITRARY NUMBER OF DEGREES OF FREEDOM BETWEEN 0 AND 6. SECOND, THE FEASIBILITY IS BEING DETERMINED OF EXTENDING THE $O(N)$ ALGORITHM TO ENCOMPASS INTERBODY MASS FLOW, A PHENOMENA PREVALENT WHEN MODELING THE DEPLOYMENT DYNAMICS OF LARGE SPACE ANTENNAS. THE DETAILS OF A TECHNIQUE FOR ACCOMPLISHING THIS EXTENSION ARE BEING DEVELOPED. THE SUCCESSFUL DEMONSTRATION OF $O(N)$ ALGORITHMS WOULD GREATLY DECREASE THE RUNNING TIME REQUIRED FOR SIMULATING THE DYNAMICS OF SPACECRAFT AND OTHER COMPLEX SYSTEMS WITH LARGE NUMBERS OF INTERCONNECTED BODIES.

PHYSICAL OPTICS CORP
2545 - W 237TH ST/STE B
TORRANCE, CA 90505
CONTRACT NUMBER:
DR WILLIAM PHILLIPS
TITLE:
INTEGRATED OPTIC MODULE BASED ON WAVEGUIDE MATERIAL WITH SWITCHAB
PHOTOREFRACTIVE SENSITIVITY
TOPIC# 11 OFFICE: IDENT#: 30670

SUBMITTED BY

A FUNDAMENTAL IMPROVEMENT OF MONOLITHIC OPTOELECTRONIC INTEGRATED SYSTEMS IS BEING INVESTIGATED USING PHOTOCROMIC AND PHOTOREFRACTIVE WAVEGUIDE LITHIUM NIOBATE (LiNbO_3) MATERIAL WITH SWITCHABLE PHOTOREFRACTIVE SENSITIVITY. THE NEW MATERIAL IS CRYSTALLINE LiNbO_3 WITH ONE OF TWO DOPING COMBINATIONS: Fe-Mn OR Fe-Mo. THESE COMBINATIONS HAVE TWO DISTINCT DYNAMIC STATES: READ-ONLY AND WRITE-SENSITIZED. THE WRITE-SENSITIZED STATE IS DIRECTLY COMPARABLE TO CONVENTIONAL Fe-DOPED PHOTO-REFRACTIVE MATERIAL, WHEREAS THE READ-ONLY STATE HAS LOW OPTICAL ABSORPTION AND IS RESISTANT TO THE BUILD-UP OF SPURIOUS SCATTERING. THE SENSITIZED STATE CAN BE "TURNED ON" USING INCOHERENT ULTRAVIOLET RADIATION AND "TURNED OFF" USING NONCOHERENT VISIBLE RADIATION. IN ADDITION, A FUNDAMENTAL IMPROVEMENT IS CONVENTIONAL (PASSIVE) LiNbO_3 WAVEGUIDES IS BEING DEVELOPED BY MAKING USE OF Mo DOPING. THESE WAVEGUIDES ARE EXPECTED TO HAVE SIGNIFICANTLY LOWER SCATTERING AND LASER DAMAGE THRESHOLD THAN CONVENTIONAL UNDOPED LiNbO_3 WAVEGUIDE MATERIAL. FURTHERMORE, THE P2 DOPING TECHNIQUE COULD BE INCORPORATED IN LOCALIZED REGIONS OF THE IMPROVED WAVEGUIDES. THE TECHNOLOGY RESULTING FROM THIS RESEARCH, WHEN SUCCESSFUL, WOULD SIGNIFICANTLY IMPROVE THE OPTICAL PERFORMANCE OF A WHOLE FAMILY OF LiNbO_3 INTEGRATED OPTIC AND ELECTROOPTIC DEVICES, AND OPTOELECTRONIC CIRCUITS.

PHYSICAL SCIENCES INC
PO BOX 3100 - RESEARCH PK
ANDOVER, MA 01810
CONTRACT NUMBER:
DR CHRISTOPHER J ROLLINS
TITLE:
FABRICATION TECHNIQUE FOR SUPERCONDUCTING FILMS
TOPIC# 15 OFFICE: IDENT#: 30206

THE FEASIBILITY IS BEING EXPLORED OF DEVELOPING A FILM FABRICATION SYSTEM WHICH WOULD YIELD LARGE AREA UNIFORM FILMS OF HIGH T_c SUPERCONDUCTORS. A HIGH FLUX PULSED ATOMIC BEAM SOURCE RECENTLY HAS BEEN DESIGNED, BUILT, AND SUCCESSFULLY DEMONSTRATED. THIS UNIQUE FACILITY HAS BEEN USED TO SIMULATE THE EROSION OF SPACECRAFT MATERIALS UNDER EXPOSURE TO HIGH VELOCITY OXYGEN ATOM ENVIRONMENTS LIKE THOSE EXPERIENCED BY ORBITAL VEHICLES. WHEN THE OXYGEN FEED GAS IS SUPPLE-

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MENTED BY OTHER SUITABLE MATERIALS, THIS DEVICE HAS THE POTENTIAL TO FUNCTION AS A HIGH FLUX, HIGH UNIFORMITY, WIDE AREA DEPOSITION SOURCE. SUCH DEPOSITION ALREADY HAS BEEN OBSERVED FROM CARBON AND ALUMINUM DURING THE OXYGEN ATOM STUDY. BY CHOOSING APPROPRIATE METAL AND METAL-OXIDE SOURCE MATERIALS AND AN OXYGEN FEED GAS, THE DEVICE IS EXPECTED TO FUNCTION AS A GENERIC METAL OXIDE DEPOSITION SOURCE. THE FEASIBILITY IS BEING INVESTIGATED ON USING THIS DEVICE TO DEPOSIT FILMS ON CUPRATE PEROVSKITE AND SIMILAR HIGH T_c OXIDE SUPERCONDUCTORS. SINCE THE APPARATUS IS INHERENTLY A WIDE AREA ATOM BEAM SOURCE, THE RESULTING FILMS ARE ANTICIPATED TO BE HIGHLY UNIFORM. THE ABILITY TO PRECISELY CONTROL ATOM VELOCITIES, TEMPERATURES, SUBSTRATE TEMPERATURE, AMBIENT ATOMSPHERE, AND GROWTH RATE WOULD ALLOW TAILORING OF THE PROCESS TO FAVOR SINGLE PHASE GROWTH, THUS PRODUCING STABLE FILMS AND POTENTIALLY ELIMINATING THE NEED FOR ANNEALING OR OTHER POST FABRICATION PROCESSING.

PHYSICAL SCIENCES INC
PO BOX 3100 - RESEARCH PK
ANDOVER, MA 01810
CONTRACT NUMBER:
STEVEN J DAVIS
TITLE:
GROUP IV-A FLUORIDE TRANSFER LASERS
TOPIC# 1 OFFICE: IDENT#: 30208

A STUDY IS BEING CONDUCTED TO DETERMINE WHETHER A RECENTLY OBSERVED EFFICIENT ENERGY TRANSFER PROCESS FROM ACTIVE N₂ TO EXCITED STATES IN SIF ALSO OCCURS IN THE MORE ATTRACTIVE LASER CANDIDATES: GEF, SNF, AND PBF. SINCE ACTIVE N₂ MAY BE THE FINAL PRODUCT OF VARIOUS CHEMICAL NITROGEN GENERATORS, EFFICIENT ENERGY TRANSFER TO GROUND STATE GROUP IV-A FLUORIDE MOLECULES COULD LEAD TO A VISIBLE CHEMICAL LASER SYSTEM. THIS EFFORT FOCUSES UPON DETERMINING THE RELATIVE ENERGY TRANSFER EFFICIENCIES TO THE POTENTIAL UPPER LASER LEVELS OF THESE SPECIES. SURVEY EXPERIMENTS ARE BEING CONDUCTED TO MEASURE THE ENERGY TRANSFER EFFICIENCY FROM ACTIVE N₂ TO THE A₂ SIGMA+ STATES OF GEF, SNF, AND PBF. GROUND STATE MOLECULES ARE BEING ADDED TO A FLOW OF ACTIVE NITROGEN AND STANDARD CHEMILUMINESCENCE TECHNIQUES ARE BEING USED TO MEASURE THE NUMBER DENSITY OF A₂ SINGMA+ PRODUCED. EFFICIENT PRODUCTION OF THESE EXCITED STATES WOULD BE A VERY SIGNIFICANT RESULT

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BECAUSE OF THE POTENTIAL FOR RECYCLING GROUND STATE MF MOLECULES. IF ONE MF MOLECULE COULD BE USED SEVERAL TIMES IN THE LASER CAVITY THEN THE OVERALL MASS EFFICIENCY WOULD BE PRIMARILY DRIVEN BY THE N2* GENERATOR CHEMISTRY. SUCCESSFUL COMPLETION OF THIS PROGRAM WOULD CONSTITUTE A PROOF OF PRINCIPLE FOR AN ENTIRELY NEW CLASS OF THREE LEVEL MOLECULAR LASERS THAT HAVE POTENTIAL FOR DEVELOPMENT INTO SHORT WAVELENGTH CHEMICAL LASER SYSTEMS.

PHYSICAL SCIENCES INC
PO BOX 3100 - RESEARCH PK
ANDOVER, MA 01810
CONTRACT NUMBER:
DR DUJ WEYL
TITLE:
RAPID PLASMA FORMATION
TOPIC# 8 OFFICE:

IDENT#: 30210

HARDENING STRUCTURES TO HIGH ENERGY REPETITIVELY PULSED OR CONTINUOUS WAVE LASER THREATS REQUIRES MATERIALS OR COATINGS THAT CAN ABSORB OR REFLECT SIGNIFICANT AMOUNTS OF ENERGY WITH SMALL LOSSES OF MATERIAL. A NOVEL COATING IS BEING INVESTIGATED THAT WOULD IGNITE PLASMA AT LOW LASER POWER DENSITIES AND FLUENCES. THIS COATING, ONCE IGNITED, IS EXPECTED TO RADIATE A SIGNIFICANT AMOUNT OF ENERGY INTO SPACE, SHIELD THE SURFACE FROM LASER RADIATION, AND POSSESS A GREATER ENTHALPY THAN IN THE NON-PLASMA REGIME. SUCH A COATING WOULD BE DESIGNED TO HARDEN A SURFACE TO LASER THREATS. IN THE WORK, THE PROBLEM OF WHAT IS THE LOWEST THRESHOLD FOR PLASMA IGNITION DUE TO LASER IRRADIATION IS BEING ADDRESSED. COATINGS THAT ARE EXPECTED TO MEET THIS CRITERION ARE BEING STUDIED. THIS WOULD PROVIDE LIMITS ON THE HARDENABILITY OF SURFACES TO LASER THREATS.

REFRACTORY COMPOSITES INC
12220-A RIVERA RD
WHITTIER, CA 90606
CONTRACT NUMBER:
E L PAQUETTE
TITLE:
CERAMIC MATRIX COMPOSITE REACTOR/RADIATOR ARMOR STRUCTURES
TOPIC# 4 OFFICE:

IDENT#: 30516

SUBMITTED BY

THE NEED EXISTS TO DEVELOP STIFF, LIGHT SPACE STRUCTURES THAT CARRY LOADS AND ALSO ACT AS ARMOR TO SHIELD MORE SENSITIVE SYSTEMS AND COMPONENTS. THE FEASIBILITY IS BEING INVESTIGATED OF UTILIZING HIGH MODULUS (>100 MILLION PSI) GRAPHITE FIBERS AND MINIMUM DENSITY CERAMIC MATRICES CONSISTENT WITH ARMOR REQUIREMENTS (I.E., RESISTANCE TO KINETIC ENERGY, LASER, AND X-RAY THREATS). SEVERAL FAMILITES OF CERAMIC MATRIX COMPOSITES HAVE BEEN DEVELOPED, BASED PRINCIPALLY ON CHEMICAL VAPOR INFILTRATION PROCESS TECHNOLOGY. RECENT WORK HAS DEMONSTRATED THE POTENTIAL OF A HAFNIUM CARBIDE MATRIX, CARBON FILER REINFORCED COMPOSITE OF VERY THIN GAUGE (.030") TO STOP VERY HIGH VELOCITY (6 KM/SEC) PROJECTILES AND TO WITHSTAND SIGNIFICANT LASER HEATING. TWO DIFFERENT CERAMIC MATRIX COMPOSITES ARE BEING FABRICATED AND A BASELINE KINETIC ENERGY IMPACT TEST PERFORMED. WHEN SUCCESSFUL, SPACE STRUCTURES WOULD BE PROVIDED WITH AN INNOVATIVE CAPABILITY FOR REDUCING WEIGHT WHILE IMPROVING COMPONENT FABRICABILITY, REPRODUCIBILITY AND RELIABILITY.

REFRACTORY COMPOSITES INC

12220-A RIVERA RD
WHITTIER, CA 90606

CONTRACT NUMBER:

E L PAQUETTE

TITLE:

NITRIDE-BASED CERAMIC MATRIX COMPOSITES FOR ELECTROMAGNETIC RAIL
GUN INSULATORS

TOPIC# 2

OFFICE:

IDENT#: 30517

HIGH TEMPERATURES AND PRESSURES OF THE PLASMA BEHIND AN ELECTROMAGNETIC GUN PROJECTILE LEADS TO SPALLING FAILURE OF CURRENT GENERATION PARTICULATE BASED CERAMICS. CERAMIC MATRIX COMPOSITE INSULATORS BASED ON SILICON CARBIDE FIBERS AND A BORON OR SILICON NITRIDE MATRIX APPEAR TO BE POTENTIALLY THE IDEAL SOLUTION TO THIS MOMETARY HIGH ENERGY FLUX-INDUCED SPALLING FAILURE. HOWEVER, NO ENGINEERING PROPERTIES FOR EITHER MATERIAL ARE KNOWN FOR THE EXTREMELY HIGH RATE CONDITIONS THAT ARE AT WORK IN SUCH AN ENVIRONMENT. BORON NITRIDE AND SILICON NITRIDE MATRIX CERAMIC COMPOSITES ARE BEING FABRICATED, USING MULLITE AND SILICON CARBIDE FIBERS. AMBIENT AND ELEVATED TEMPERATURE RESISTIVITY ARE BEING DETERMINED. EARLY SAMPLES

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ARE BEING INSTALLED AND TESTED IN SEVERE ARC DAMAGE (POTENTIAL) AREA OF AN EXPERIMENTAL ELECTROMAGNETIC GUN TO DETERMINE THE INSULATOR ABLATION RESISTANCE OF THE NITRIDE-BASED CERAMIC MATRIX COMPOSITES. POST TEST INSPECTION AND DOCUMENTATION OF THE COMPONENTS IS BEING USED TO DEFINE FIBER ORIENTATION IMPROVEMENTS IF DEEMED NECESSARY AND TO AID SELECTION BETWEEN BORON NITRIDE AN SILICON NITRIDE CERAMIC MATRIX COMPOSITES.

RLS ENTERPRISES LTD
PO BOX 8175 - 1425 SEMINOLE/STE 310
CHARLOTTESVILLE, VA 22906
CONTRACT NUMBER:
MICHAEL D LOCKHART
TITLE:
INFRARED SENSOR AND IMAGING SYSTEM
TOPIC# 3 OFFICE: IDENT#: 30352

A METHOD IS BEING DEVELOPED USING LIQUID CRYSTALS (LC) FOR AN INFRARED (IR) DETECTOR THAT AFFORDS NON-CRYOGENIC, FAR IR IMAGING WITH HIGH SENSITIVITY, GOOD RESOLUTION AND LOW COST. THERMAL IMAGING IS EXPENSIVE BECAUSE THE DETECTORS, SCANNERS, CRYOGENICS AND LENSES ARE EXPENSIVE. THE LC METHOD REQUIRES ONLY AN EXPENSIVE LENS AND SOLVES A COST PROBLEM IMMEDIATELY. MAINTENANCE PROBLEMS ARE VIRTUALLY ELIMINATED AS THERE ARE NO MOVING PARTS REQUIRED IN THIS IR SYSTEM. LCS ARE WELL KNOWN AS TEMPERATURE SENSORS USED AS HUMAN THERMOMETERS, CIRCUIT COMPONENT TEMPERATURE INDICATORS, AND RADAR FIELD PATTERN TRANSDUCERS. IN THIS SYSTEM, EXTREMELY LOW POWER IS REQUIRED TO VIEW THE DISPLAY THROUGH A TYPE OF POLARIMETRY GENERATING HIGH CONTRAST. A THERMAL SCENE IS BEING IMAGED ONTO A VERY THIN FILM WHICH HOLDS AN LC FILM OPTIMIZED FOR A PHASE TRANSFORMATION OCCURING NEAR 10 MICRONS. BY REVIEWING THIS FILM THROUGH VISIBLE ELLIPSOMETRY, MINUTE TEMPERATURE CHANGES ARE EXPECTED TO BE OBSERVED DIRECTLY OR BY A TV CAMERA. IN ADDITION TO MILITARY USES, POSSIBLE COMMERCIAL USES EXIST FOR A BASIC IR VIEWING SYSTEM IN MEDICAL IMAGING AND AUTOMOBILES.

ROCKY RESEARCH
PO BOX 1086 - 674 WELLS RD
BOULDER CITY, NV 89005
CONTRACT NUMBER:
UWE ROCKENFELLER
TITLE:
COMPLEX COMPOUND PAIRS FOR ADVANCED HEAT PUMP CYCLES FOR SPACE STATION HEAT REJECTION SYSTEMS
TOPIC# 7 OFFICE: IDENT#: 30088

SUBMITTED BY

THE THERMAL LOAD OF SPACE POWER SYSTEMS REQUIRES ELABORATE HEAT REJECTION SYSTEMS TO KEEP AN ACCEPTABLE SPACE CRAFT TEMPERATURE. SAVINGS IN RADIATOR AREA AS WELL AS IN TOTAL SYSTEM MASS ARE POSSIBLE THROUGH AN INCREASE IN THE RADIATOR TEMPERATURE FROM 300K TO 400K OR HIGHER. THIS CAN BE ACCOMPLISHED WITH A HEAT PUMP. PREVIOUS RESEARCH HAS SHOWN THAT SOLID-VAPOR HEAT PUMPS USING COORDINATIVE COMPLEX COMPOUNDS CAN PROVIDE SUBSTANTIAL RADIATOR AREA AND SYSTEM MASS SAVINGS. WHILE AMMONIATED AND HYDRATED COMPLEX COMPOUNDS PROVIDE THE UNIQUE POTENTIAL TO ACHIEVE EXTREMELY HIGH TEMPERATURE LIFTS IN SOLID-GAS HEAT PUMPS AND, THEREFORE, SIGNIFICANT RADIATOR AREA AND SYSTEM MASS SAVINGS (60%), THE REQUIRED HIGH TEMPERATURE STABILITY AND EFFECTIVE REACTION KINETICS ARE THE KEY QUESTION. HYDRATED AND AMMONIATED COMPOUNDS ARE BEING ANALYZED FOR HIGH TEMPERATURE SUITABILITY AND THE EXPECTED PERFORMANCE OF HEAT PUMPS AND THE TOTAL HEAT REJECTION SYSTEMS ARE BEING CALCULATED, USING COMPUTER MODELING. FEASIBILITY OF SIGNIFICANTLY INCREASING THE COEFFICIENT OF PERFORMANCE OF HEAT PUMPS BY THE USE OF COMPLEX COMPOUNDS IS BEING DETERMINED AS IF THE EFFECT OF THESE COMPLEX COMPOUNDS ON THE TOTAL HEAT REJECTION SYSTEM PERFORMANCE. IN ADDITION TO EFFECTING SIGNIFICANT SAVING IN SPACE-CRAFT RADIATOR AREA AND HEAT REJECTION SYSTEM MASS, THE CURRENT DEVELOPMENT STATUS OF THE TECHNOLOGY IS ALREADY APPLICABLE TO COMMERCIAL AIR CONDITIONING AND INDUSTRIAL HEAT PUMPS.

SAT-CON TECHNOLOGY CORP
71 ROGERS ST
CAMBRIDGE, MA 02142
CONTRACT NUMBER:
RICHARD HOCKNEY
TITLE:
TWO-AXIS SUPERCONDUCTING TORQUE GENERATOR
TOPIC# 1 OFFICE: IDENT#: 30696

TWO-AXIS, HIGH-TORQUE SUPERCONDUCTING ACTUATORS REPRESENT A PROMISING APPROACH TO ISOLATING AND CONTROLLING THE FORE-BODY IN MANY SPACE-BASED DEFENSE APPLICATIONS. THESE ACTUATORS, WHICH WORK ON THE D'ARSONVAL PRINCIPLE, COMBINE HIGH TORQUE, LIGHT WEIGHT, AND HIGH BANDWIDTH. BECAUSE OF THEIR OPERATING PRINCIPLES AND CHARACTERISTICS, THEY ARE CAPABLE OF SIMULTANEOUSLY PROVIDING LARGE TORQUE TRANSMISSION

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AND HIGH LEVELS OF VIBRATION ISOLATION. THESE ACTUATORS ARE AN EN-
ABLING TECHNOLOGY WHERE IMPROVEMENTS ARE ANTICIPATED TO TRANSLATE
DIRECTLY INTO IMPROVED SYSTEM PERFORMANCE AND CAPABILITIES. FEASI-
BILITY OF THIS ACTUATOR IS BEING INVESTIGATED FOR A FOREBODY SLEWING
TASK. A TWO-AXIS SUPERCONDUCTING ACTUATOR SIZED FOR THIS APPLICATION
IS BEING DEVELOPED AND ANALYZED. A SUB-SCALE PROTOTYPE SYSTEM COULD
BE CONSTRUCTED AND TESTED AT A LATER EFFORT. THIS CONCEPT HAS
APPLICATION IN COMMERCIAL CONTROL SYSTEMS WHERE HIGH-TORQUE, HIGH-
BANDWIDTH ELECTROMAGNETIC ACTUATORS ARE REQUIRED.

SAT-CON TECHNOLOGY CORP
71 ROGERS ST

CAMBRIDGE, MA 02142

CONTRACT NUMBER:

RICHARD HOCKNEY

TITLE:

HIGH TEMPERATURE CERAMIC SUPERCONDUCTING SWITCH

TOPIC# 15

OFFICE:

IDENT#: 30697

THE FEASIBILITY IS BEING INVESTIGATED OF DEVELOPING A NEW CLASS OF
HIGH PERFORMANCE SWITCHES BASED ON HIGH TEMPERATURE CERAMIC SUPERCON-
DUCTORS. SUPERCONDUCTING SWITCHES CALLED CRYOTRONS HAVE BEEN DEMON-
STRATED UTILIZING CONVENTIONAL LOW TEMPERATURE SUPERCONDUCTORS. THESE
DEVICES ARE LIMITED IN THEIR PERFORMANCE POTENTIAL DUE TO BOTH THE
REFRIGERATION DEMANDS AND MATERIAL PROPERTY LIMITATIONS IMPOSED BY
OPERATION AT TEMPERATURES BELOW 4 DEGREES KELVIN. THE POSSIBILITY OF
OPERATING ABOVE 77 DEGREES KELVIN COUPLED WITH THE EXTREMELY HIGH
RESISTANCE OF THE CERAMICS WHEN NOT IN A SUPERCONDUCTING MODE COULD
ELIMINATE THESE LIMITATIONS. SUCH SWITCHES HAVE THE POTENTIAL TO BE
FASTER, SMALLER, AND MORE EFFICIENT THAN CONVENTIONAL SWITCHES. IN
THIS EFFORT, THE FEASIBILITY OF THESE SWITCHES IS BEING INVESTIGATED;
SEVERAL STRAWMAN CONFIGURATIONS ARE BEING COMPARED; AND A BASELINE
CONFIGURATION IS BEING ESTABLISHED FOR FURTHER DEVELOPMENT. WHEN SUC-
CESSFULLY DEMONSTRATED, THIS SWITCHING CONCEPT WOULD HAVE UTILITY,
MARINE, TRANSPORTATION, INDUSTRIAL AS WELL AS DEFENSE APPLICATIONS.
THESE WOULD INCLUDE REPLACEMENTS FOR EXISTING SWITCH TECHNOLOGY (E.G.,
TRANSISTORS, SILICON CONTROLLED RECTIFIERS, IGNITRONS, THYRATRONS,
LIQUID METAL PLASMA VALVES, AND SPARKGAP DEVICES) AND HIGHER
PERFORMANCE APPLICATIONS WHICH CANNOT BE UNDERTAKEN WITH EXISTING

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TECHNOLOGY.

SAT-CON TECHNOLOGY CORP
71 ROGERS ST
CAMBRIDGE, MA 02142
CONTRACT NUMBER:
DR JAMES DOWNER
TITLE:
REACTIONLESS PULSE POWER GENERATION SYSTEM
TOPIC# 5 OFFICE: IDENT#: 30699

CURRENTLY ENVISIONED SPACE POWER GENERATION EQUIPMENT CONSISTS OF ROTATING MACHINES SUCH AS TURBINES AND GENERATORS, WHICH EXERT LARGE REACTION TORQUES AGAINST THE SPACE STRUCTURE DURING OPERATION. IT IS EXPECTED THAT THESE MACHINES WOULD BE CONFIGURED IN COUNTER ROTATING PAIRS IN ORDER TO MINIMIZE THE NET TORQUE APPLIED TO THE SPACE STRUCTURE. PULSED INERTIAL POWER SUPPLIES CONSISTING OF TWO COUNTER-ROTATING FLYWHEELS WHICH INTERACT, NOT WITH THE STRUCTURE BUT WITH EACH OTHER, SHOULD COMPLETELY ELIMINATE THIS EFFECT AND ALLOW REACTION LESS PULSE GENERATION. THIS TECHNIQUE, WHICH SEEMS IDEAL FOR EXTREMELY HIGH TORQUE PULSED APPLICATIONS, MIGHT ALSO BE APPLIED TO ALL OTHER TYPES OF SPACE-BASED ROTATING MACHINERY. THE FEASIBILITY IS BEING INVESTIGATED OF APPLYING THIS TECHNIQUE TO A FLYWHEEL PULSE POWER SYSTEM. REPRESENTATIVE "STRAWMAN" CONFIGURATIONS OF HIGH-ENERGY DENSITY FLYWHEELS, HIGH PERFORMANCE GENERATORS, AND PRIME MOVERS ARE BEING SELECTED FOR DETAILED ANALYSIS. CONTROL CONCEPTS FOR THESE SYSTEMS ARE BEING DEVELOPED AND EVALUATED THAT ARE ANTICIPATED TO MANAGE AUTONOMOUSLY THE OUTPUT OF THESE SYSTEMS AND TO ATTENUATE VIBRATION INPUTS TO THE SPACECRAFT. WHEN SUCCESSFUL, APPLICATIONS FOR THIS TECHNOLOGY WOULD BE FOUND IN ALMOST ALL SATELLITES AS A REPLACEMENT FOR EXISTING BATTERY SYSTEMS.

SCHWARTZ ELECTRO-OPTICS INC
45 WINTHROP ST
CONCORD, MA 01742
CONTRACT NUMBER:
DR JAMES HARRISON
TITLE:
NIOBIUM-DOPED BERYLLIUM LANTHANATE LASER SYSTEM FOR THALLIUM FILTERS
TOPIC# 3 OFFICE: IDENT#: 30519

SUBMITTED BY

LASER TRANSMITTER/RECEIVER SYSTEMS INVOLVING THALLIUM FILTERS FOR HIGH-SENSITIVITY DETECTION ARE BEING CONSIDERED FOR A NUMBER OF IMPORTANT APPLICATIONS. A SUITABLE LASER SOURCE REMAINS TO BE DEVELOPED THAT EMITS AT THE WAVELENGTH OF THE THALLIUM RESONANCE. AN EXCELLENT CANDIDATE SOURCE IS A FREQUENCY-DOUBLED NEODYMIUM-DOPED BERYLLIUM LANTHANATE (Nd:BEL) OSCILLATOR/AMPLIFIER SYSTEM. THE EVENTUAL SYSTEM CONFIGURATION IS ENVISIONED AS INCLUDING A SINGLE-FREQUENCY, Q-SWITCHED OSCILLATOR FOLLOWED BY AMPLIFIER CHAIN AND A DOUBLING STAGE. THE Q-SWITCHED OSCILLATOR WOULD BE INJECTION SEEDING WITH A SEPARATE Nd:BEL MASTER OSCILLATOR. THE FEASIBILITY OF SUCH A SYSTEM EMPLOYING Nd:BEL AS THE GAIN MEDIUM IS BEING INVESTIGATED. THE BULK OF THE PROGRAM CONSISTS OF AN EXPERIMENTAL DEMONSTRATION OF THE MASTER OSCILLATOR: A GAIN-SWITCHED, DIODE-LASER-PUMPED, SINGLE-FREQUENCY Nd:BEL RING LASER. THE DEMONSTRATION INCLUDES TUNING THE LASER OVER THE THALLIUM RESONANCE AT 535 NM, AND IS BEING FOLLOWED BY A PRELIMINARY SYSTEM POINT DESIGN. WHEN SUCCESSFUL, POTENTIAL APPLICATIONS ARE TIED TO SENSITIVE LASER TRANSMITTER/RECEIVER SYSTEMS BASED ON THE THALLIUM DETECTOR INCLUDING SPACE, TRANSATMOSPHERIC, AND SUBMARINE COMMUNICATION SYSTEMS AS WELL AS TARGET DESIGNATORS AND TARGET DISCRIMINATORS.

SCHWARTZ ELECTRO-OPTICS INC
3404 N ORANGE BLOSSOM TRAIL
ORLANDO, FL 32804
CONTRACT NUMBER:
RICHARD J WANGLER
TITLE:
ONE MICRON LASER DOPPLER RADAR
TOPIC# 3 OFFICE:

IDENT#: 30520

THE HOMODYNE CHARACTERISTICS ARE BEING EVALUATED OF A BREADBOARD COHERENT ONE MICRON SOLID-STATE LASER IN A LASER RADAR (LADAR) CONFIGURATION OPERATION AGAINST LABORATORY MOVING (DOPPLER) TARGETS. THIS PROGRAM BUILDS UPON PREVIOUS WORK THAT DEMONSTRATED COHERENT BEAM SUMMATION IN WHICH TWO BREADBOARD DIODE PUMPED, RING STABILIZED, ONE-MICRON LASERS WERE CONSTRUCTED. THIS PROGRAM ALSO IS UTILIZING COHERENT LASER RADAR INTERFEROMETER AND DOPPLER FREQUENCY DISCRIMINATOR DESIGNS. FROM THESE VARIOUS SUBASSEMBLIES, A COHERENT ONE MICRON

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LADAR IS BEING EVALUATED WITH TESTS BEING CONDUCTED TO INDICATE VELOCITY DISCRIMINATION CAPABILITY AND LIMITATIONS. FINALLY, A SYSTEM ANALYSIS IS BEING CONDUCTED TO DETERMINE THE CHARACTERISTICS OF A LADAR APPROPRIATE FOR TRACKING AND DISCRIMINATION MEASUREMENTS. THIS LASER DOPPLER RADAR, WHEN SUCCESSFUL, WOULD HAVE APPLICATION AS A SPACE-BORNE OR TERRESTRIAL WIND SENSOR OR IN OTHER APPLICATIONS WHERE REMOTE, VERY ACCURATE VELOCITY MEASUREMENT IS REQUIRED.

SCIENCE RESEARCH LAB INC
15 WARD ST
SOMERVILLE, MA 02143
CONTRACT NUMBER:
DR JONAH JACOB

TITLE:

SCALING DISCHARGE PUMPED RARE GAS LASERS TO ULTRA-HIGH AVERAGE POWER

TOPIC# 1 OFFICE: IDENT#: 30100

THE FEASIBILITY IS BEING DETERMINED OF DEVELOPING EFFICIENT ELECTRON BEAM CONTROLLED DISCHARGE-PUMPED RARE GAS LASERS TO THE MULTI-MEGAWATT AVERAGE POWER LEVELS (GREATER THAN OR EQUAL TO 100 MW) REQUIRED FOR STRATEGIC DEFENSE APPLICATIONS. DISCHARGE PUMPED RARE GASES HAVE BEEN MADE TO LASE ON A NUMBER OF TRANSITIONS FROM 0.63 MICROMETERS IN THE VISIBLE SPECTRUM TO 4 MICROMETER IN THE INFRARED SPECTRUM. MOST OF THESE LASERS HAVE OPERATED IN LOW PRESSURE DISCHARGES WITH EFFICIENCIES OF LESS THAN 1%. THESE LASERS OFFER SEVERAL ADVANTAGES INCLUDING: HIGH DUTY FACTOR WAVEFORMS WHICH WILL ELIMINATE THE EFFECTS OF STIMULATED RAMAN SCATTERING ON ATMOSPHERIC PROPAGATION, NO FUEL BURNUP, AND HIGH SPECIFIC ENERGY EXTRACTION (50 J/L) RESULTING IN COMPACT, INEXPENSIVE LASER DEVICES. THE KEY ISSUE TO BE ADDRESSED BEFORE THE POTENTIAL OF THESE LASERS CAN BE REALIZED IS THE STABILITY OF THE LASER DISCHARGE FOR LONG PULSE DURATIONS AT THE REQUIRED POWER DENSITIES. THIS ISSUE IS BEING INVESTIGATED THROUGH COMPREHENSIVE LASER DISCHARGE MODELING. WHEN SUCCESSFUL, AN ALTERNATE, COST EFFECTIVE GROUND-BASED LASER WOULD BE DEVELOPED WITH SEVERAL POTENTIAL ADVANTAGES OVER EXISTING FREE ELECTRON LASERS AND EXCIMER CONCEPTS. MANY MEDICAL AND DEFENSE APPLICATIONS WOULD EXIST, INCLUDING SENSOR NEGATION AND JAMMING, AS WELL AS TARGET ILLUMINATION AND DESIGNATION ON THE TACTICAL BATTLEFIELD.

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RECENT ADVANCES IN HIGH POWER MICROWAVE SOURCES SUCH AS UNDULATORS (UNITRONS) AND CYCLOTRON AUTO-RESONANCE MASERS (CARMS) REQUIRE ACCOMPANYING DEVELOPMENTS IN HIGH CURRENT INDUCTION ACCELERATOR TECHNOLOGY IF DEPLOYMENT OF THESE SOURCES ON MOBILE PLATFORMS IS TO BE FEASIBLE. IN THIS EFFORT, AN ENGINEERING DESIGN IS BEING DEVELOPED OF A CARM OPERATING AT A WAVELENGTH OF 0.6 MM AND CAPABLE OF PRODUCING GREATER THAN 200 MW PEAK POWER AT A DUTY FACTOR OF $10E-3$. THE INJECTOR FOR THE CARM DEVICE WOULD BE FABRICATED AND TESTED IN A LATER EFFORT. THIS CARM IS PRIMARILY COMPRISED OF A BRAGG RESONATOR HOUSED INSIDE A 5 TESLA SUPERCONDUCTION MAGNET DRIVEN BY A 1.5 MEV, 1.5 KA ELECTRON BEAM SUPPLIED BY AN INDUCTION ACCELERATOR. THE 1.5 MEV ELECTRON SOURCE IS BEING DRIVEN BY A 5 STAGE INDUCTION LINAC WITH EACH STAGE PROVIDING AN ENERGY INCREMENT OF 300 KEV TO THE BEAM WITH AN ALL SOLID STATE SCR-COMMUTATED NONLINEAR MAGNETIC PULSE COMPRESSOR. THE DEVELOPMENT OF COMPACT, LIGHTWEIGHT, EFFICIENT SUBMILLIMETER MICROWAVE SOURCES OPERATING AT HUNDREDS OF KILOWATTS AVERAGE POWER AND FRACTIONS OF GIGAWATTS PEAK POWER WOULD SIGNIFICANTLY IMPROVE THE STATE OF THE ART IN SPACE QUALIFIABLE HIGH RESOLUTION RADAR FOR TARGET DISCRIMINATION AND IMAGING. IN ADDITION, THESE SOURCES MAY FIND APPLICATIONS IN SUCH DIVERSE AREAS AS ELECTRON CYCLOTRON HEATING AND MICROWAVE POWER TRANSMISSION.

SCIENCE RESEARCH LAB INC
15 WARD ST
SOMERVILLE, MA 02143
CONTRACT NUMBER:
DR VLADIMIR KRAPCHEV
TITLE:

LASER PULSE FORMATTING TO REDUCE THERMAL BLOOMING BY AEROSOL VAPORIZATION
TOPIC# 1 OFFICE: IDENT#: 30523

THE PROPAGATION OF A GROUND BASED LASER BEAM TO A RELAY MIRROR IN SPACE REQUIRES COMPENSATION FOR THE DELETERIOUS EFFECTS OF ATMOSPHERIC TURBULENCE AND THERMAL BLOOMING TO ACHIEVE NEAR DIFFRACTION LIMITED PERFORMANCE. THE EFFECTS OF PULSE FORMATTING ON THE UPLINK PROPAGATION OF HIGH POWER LASER BEAMS THROUGH THE ATMOSPHERE NEEDS TO BE DETERMINED. FOR A LASER WAVELENGTH OF 1 MICROMETER, THE ABSORPTION WILL

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LIKELY BE DOMINATED BY AEROSOLS SINCE MOLECULAR ABSORPTION OF 2-3% LEADS TO INEFFICIENT BEAM PROPAGATION FROM THE GROUND TO A RELAY MIRROR OR A TARGET IN SPACE. A PULSE FORMAT FOR THE HIGH POWER UPLINK BEAM IS BEING DEVELOPED CONSISTING OF A BURST OF PULSES AT A PULSE REPETITION FREQUENCY GREATER THAN OR EQUAL TO 1 MHZ FORMING A MACROPULSE OF LENGTH 100-200 MICROSECONDS. DURING A SINGLE MACROPULSE, THE AERISIKS ARE EXPECTED TO BE VAPORIZED AND THE BEAM PATH CLEARED. SUBSEQUENT PULSES WOULD BE EXPECTED TO EXPERIENCE SIGNIFICANTLY REDUCED THERMAL BLOOMING. THIS CONCEPT OF PULSE FORMATTING FOR AEROSOL VAPORIZATION FOR REDUCING THERMAL BLOOMING IS BEING MODELED. A LABORATORY SCALE EXPERIMENT IS BEING DESIGNED TO MEASURE THERMAL BLOOMING BY AEROSOLS. DEVELOPMENT OF PULSE FORMATTING TO REDUCE AEROSOL ABSORPTION, WHEN SUCCESSFUL, WOULD RESOLVE A DIFFICULT PROBLEM ASSOCIATED WITH THE UPLINK PROPAGATION OF HIGH POWER GROUND BASED LASERS FOR BALLISTIC MISSILE DEFENSE APPLICATIONS.

SCIENTIFIC RESEARCH ASSOCS INC
PO BOX 1058 - 50 NYE RD
GLASTONBURY, CT 06033
CONTRACT NUMBER:
DR JAYANT S SABNIS
TITLE:
HYPERSONIC VEHICLE ENVIRONMENT SIMULATION
TOPIC# 2 OFFICE: IDENT#: 30273

THE NEED EXISTS TO ACCURATELY PREDICT THE ENVIRONMENT CREATED AROUND A VEHICLE TRAVELLING AT HIGH MACH NUMBER WITHIN THE ATMOSPHERE. THE APPROACH IS BEING INVESTIGATED, COMPUTATIONALLY-BASED ANALYSIS, BUILT UPON A HYBRID OF CONTINUUM GAS DYNAMICS AND A MONTE CARLO MOLECULAR REPRESENTATION. IN THE CONTINUUM PHASE, MOLECULES, ACTUALLY VARIOUS GROUPS OF MOLECULES, ARE BEING TRANSPORTED BY THE MEAN VELOCITY. AT THE MOLECULAR LEVEL, A MONTE CARLO APPROACH IS BEING USED ALONG WITH THE KINETIC THEORY OF GASES TO DETERMINE THE VARIOUS POPULATION STATES RESULTING FROM MOLECULAR COLLISIONS, INCLUDING BOTH CHEMISTRY AND ELECTRONIC INTERACTIONS. THIS INFORMATION IS THEN BEING USED TO DETERMINE THE MEAN DENSITY AND TEMPERATURE. THE APPROACH AIMS TO REPRESENT THE COMPLEX CHEMICAL AND THERMAL PROCESSES OCCURING AROUND A VEHICLE TRAVELLING AT HYPERSONIC SPEEDS ($M > 10$) WITHIN THE ATMOSPHERE (<300 KFT) IN MUCH MORE DETAIL AND MORE ACCURATELY THAN IS CURRENTLY

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POSSIBLE WITH EITHER CURRENT APPROACHES. SUCCESSFUL COMPLETION OF A LATER RESEARCH EFFORT COULD LEAD TO A HYBRID VISCOUS FLOW FIELD COMPUTATIONAL-FLUID-DYNAMICS-BASED COMPUTER CODE FOR ANALYZING THE ENVIRONMENT OF A HYPERSONIC VEHICLE. SENSOR AND VEHICLE DESIGN ENGINEERS WOULD BE ABLE TO ASSESS THE GEOMETRY AND FLIGHT CONDITION EFFECT ON THE SENSOR PERFORMANCE AND COULD PURSUE MEANS OF IMPROVING OR CHANGING BOTH THE ENVIRONMENT AND SENSOR PERFORMANCE.

SCIENTIFIC SYSTEMS INC
ONE ALEWIFE PL
CAMBRIDGE, MA 02140
CONTRACT NUMBER:
DR DONALD E GUSTAFSON

TITLE:

OPTIMAL SENSOR CONFIGURATION AND SURVIVABLE PROCESSING WITH
CORRELATED NOISE

TOPIC# 3

OFFICE:

IDENT#: 30526

METHODOLOGIES AND ALGORITHMS ARE BEING DEVELOPED FOR TRACKING OF MULTIPLE BALLISTIC MISSILE TARGETS IN A DISTRIBUTED SENSING AND COMMUNICATION ENVIRONMENT. THE PROBLEM IS MADE PARTICULARLY DIFFICULT BY THE POSSIBILITY OF SEVERE CLUTTER IN THE TRACKING DATA AND BY THE FACT THAT THE MEASUREMENT NOISE IS CORRELATED ACROSS SENSORS. SINCE EVEN THE SIMPLEST DISTRIBUTED ESTIMATION PROBLEMS ARE HARD IN THE SENSE OF COMPUTATIONAL COMPLEXITY, THE FOCUS IS ON DEVELOPMENT OF APPROPRIATE ESTIMATION AND DETECTION STRUCTURES BASED ON BOTH QUALITATIVE AND QUANTITATIVE RESULTS OF DISTRIBUTED ESTIMATION THEORY. CONCEPTS FROM ROBUST ESTIMATION THEORY ARE BEING UTILIZED TO DEVELOP THE OVERALL METHODOLOGY. SIMULATIONS ARE BEING CARRIED OUT TO TEST THE ALGORITHMS. TRACKING SYSTEMS ARE EXPECTED TO BE ACHIEVED THAT ARE MORE SURVIVABLE AND ROBUST THAN IS POSSIBLE WITH CURRENT METHODOLOGIES AND THAT CAN MEET THE REQUIRED TRACKING ACCURACY.

SCIFERS T INC
111 N SEPULVEDA BLVD - STE 330
MANHATTAN BEACH, CA 90266

CONTRACT NUMBER:

DR L V (JOE) SCIFERS

TITLE:

INNOVATIVE DECOY RESEARCH

TOPIC# 8

OFFICE:

IDENT#: 30563

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SURVIVABILITY OF SPACE SYSTEMS MAY DEPEND HEAVILY ON THE USE OF DECOYS, PARTICULARLY RESPONSIVE OR SHORT-LIVED DECOYS, TO ENHANCE SATELLITE SURVIVABILITY. IDEALLY, SUCH DECOYS FOR SPACE APPLICATIONS SHOULD BE SIMPLE, EFFECTIVE, LIGHTWEIGHT, AND LOW COST. HOWEVER, A VERY WIDE RANGE OF RADAR FREQUENCIES CAN BE USED TO DETECT, TRACK, AND TARGET SPACE OBJECTS RESULTING IN DIFFERING DECOY REQUIREMENTS FOR DIFFERING RADAR FREQUENCIES. THE PROBLEM IS MULTISPECTRAL, REQUIRING DIFFERING SIZES OF DECOYS TO SIMULATE A GIVEN SATELLITE SIGNATURE. ONE SOLUTION IS TO DEPLOY MULTIPLE DECOYS, EACH ONE SIZED FOR THE VARIOUS THREAT RADARS THAT MIGHT BE CONFRONTED. THIS SOLUTION HAS A SERIOUS DRAWBACK IN THAT, IF ANY OF THE OPTIMALLY SIZED (FOR A GIVEN FREQUENCY) DECOYS ARE SEEN SIMULTANEOUSLY BY TWO OR MORE RADARS OF DIFFERENT FREQUENCIES, THEN THE DECOY IS EXPOSED AS A DECOY. AN INHERENTLY MULTISPECTRAL DECOY (IMD) FOR USE AGAINST RADAR THREAT SENSORS OF WIDELY DIFFERENT FREQUENCIES IS BEING INVESTIGATED IN THIS STUDY. GENERIC BUT REPRESENTATIVE RADAR THREATS AND KINEMATICS ARE BEING DEFINED AND ANALYZED. VARIOUS CAVITY MODIFICATIONS AND TYPES OF MODIFICATIONS ARE BEING EXPLORED AND EVALUATED WITHIN THE THREAT SENSOR AND KINEMATICS CONTEXT. WHEN SUCCESSFUL, CONSIDERABLE SURVIVABILITY ENHANCEMENTS FOR FUTURE SPACE SYSTEMS WOULD BE ACHIEVED.

SIERRA MONOLITHICS INC
13721 GRAMERCY PL
GARDENA, CA 90249
CONTRACT NUMBER:
DR BINNEG Y LAO

TITLE:
MINIATURE HIGH-TEMPERATURE SUPERCONDUCTING GYROSCOPE
TOPIC# 2 OFFICE: IDENT#: 30528

TRADITIONAL HIGH ACCURACY INERTIAL MEASUREMENT UNITS (IMU'S) RELY ON MECHANICAL OR RING LASER GYROSCOPES FOR ANGULAR POSITION MEASUREMENT. RECENT DEVELOPMENT OF HIGH TEMPERATURE SUPERCONDUCTING (HTS) MATERIALS HAS OPENED NEW METHODS OF ANGULAR POSITION SENSING THAT CAN GREATLY LOWER THE SIZE, WEIGHT, AND COST OF THE IMU FUNCTION. IN THIS EFFORT, THE ENGINEERING PROBLEMS ASSOCIATED WITH PRODUCING A SUPERCONDUCTING GYROSCOPE ARE BEING DEFINED AND ANALYZED. A MINIATURE AND LOW POWER-CONSUMING GYROSCOPE IS BEING DESIGNED UTILIZING THE ELECTRON-ELECTRON

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INTERACTION IN THE NEW CLASS OF HTS MATERIAL. SPECIFICALLY, MECHANICAL AND PHYSICAL ANALYSIS OF THE GYROSCOPE IS BEING UNDERTAKEN, INCLUDING SENSOR PERFORMANCE ANALYSIS. HTS MATERIALS ARE BEING STUDIED TO DETERMINE THE MOST SUITABLE CANDIDATE FOR THE SENSOR. AN ACCURACY ASSESSMENT IS BEING CONDUCTED FOR BOTH GIMBALED AND STRAP-DOWN VERSIONS OF THE DEVICE. THE MECHANICAL DESIGN AND MATERIAL REQUIREMENTS ARE THE BASIC GYROSCOPE ARE BEING COMPLETED. FABRICATION TECHNIQUES ARE BEING DETERMINED. THE ACTUAL FABRICATION OF THE SENSOR WILL BE ACCOMPLISHED AT A LATER STAGE. APPLICATIONS OF MINIATURE SUPERCONDUCTING GYROSCOPE INCLUDE A HOST OF DEFENSE SYSTEMS REQUIRING SMALL AND LIGHT WEIGHT IMU'S SUCH AS MISSILE GUIDANCE AND CONTROL, AIRCRAFT ON-BOARD INERTIAL SYSTEMS, DEAD RECKONING EQUIPMENT ON SHIPS OF ALL TYPES PROJECTILE GUIDANCE, AND STRATEGIC DEFENSE APPLICATIONS.

SPACE POWER INC
1977 CONCOURSE DR
SAN JOSE, CA 95131
CONTRACT NUMBER:
LESTER L BEGG
TITLE:
HIGH CREEP STRENGTH THERMIONIC EMITTER
TOPIC# 4 OFFICE: IDENT#: 30355

PERFORMANCE AND LIFETIMES OF THERMIONIC SPACE NUCLEAR POWER SYSTEMS ARE LIMITED BY DEFORMATION OF THE CHEMICAL VAPOR DEPOSITION-TUNGSTEN (CVD-W) EMITTER. THIS LIFE-LIMITING PHENOMENON IS ATTRIBUTABLE ALMOST ENTIRELY TO SWELLING OF THE NUCLEAR FUEL. HIGH STRENGTH EMITTER MATERIALS HAVE BEEN IDENTIFIED WHICH WOULD ELIMINATE EMITTER DEFORMATION AS A DESIGN CONSTRAINT. THE EMITTER BEING DEVELOPED IN THIS STUDY IS EXPECTED TO RETAIN ALL OF THE REQUIRED CHARACTERISTICS OF THE PRESENT CVD-W EMITTER: COMPATIBILITY WITH CESIUM AND NUCLEAR FUEL, THERMIONIC EMISSION PROPERTIES, AND MATERIAL JOINING CHARACTERISTICS. THIS HIGH STRENGTH, LOW CREEP RATE MATERIAL IS ANTICIPATED TO HAVE A TESTING DATA BASED ON WHICH TO PREDICT PERFORMANCE. THE MATERIAL HAS BEEN SUCCESSFULLY FABRICATED IN ANOTHER MATRIX MATERIAL (WHICH IS NOT SUITED TO THE THERMIONIC APPLICATION). IN THIS EFFORT, THE FEASIBILITY OF FABRICATING THE HIGH STRENGTH MATERIAL INTO A CVD-W MATRIX IN THE GEOMETRY OF INTEREST TO THERMIONIC SYSTEMS IS BEING ESTAB-

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LISHED. TUNGSTEN METAL IS BEING VAPOR DEPOSITED ONTO A HIGH-CREEP STRENGTH WIRE REINFORCEMENT AND, SUBSEQUENTLY, METALLOGRICALLY EXAMINED TO DEMONSTRATE THE FABRICABILITY OF THE PROPOSED EMITTER CONCEPT. WHEN SUCCESSFUL, THE HIGH STRENGTH EMITTER WOULD ALLOW HIGHER EMITTER TEMPERATURES, WHICH IN TURN WOULD PRODUCE HIGHER POWER OUTPUT AND/OR LOWER SYSTEM MASS.

SPACE POWER INC
1977 CONCOURSE DR
SAN JOSE, CA 95131
CONTRACT NUMBER:
DR JOHN L LAWLESS
TITLE:
TUNABLE SHORT-WAVELENGTH COMPACT NEW LASER
TOPIC# 1 OFFICE: IDENT#: 30707

A CLASS OF POTENTIAL NEW EFFICIENT TUNABLE SHORT-WAVELENGTH HIGH-POWER-DENSITY LASERS IS BEING INVESTIGATED. IT IS ANTICIPATED THAT IT SHOULD BE POSSIBLE TO TUNE THESE LASERS FROM FAR RED TO VACUUM ULTRA-VIOLET (VUV) WAVELENGTHS AND TO ACHIEVE POWER DENSITIES OF 100KJ/LITER OR MORE. THIS LASER CONCEPT USES EXCIMER ACTION IN A CONDENSED PHASE, EITHER LIQUID OR SOLID, AND ISOPTICALLY PUMPING THE MEDIUM USING COOPERATIVE PHOTO-INDUCED CHARGE TRANSFER (CPICT). MIXTURES OF CONDENSED RARE GASES AND HALIDES ARE WELL SUITED TO CPICT. QUANTUM YIELDS NEAR 100% ARE EXPECTED. FOR INITIAL EXPERIMENTS, THE PUMP LIGHT FROM EXCIMER LASERS IS BEING USED. FOR EVENTUAL SYSTEM APPLICATIONS, OTHER SOURCES, SUCH AS FLASHLAMPS, WOULD BE INVESTIGATED. THIS WORK IS THE FIRST TO ATTEMPT TO DEMONSTRATE LASING IN A CONDENSED-PHASE RARE GAS HALIDE MIXTURE USING THE EFFICIENT CPICT PUMPING METHOD. A LIQUID PHASE VISIBLE (BLUE-GREEN) LASER IS BEING DEMONSTRATED. SPECTROSCOPIC PARAMETERS AND PUMPING SCHEMES ARE BEING EVALUATED APPROPRIATE FOR VUV LASERS. AN EXPERIMENTAL SYSTEM IS BEING BUILT AND TESTED FOR THIS APPLICATION, AND THEORETICAL MODELS OF THE SYSTEM KINETICS ARE BEING DEVELOPED. THIS TUNABLE SHORT-WAVELENGTH LASER, WHEN SUCCESSFUL, HAS POTENTIAL APPLICATION AS A JAMMING-RESISTANT INTER-SATELLITE COMMUNICATIONS LASER AND AS A POSSIBLE SPACE-TO-SUBMARINE COMMUNICATIONS LASER.

SPACE POWER INC
1977 CONCOURSE DR
SAN JOSE, CA 95131
CONTRACT NUMBER:
DR JOHN L LAWLESS
TITLE:
SURVIVABLE MIRRORS AND RADIATOR CONCEPTS FOR SOLAR SPACE POWER SYSTEMS
TOPIC# 5 OFFICE: IDENT#: 30712

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A STRONG TECHNOLOGY BASE HAS BEEN ESTABLISHED FOR SURVIVABILITY OF SOLAR PHOTOVOLTAIC SYSTEMS. HOWEVER, HIGHER LEVELS OF LASER HARDNESS ARE REQUIRED TO MEET INCREASED LASER CAPABILITY THREATS. METHODS FOR ACHIEVING SUCH LASER HARDNESS ARE LIMITED IN SOLAR SPACE POWER SYSTEMS. OF THE INCOMING LASER ENERGY WOULD BE REFLECTED, BUT THE SMALL AMOUNT OF REMAINING ENERGY MUST BE ACCOMMODATED WITH THERMAL STORAGE MATERIALS WITH SIGNIFICANTLY HIGHER HEAT CAPACITY THAN THOSE TRADITIONALLY USED IN A MIRROR OR RADIATOR. INNOVATIVE CONCEPTS FOR INTEGRATING THE MIRROR AND RADIATOR TOGETHER INTO A SINGLE LOW-MASS MANEUVERABLE, AND HIGHLY SURVIVABLE, STRUCTURE ARE BEING EXPLORED. CONCEPTUAL DESIGNS ARE BEING DEVELOPED AND HARDNESS LEVELS CALCULATED. EXPERIMENTAL TESTS OF SURVIVABILITY OF IMPROVED DESIGNS WOULD BE CONDUCTED IN A LATER PHASE. THE COMBINATION OF INNOVATIVE DESIGN AND USE OF THERMAL STORAGE MATERIAL IS EXPECTED TO RESULT IN THE SYSTEM BEING HARD TO LASER, PELLET, AND NUCLEAR ATTACK. THE SYSTEM SHOULD ALSO SURVIVE NATURAL THREATS SUCH AS DEBRIS, MICROMETERS, TRAPPED RADIATION, AND ATOMIC OXYGEN AND, THUS, BE USEFUL AND FOR NON-DEFENSE SOLAR SPACE POWER SYSTEMS.

SPACE POWER INC
1977 CONCOURSE DR
SAN JOSE, CA 95131
CONTRACT NUMBER:
DR HYOP RHEE

TITLE:
MICRO-GRAVITY BOILER - SEPARATOR DRYER AND REHEATER
TOPIC# 4 OFFICE: IDENT#: 30713

THE BOILING OF LIQUID METAL IN A MICROGRAVITY ENVIRONMENT HAS LONG REPRESENTED A PROBLEM, WHICH IS COMPLICATED FURTHER BY THE DIFFICULTY OF DRYING THE VAPOR TO 0-1% MOISTURE IN A ZERO-G ENVIRONMENT. KINETIC ENERGY (CYCLONE) SEPARATION AND SURFACE TENSION ARE THE TWO MAJOR FORCES AVAILABLE TO ACCOMPLISH THE TASK. SOLVING THIS PROBLEM IS KEY TO PROVIDING A COMPACT RANKINE POWER CONVERSION SYSTEM FOR INTEGRATION WITH THE SP-100 REACTOR AND FOR MULTIMEGAWATT STEADY STATE NUCLEAR SPACE POWER SYSTEMS. THE METAL RANKINE CONVERSION SYSTEM IS EXPECTED TO INCREASE ELECTRIC POWER PRODUCTION 4-FOLD AT THE SAME THERMAL POWER LEVEL, WITH REDUCED RADIATOR SIZE AND AT REDUCED TEMPERATURES FROM THE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM - PHASE 1
BY SERVICE
FISCAL YEAR 1988
SDIO

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SUBMITTED BY

PRESENT 100 KWE THERMO-ELECTRIC SYSTEM DESIGN. IN THIS INVESTIGATION, BOILER-EVAPORATOR TUBES (MODULES) AND DRYERS ARE BEING IDENTIFIED, DESIGNED, AND FABRICATED THAT ARE CAPABLE OF ACHIEVING 0 TO 1% MOISTURE OUTPUT. COMPACT LOW MASS BOILER MODULES (TUBES AND DRYERS) ARE ANTICIPATED TO BE ACHIEVED BY HIGH HEAT TRANSFER RATES THROUGHOUT THE SECTION. DRY VAPOR PRODUCTION IS EXPECTED WITH COMPACT LOW MASS LIQUID SEPARATORS THAT ARE LIKELY TO BE RELIABLE IN A MICRO-GRAVITY ENVIRONMENT. AN EFFECTIVE AND EFFICIENT LOW PRESSURE LIQUID SEPARATOR IS BEING IDENTIFIED AND DESIGNED THAT IS EXPECTED TO OPERATE WITH LITTLE PRESSURE LOSS AND WITH SMALL SIZE AND MASS.

SPACE POWER INC
1977 CONCOURSE DR
SAN JOSE, CA 95131
CONTRACT NUMBER:
DR J K KOESTER

TITLE:

COMPACT SURVIVABLE ADVANCED CONVERSION FOR ALKALI METAL RANKINE
SPACE POWER REACTOR SYSTEM
TOPIC# 4 OFFICE: IDENT#: 30715

THE PROPOSED SP-400 POWER CONVERSION SYSTEM IS EXPECTED TO BE 3 TO 6 TIMES SMALLER AND OF LOWER MASS THAN ANY OF THE LEADING SYSTEMS CURRENTLY BEING DEVELOPED OR PROPOSED. THE SP-400 CONVERSION SYSTEM IS EXPECTED TO GENERATE ABOUT 400 KWE WITH THE SAME SP-100 REACTOR, SHIELD AND PRIMARY PUMPS BUT WITH A SMALLER RADIATOR THAN REQUIRED BY THE 100 KWE THERMOELECTRIC SYSTEM. THE SYSTEM SPECIFIC MASS IS ANTICIPATED TO DECREASE AT LEAST TWO-THIRDS. THE SMALLER SIZE HIGH TEMPERATURE RADIATOR IS EXPECTED TO LEAD TO SUBSTANTIALLY INCREASED SURVIVABILITY AND MANEUVERABILITY. THE CONCEPT WOULD HAVE FULL SHUTDOWN, DORMANCY AND RESTART CAPABILITY. THE FEASIBILITY OF SUCH A POWER CONVERSION SYSTEM IS BEING INVESTIGATED. A TEST LOOP IS BEING DESIGNED FOR STEADY STATE OPERATION OF A 2-COMPONENT, 2-PHASE EUTECTIC LIQUID METAL, PUMPED LOOP WITH ELEVATED PRESSURE-TEMPERATURE BOILING, AND LOWER PRESSURE-TEMPERATURE CONDENSATION. A HEAT SOURCE, POWER SUPPLY, TWISTED RIBBON BOILER IS BEING FABRICATED WITH CENTRIFUGAL SEPARATION OF TEST INSTALLATION. OVERALL RANKINE CYCLE SYSTEM ANALYSIS IS BEING UNDERTAKEN TO PROVIDE GUIDANCE AND EVALUATION OF RANKINE CYCLE DEVELOPMENT PROGRESS. WHEN SUCCESSFUL, ELECTRIC PROPULSION WOULD BE-

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COME PRACTICAL FOR ORBITAL TRANSFER AND MANEUVER OF STRATEGIC DEFENSE SATELLITES AS WELL AS FOR HIGH POWERED COMMERCIAL BROADCAST AND AIR-SEA TRAFFIC CONTROL RADAR IN HIGH ORBITS AND GEOSYNCHRONOUS ORBIT.

SPACE POWER INC
1977 CONCOURSE DR
SAN JOSE, CA 95131

CONTRACT NUMBER:

DR STEVE KOHEN

TITLE:

MIRCO-GRAVITY VAPOR CONDENSATION AND VAPOR-LIQUID MANAGEMENT

TOPIC# 7 OFFICE: IDENT#: 30716

LIQUID METAL RANKINE TURBINE-ALTERNATOR AND INCORE THERMIONIC POWER CONVERSION SYSTEMS REPEATEDLY HAVE BEEN VERIFIED AS THE PRIME CANDIDATES TO PRODUCE COMPACT AND SURVIVABLE SPACE POWER SYSTEMS. THE ALKALI METAL RANKINE CYCLE SYSTEMS CONSISTENTLY SHOW HIGH POWER LEVELS ABOVE 100 KWE BECAUSE ACHIEVEMENT OF LOW MASS AND COMPACTNESS IS ESSENTIAL FOR ELECTRIC PROPULSION OPERATIONS IN SPACE. THE SP-100 REACTOR SYSTEM CURRENTLY UNDER DEVELOPMENT CAN BE USED DIRECTLY AS THE THERMAL POWER SOURCE TO THE ALKALI METAL RANKINE CYCLE POWER CONVERSION SYSTEM, THUS MINIMIZING REACTOR DEVELOPMENT REQUIREMENTS FOR THE RANKINE CYCLE SYSTEM. ONE KEY DEVELOPMENT ISSUE CONCERNING THE RANKINE CYCLE SYSTEM IN SPACE IS THE TWO-PHASE FLUID MANAGEMENT IN MIRCO-GRAVITY ENVIRONMENT, INCLUDING THE ZERO-G CONDENSER AND THE HIGH TEMPERATURE, HIGH FLOW RECIRCULATION PUMP. IN THIS STUDY, HIGH VELOCITY METAL VAPOR CONDENSATION, LIQUID MANAGEMENT, AND PUMPING IN MICRO-GRAVITY AND ADVERSE GRAVITATIONAL ENVIRONMENTS ARE BEING DEFINED, ANALYTICALLY CHARACTERIZED, DESIGNED, FABRICATED, AND DEMONSTRATED. THE CONCEPTS ARE BASED UPON EFFECTIVE MANAGEMENT OF KINETIC ENERGY, MOMENTUM AND SURFACE TENSION FORCES. WHEN SUCCESSFUL, THE RESULTS OF THIS EFFORT COULD INCREASE THE USEFUL POWER GENERATION FROM THE SP-100 REACTOR FROM 100 KWE TO 400KWE AT THE SAME SIZE AND TOTAL MASS AT REDUCED REACTOR OPERATING TEMPERATURES.

SPARTA INC
1104 CAMINO DEL MAR
DEL MAR, CA 92014

CONTRACT NUMBER:

S N ROSENWASSER

TITLE:

CONFINED PLASMA ARMATURE DESIGN FOR IMPROVED RAILGUN PERFORMANCE

TOPIC# 2 OFFICE: IDENT#: 30537

SUBMITTED BY

THE ARMATURE IS A CRITICAL COMPONENT OF THE RAILGUN HYPERVELOCITY ELECTROMAGNETIC SYSTEM AND PLAYS A MAJOR ROLE IN DETERMINING ITS PERFORMANCE, EFFICIENCY AND LIFETIME. CONFINED PLASMA ARMATURES APPEAR TO HAVE SIGNIFICANT POTENTIAL ADVANTAGES WITH RESPECT TO REDUCING BORE DAMAGE AND INCREASING SYSTEM EFFICIENCY COMPARED TO THE CURRENTLY STUDIED UNCONFINED PLASMA, SOLID, TRANSITIONING AND HYBRID ARMATURE CONCEPTS. THE FEASIBILITY IS BEING INVESTIGATED USING A CONFINED PLASMA ARMATURE DESIGN (CPAD). THE CONCEPT IS BASED ON THE DESIGN OF A VERY HIGH STRENGTH TO WEIGHT RATIO ADVANCED COMPOSITE STRUCTURE TAILORED TO MEET THE COMPLEX THERMAL/STRUCTURAL LOADING CONDITIONS OF THE CONFINED PLASMA AND ACCELERATION FORCES. THIS PROGRAM INCLUDES MODELING THE CONFINED PLASMA TO DEFINE THE DESIGN ENVIRONMENTS; ADVANCED COMPOSITE MATERIALS EVALUATION AND SELECTION; THERMAL ANALYSIS AND DESIGN OF THE CONFINING STRUCTURE; CPAD PROTOTYPE FABRICATION; AND AN ANALYSIS OF THE PERFORMANCE PAYOFFS OF THE CPAD CONCEPT. WHEN SUCCESSFUL, THIS RESEARCH WOULD LEAD TO HYPERVELOCITY RAILGUNS THAT OPERATE AT HIGH EFFICIENCY WITH MUCH IMPROVED BARREL LIFETIME. POTENTIAL APPLICATIONS OF CONFINED ARMATURES ARE FOUND IN IMPROVED PERFORMANCE ELECTROMAGNETIC RAILGUNS FOR STRATEGIC AND TACTICAL DEFENSE WITH COMMERCIAL APPLICATIONS FOR LAUNCHING PAYLOADS INTO SPACE AND FOR MATERIALS PROCESSING.

SPARTA INC
21 WORTHEN ROAD
LEXINGTON, MA 02173
CONTRACT NUMBER:
DR R F ADAMOWICZ
TITLE:
LOW-POWER OPTICAL BEAMSTEERING WITH ARTIFICIAL DIELECTRICS
TOPIC# 3 OFFICE: IDENT#: 30545

DEVELOPMENT AND APPLICATION OF MIXED-PHASE MEDIA IS BEING INVESTIGATED AS RAPID RESPONDING ARTIFICIAL DIELECTRICS FOR LOW POWER OPTICAL BEAMSTEERING IN SPACE-BASED OPTICAL SURVEILLANCE AND DISCRIMINATION SYSTEMS AT INFRARED WAVELENGTHS. THE GRADIENT AND THE MOMENTUM FORCES ASSOCIATED WITH THE INTERFERENCE OF TWO COHERENT LIGHT BEAMS ON A DISTRIBUTION OF SMALL PARTICLES FORMING A VOLUMETRIC PHASE GRATING IN AEROSOL-GAS MIXTURES ARE THE PHENOMENA UNDER STUDY. PREVIOUS STUDIES

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HAD SUGGESTED THAT VOLUMETRIC GRATING WITH DIFFRACTION EFFICIENCIES APPROACHING 100% MAY BE FORMED IN THE MULTI-PHASE MEDIA ON TIME SCALES LESS THAN A MILLISECOND. THESE FORCES ARE BEING STUDIED AS ARE THE ENERGY AND TIME REQUIRED FOR GRATING FORMATION, AND THE IDENTIFICATION OF THE PHENOMENA THAT MAY LIMIT HIGH DIFFRACTION EFFICIENCY. ENHANCEMENT OF THE EFFECT OF THE FORCES FORMING THE VOLUMETRIC GRATING, THROUGH NEAR-RESONANCE WITH ELECTRONIC TRANSITIONS AND SURFACE MODES, AEROSOL SHAPE, COMPOSITION, AND LAYERED-COMPOSITION ARE BEING INVESTIGATED. ANTICIPATED BENEFITS OF THIS WORK, WHEN SUCCESSFUL, ARE NOVEL, EFFICIENT, RAPID RESPONSE BEAM STEERING MEDIA CAPABLE OF DEFLECTING BOTH HIGH-POWER LASER BEAMS AND THEIR RETURN SIGNALS USING A LOW POWER, FREQUENCY AGILE CONTROL LASER. ADDITIONAL BENEFITS OF THIS STUDY COULD BE THE DEVELOPMENT OF NEW MEDIA FOR FOUR-WAVE MIXING STUDIES AND PROCESSES AND FOR LOW POWER OPTICAL SWITCHING SYSTEMS.

SPIRE CORP
PATRIOTS PK
BEDFORD, MA 01730
CONTRACT NUMBER:
DR WARD D HALVERSON
TITLE:
ION IMPLANTED INSULATORS FOR KINETIC ENERGY WEAPONS
TOPIC# 2 OFFICE: IDENT#: 30357

EROSION OF THE INSULATING MATERIAL IN THE BORE OF ELECTROMAGNETIC (EM) LAUNCHERS WILL LIMIT THE LIFETIME, ACCURACY, RELIABILITY, AND PERFORMANCE OF TACTICAL AND STRATEGIC DEFENSE WEAPONS. ION IMPLANTATION IS BEING INVESTIGATED TO IMPROVE FRACTURE TOUGHNESS OF CERAMICS WHICH HAVE BEEN SHOWN TO HAVE GOOD EROSION RESISTANCE IN RAILGUN EXPERIMENTS: ALUMINA, YTTRIUM STABILIZED ZIRCONIA, AND SILICON NITRIDE. ION SPECIES WHICH INCREASE SURFACE HARDNESS, FRACTURE TOUGHNESS, AND DUCTILITY OF THESE CERAMICS ARE BEING IMPLANTED INTO SAMPLE COUPONS, AND THE SAMPLES ARE BEING EXPOSED TO AN ARCHING ENVIRONMENT WHICH SIMULATES THE BREECH REGION OF A HIGH PERFORMANCE EM RAILGUN. THE TESTED COUPONS, ALONG WITH APPROPRIATE CONTROLS, ARE THEN BEING ANALYZED FOR EROSION RATE, CRACKING, SPALLING, AND OTHER PROPERTIES. SIGNIFICANT REDUCTIONS OF ARC-INDUCED EROSION COULD LEAD TO A LATER RESEARCH EFFORT IN WHICH THE ION IMPLANTATION PARAMETERS AND CERAMIC MATERIALS WOULD BE OPTIMIZED AND TESTED IN A FULL-SCALE EXPERIMENT.

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WHEN SUCCESSFUL, INCREASED LIFETIME OF INSULATORS IN ELECTROMAGNETIC LAUNCHERS WOULD INDICATE THAT INSULATORS IN CIRCUIT BREAKERS, SPARK SWITCHES, LASERS, AND PARTICLE ACCELERATORS ALSO CAN HAVE IMPROVED EROSION PROPERTIES.

SPIRE CORP
PATRIOTS PK
BEDFORD, MA 01730
CONTRACT NUMBER:
VICTOR E HAVEN
TITLE:
SELECTIVE-AREA EPITAXY OF GALLIUM ARSENIDE ON SILICON
TOPIC# 14 OFFICE: IDENT#: 30769

THERMAL EXPANSION MISMATCH BETWEEN GALLIUM-ARSENIDE (GaAs) AND SILICON (Si) CAUSES SUBSTRATE BOWING AND CRACKING DURING COOLING FROM THE GROWTH TEMPERATURE. THIS IS A MAJOR OBSTACLE TO OVERCOME BEFORE THE FULL POTENTIAL OF THIS MATERIAL CAN BE REALIZED. THE FEASIBILITY IS BEING INVESTIGATED OF USING SELECTIVE-AREA EPITAXY OF GaAs ON Si TO REDUCE THE TENSILE STRESS TO A LEVEL WHERE SUCH SUBSTRATE BOWING AND CRACKING WILL NOT BE A PROBLEM. METALORGANIC CHEMICAL VAPOR DEPOSITION (MOCVD) IS BEING UTILIZED FOR DEPOSITING AREAS OF GaAs, WITH VARYING DIMENSIONS, ON TWO-INCH Si SUBSTRATES THROUGH OPENINGS PATTERNED ON SILICON DIOXIDE (SiO₂). THE EFFECTS OF THIS TECHNIQUE ON SUBSTRATE BOWING, FILM CRACKING, CRYSTALLOGRAPHIC PROPERTIES AND TREADING DISLOCATIONS ARE BEING DETERMINED. SPECIFICALLY THE FOLLOWING ARE BEING ESTABLISHED: BASIC PROCESS FOR PATTERNING THERMALLY GROWN SiO₂; MOCVD GROWTH PARAMETERS FOR THE DEPOSITION OF GaAs OVER PATTERNED SiO₂ ON Si; AND WORKABLE PROCESS TO REMOVE GaAs AND SiO₂ FROM UNWANTED AREAS. THE TECHNIQUES DEVELOPED ARE EXPECTED TO BE INSTRUMENTAL IN REDUCING TREADING DISLOCATIONS TO BE ADDRESSED IN A LATER STUDY. WHEN SUCCESSFUL, THIS TECHNOLOGY WOULD YIELD DEVICE QUALITY GaAs ON Si AND A PROCESS APPLICABLE FOR MONOLITHIC INTEGRATION OF GaAs AND Si DEVICES, GREATLY ENHANCING PRESENT DEVICE CAPABILITIES.

SRS TECHNOLOGIES
990 EXPLORER BLVD NW
HUNTSVILLE, AL 35806
CONTRACT NUMBER:
ROBERT A PILGRIM
TITLE:
OPTICAL COMPUTING AND OPTICAL SIGNAL PROCESSING
TOPIC# 11 OFFICE: IDENT#: 30547

SUBMITTED BY

THE REDUCED LEVEL OF INTERFERENCE IN OPTICAL COMPUTERS AND THE LOW THERMAL MASS OF THEIR MATERIALS MAKE OPTICAL COMPUTING SIGNAL PROCESSORS AN ATTRACTIVE ALTERNATIVE FOR STRATEGIC APPLICATIONS. THE NEURAL-NETWORK APPLIED TO SIGNAL AND IMAGE PROCESSING HAS BEEN DEMONSTRATED TO EXHIBIT COMPARABLE PERFORMANCE TO THAT ACHIEVABLE USING MORE CONVENTIONAL APPROACHES. OPERATIONAL AND PERFORMANCE REQUIREMENTS ARE BEING DEFINED FOR THE NEURAL NETWORK SIGNAL PROCESSOR (NNSP). THIS FEASIBILITY IS BEING INVESTIGATED OF THE NNSP CONCEPT IN BOTH ITS ELECTRONIC AND OPTICAL IMPLEMENTATIONS. THE NEURAL NETWORK APPROACH IS BEING COMPARATIVELY ANALYZED WITH STANDARD METHODS IN TERMS OF PERFORMANCE LEVEL, COMPUTATIONAL COMPLEXITY AND TECHNICAL RISK. THE APPROPRIATE NNSP MODEL IS BEING DEFINED FOR A PROOF-OF-PRINCIPLE DEMONSTRATION. THE IMPLEMENTATION OF THIS SIGNAL PROCESSING MODEL INTO OPTICS IS BEING EXPLORED INCLUDING THE DEFINITION OF THE INPUT-OUTPUT INTERFACES BETWEEN THE OPTICAL NNSP AND THE LONG WAVELENGTH INFRARED SENSOR FOCAL PLANE AND PROCESSOR. DESIGN TRADE STUDIED FOR THIS DEVICE ARE BEING PERFORMED AND A DETAILED DESCRIPTION PROVIDED OF A METHODOLOGY LEADING TO THE FABRICATION OF A PROTOTYPE OPTICAL NNSP. THE POTENTIAL APPLICATIONS FOR OPTICAL COMPUTING AND FOR NEURAL-NETWORKS INCLUDE IMAGE UNDERSTANDING SYSTEMS; COGNITIVE SYSTEMS FOR DECISION SUPPORT APPLICATIONS; AND PATTERN RECOGNITION SYSTEMS IN STABLE TRAINING ENVIRONMENTS.

STD RESEARCH CORP

PO BOX C

ARCADIA, CA 91006

CONTRACT NUMBER:

STERGE T DEMETRIADES

TITLE:

EXTENDED-DURATION BENCHTOP HYBRID COMBUSTOR EXPERIMENTAL DEVICE

TOPIC# 5

OFFICE:

IDENT#: 30364

AN EXTENDED-DURATION BENCHTOP HYBRID COMBUSTOR, SOLID FUEL, LIQUID OXIDIZER, EXPERIMENTAL APPARATUS IS BEING DEVELOPED TO PRODUCE A TEST DEVICE FOR AFFORDABLE, SMALL-SCALE, REALISTIC EXPERIMENTS WITH HIGH-PRESSURE (GREATER THAN 1500 PSI) AND LONG DURATION (MORE THAN 500 SEC) HYBRID COMBUSTOR FIRINGS. A SIMILAR COMBUSTOR IS BEING DESIGNED AND BUILT WITHOUT AUTOMATIC CONTROLS AND SERVO ACTUATORS. AN INJECTION

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AND NOZZLE COOLING SYSTEM ALSO IS BEING DESIGNED AND FABRICATED TO OBTAIN THE OPTIMAL SPRAY PATTERN IN THE SPHERICAL COMBUSTION CHAMBER. TESTS ARE BEING CONDUCTED TO ENSURE THAT A FINAL DESIGN WILL WORK. WHEN SUCCESSFUL, THIS APPARATUS WOULD PROVIDE THE BASIS FOR REALISTIC TESTING AND CHARACTERIZATION OF NEW AND MORE POTENT HYBRID FUEL COMBINATIONS FOR SPACE POWER DEVICES, VARIOUS HYBRID COMBUSTOR COMPONENTS (E.G. COOLED NOZZLES), MAGNETO-HYDRODYNAMIC (MHD) GENERATOR MATERIALS, AND STOP-START CAPABILITIES IN THE SUCCESSFUL DEVELOPMENT OF MHD OR OTHER SPACE POWER SYSTEMS. COMMERCIAL APPLICATIONS IN EARTH SOUNDINGS OR TOMOGRAPHY FOR DETAILED, LARGE SCALE UNDERGROUND EXPLORATION AND MAPPING, EARTHQUAKE FAULT AND ORE DETECTION ALSO WOULD BECOME POSSIBLE WITH THE DEVELOPMENT OF THIS TECHNOLOGY.

SUPERCON INC
830 BOSTON TURNPIKE
SHREWSBURY, MA 01545

CONTRACT NUMBER:

DR JAMES WONG

TITLE:

ENHANCED J IN $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ CONDUCTORS USING DUAL-TEMPERATURE EXTRUSION PROCESSING

TOPIC# 15

OFFICE:

IDENT#: 30367

THE DEVELOPMENT OF YBaCuO ("123"), LIQUID NITROGEN SUPERCONDUCTORS IS LIMITED BY THE INABILITY TO ACHIEVE LARGE TRANSPORT CRITICAL CURRENT DENSITIES (J_c 'S) IN BULK-PROCESSED POLYCRYSTALLINE MATERIALS BECAUSE OF WEAK LINK BEHAVIOR. THE FEASIBILITY IS BEING EXPLORED OF INCREASING THE HIGH FIELD CURRENT DENSITY OF YBaCuO SUPERCONDUCTORS USING DUAL TEMPERATURE EXTRUSION PROCESSING WHILE MAINTAINING CLEAR GRAIN BOUNDARIES. THE "123" POWDERS ARE BEING PROCESSED, AVOIDING THE PRESENCE OF A NON-SUPERCONDUCTING $\text{BaCuO}_2\text{-CuO}$ EUTECTIC, WITH A MELTING TEMPERATURE AROUND 900 CELSIUS. DUAL-TEMPERATURE EXTRUSION TECHNIQUES ARE BEING USED TO COLD WORK AND DENSIFY POWDERS. THE PROCESS IS EXPECTED TO PRODUCE A WORKABLE, DUCTILE, HIGH TEMPERATURE SUPERCONDUCTOR ABLE TO STAND FURTHER FABRICATION. WHEN SUCCESSFULLY DEMONSTRATED, A SUBSTANTIAL IMPROVEMENT WOULD BE MADE IN TRANSPORT J_c IN BULK-PROCESSED "123" MATERIALS. SECONDARY RESULTS WOULD COME FROM THE RESEARCH EFFORT, SUCH AS UNDERSTANDING THE DEFORMABILITY OF THE "123" MATERIALS; INFORMATION ON COMPATIBILITY, BOTH CHEMICAL AND MECHANICAL,

SUBMITTED BY

WITH THE CLADDING MATERIALS; AND INFORMATION ON THE ABILITY TO DENSIFY THESE MATERIALS WITHOUT LOSS OF OXYGEN.

SUPERCON INC
830 BOSTON TURNPIKE
SHREWSBURY, MA 01545
CONTRACT NUMBER:
DR JAMES WONG
TITLE:
ENHANCED J IN $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ CONDUCTORS USING LOW-TEMPERATURE DENSIFICATION
TOPIC# 15 OFFICE: IDENT#: 30369

THE DEVELOPMENT OF HIGH- T_c SUPERCONDUCTING OXIDES IS LIMITED BY THE INABILITY TO ACHIEVE LARGE TRANSPORT CRITICAL CURRENT DENSITIES (J_c 'S) IN BULK-PROCESSED POLYCRYSTALLINE MATERIALS BECAUSE OF WEAK LINK BEHAVIOR. IN THE YBaCuO SYSTEM, THESE WEAK LINKS SEEM TO BE RELATED TO THE FORMATION OF A LIQUID EUTECTIC SECOND PHASE WHICH COATS THE SURFACES OF GRAIN BOUNDARIES. RECENTLY, ENCOURAGING RESULTS HAVE BEEN OBTAINED THAT SUGGEST THAT THE THALLIUM-BASED SYSTEM MAY BE LESS SUSCEPTIBLE TO THIS WEAK-LINK EFFECT. ROOM TEMPERATURE SWAGING TECHNIQUES ARE BEING USED TO COLD WORK AND DENSIFY THE POWDERS. WHEN SUCCESSFULLY DEMONSTRATED, THE PROCESS IS EXPECTED TO PRODUCE A WORKABLE, FLEXIBLE, HIGH TEMPERATURE SUPERCONDUCTOR ABLE TO STAND FURTHER FABRICATION. SECONDARY RESULTS WOULD COME FROM THE RESEARCH EFFORT, SUCH AS UNDERSTANDING THE DEFORMABILITY OF THE "123" MATERIALS, INFORMATION ON THE COMPATIBILITY, BOTH CHEMICAL AND MECHANICAL, WITH THE CLADDING MATERIALS, AND INFORMATION ON THE ABILITY TO DENSIFY THESE MATERIALS WITHOUT LOSS OF OXYGEN.

SYMETRIX CORP
1873 AUSTIN BLUFFS PKWY
COLORADO SPRINGS, CO 80918
CONTRACT NUMBER:
L D McMILLAN
TITLE:
RADIATION-HARD FERROELECTRIC-ON-GaAs RANDOM ACCESS MEMORIES FOR MISSILES AND/OR SPACECRAFT
TOPIC# 14 OFFICE: IDENT#: 30549

SUBMITTED BY

A SYSTEMATIC STUDY OF THE SPUTTERING TECHNOLOGY AND INTERFACE METALLURGY FOR LEAD ZIRCONATE TITANATE/PLATINUM/GALLIUM-ARSENIDE (PZT/Pt/GaAs) IS BEING UNDERTAKEN THAT IS EXPECTED TO PERMIT LARGE, RAD-HARD, NONVOLATILE FERROELECTRIC RANDOM ACCESS MEMORIES (RAMS) TO BE CONSTRUCTED. EXISTING PROTOTYPE PZT MEMORY DEVICES HAVE BEEN FABRICATED THUS FAR ONLY ON COMPOSITE METAL-OXIDE SEMICONDUCTOR (CMOS) SILICON DECODERS AND EXTENSION OF THE TECHNOLOGY TO RAD-HARD SUBSTRATES SUCH AS GaAs IS URGENT. AN EXPERIMENTAL STUDY OF UNDECODED PZT/Pt/GaAs ARRAYS IS BEING CONDUCTED TO DETERMINE PROCESSING STEPS REQUIRED TO FABRICATE COMMERCIALY VIABLE RAD-HARD MEMORIES. SPECIFICALLY, GaAs SUBSTRATES ARE BEING USED THAT HAVE TEST PATTERNS OF FERROELECTRIC CAPACITORS OF SIZES FROM 2 TO 250 MICRONS DEPOSITED ON THEM WITH PLATINUM ELECTRODES WITH AND WITHOUT POLY LAYERS. COMPATIBILITY OF GaAs/Pt, GaAs/POLY-Si/Pt, AND GaAs/PZT, GaAs/POLY-Si/PZT INTERFACES ARE BEING TESTED WITH RESPECT TO MECHANICAL ADHESION AND ELECTRICAL SWITCHING CHARACTERISTICS. TOGETHER WITH PROCESSING PARAMETER. ANNEALING STUDIES ARE BEING UNDERTAKEN. Pt ELECTRODES ARE BEING ALLOYED TO MAXIMIZE ADHESION. MULTIPLE METAL LAYERS ARE BEING EXPERIMENTED WITH AS AN ALTERNATIVE TO POLYSILICON. FABRICATION AND TESTING OF A PROTOTYPE, FULLY DECODED 256-OR 512 PZT-ON-GaAs CMOS RAM WOULD BE PERFORMED IN A LATER PHASE.

SYNTERIALS

318 VICTORY DR
HERNDON, VA 22070

CONTRACT NUMBER:

DR RICHARD E ENGDahl

TITLE:

HIGH TEMPERATURE ZERO COEFFICIENT OF THERMAL EXPANSION SPACE
STRUCTURE MATERIAL

TOPIC# 13

OFFICE:

IDENT#: 30720

GRAPHITE/EPOXY MATERIALS CURRENTLY USED FOR VARIOUS SPACE STRUCTURES NEED IMPROVED THERMAL AND DIMENSIONAL STABILITY. A PROCESS IS BEING DEVELOPED TO PRODUCE "ZERO" COEFFICIENT OF THERMAL EXPANSION (CTE) SHEET MATERIAL WITH ZERO WATER ABSORPTION FOR CONSTRUCTING A WIDE VARIETY OF SPACE STRUCTURES. ADVANCED COATING TECHNOLOGIES MAKE IT POSSIBLE TO COAT THE INDIVIDUAL FILAMENTS IN GRAPHITE CLOTH MATE-

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RIAL. THIS TECHNOLOGY PERMITS THE APPLICATION OF A QUARTZ TYPE MATRIX OVER A SUITABLE INTERFACE MATERIAL, ON A GRAPHITE CLOTH. COMPOSITE SPECIMENS ARE BEING DEVELOPED FOR LABORATORY TESTING AND HOT ROLLED INTO THIN SHEETS FOR SECONDARY FABRICATION INTO HONEYCOMB STRUCTURES. THE UNIFORMITY OF THE MULTIPLE LAYER COATING, THE CTE OF THE COMPOSITES, AND THE STRENGTH AND FORMABILITY OF THE FABRICATED COMPOSITE ARE BEING MEASURED. ROLL FORMING THIS PRECURSOR MATERIAL IS EXPECTED TO PROVIDE A THIN "ZERO" CTE SHEET STOCK FOR LIGHT WEIGHT, STIFF, STABLE SPACE STRUCTURES. PAPER THIN SHEETS OF THIS MATERIAL, WHEN SUCCESSFULLY FABRICATED AND DEMONSTRATED, COULD BE FURTHER PROCESSED INTO THE MANY DIFFERENT TYPES OF SPACE STRUCTURE REQUIRED. LONG, THIN WALL TUBES AND HONEYCOMB STRUCTURES ARE TWO SUCH POSSIBLE SECOND STAGE CONFIGURATIONS. THESE WOULD PROVIDE THE BASIS FOR AN ARRAY OF MATERIALS SUITABLE TO MEET THE DEMANDING REQUIREMENTS OF SPACE STRUCTURES.

TECHNO-SCIENCES INC
7833 WALKER DR - STE 620
GREENBELT, MD 20770
CONTRACT NUMBER:
CHARLES FLETCHER
TITLE:
DIGITAL DECONVOLUTION METHODS FOR MULTIPLE SENSORS
TOPIC# 3 OFFICE: IDENT#: 30723

ANALYTICAL SIGNAL PROCESSING AND MODELING TOOLS FOR THE ENHANCEMENT OF TARGET DETECTION AND ESTIMATION IN ADVANCED RADARS ARE BEING INVESTIGATED. AN APPROACH IS BEING USED BASED ON RECENT WORK OF DECONVOLUTION METHODS FOR MULTI-SENSOR SYSTEMS, A VERSION OF COMPUTED TOMOGRAPHY. THE METHODOLOGY CAN FUNCTION EFFECTIVELY EITHER FROM MULTI-PULSE SIGNALS OR FROM MULTIPLE (SPLIT) BEAMS WITHOUT INCREASING THE PROCESSING TIME OVER SINGLE PULSE SYSTEMS. ENHANCED RANGE RESOLUTION CAPABILITIES FOR ADVANCED RADARS IS ANTICIPATED TO BE DEMONSTRATED BASED ON THE DECONVOLUTION METHODOLOGY IN COMBINATION WITH SOME RECENT WORK ON THE USE OF FALOIS SEQUENCES FOR PRECISE RESOLUTION. WHEN SUCCESSFUL, THIS PROJECT WOULD PROVIDE A PROOF OF CONCEPT FOR SIGNAL PROCESSING ALGORITHMS AND NOISE MODES TO REDUCE THE STATISTICAL RANGING ERROR INHERENT IN RADAR SYSTEMS.

TETRA CORP
4905 HAWKINS ST NE
ALBUQUERQUE, NM 87109
CONTRACT NUMBER:
WILLIAM M MOENY
TITLE:
CLOSED CYCLE REPETITIVE CLOSING SWITCH
TOPIC# 5 OFFICE: IDENT#: 30286

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ONE OF THE PROBLEMS IN PULSED SYSTEMS FOR SPACE IS CONSUMABLES REQUIRED FOR CERTAIN TYPES OF SWITCHES. MANY OF THE PRESENT HIGH POWER SWITCHING FUNCTIONS ARE CARRIED OUT USING SPARK GAPS BUT SPARK GAPS REQUIRE GAS PURGE FOR REPETITIVE OPERATION. THE FEASIBILITY OF USING SELF-SUSTAINED GLOW DISCHARGES AS A SWITCH MEDIUM FOR HIGH REPETITION RATE CLOSING SWITCHES PREVIOUSLY HAS BEEN DEMONSTRATED. THOSE RESEARCH RESULTS ARE BEING EXTENDED TO THE DEVELOPMENT OF CLOSED CYCLE REPETITIVE CLOSING SWITCHES. SUCH A CLOSED CYCLE SWITCH MIGHT PASS THE GAS FOR THE SWITCH FOR REPETITIVE OPERATION PERHAPS 1 TO 200 HZ IN PERHAPS 500 KA. INSTEAD OF THROWING THE GAS OVERBOARD BECAUSE OF IRREVERSIBLE CHEMISTRY CHANGES, IT WOULD BE EXPECTED TO COOL THE GAS AND RECYCLE IT. THE FEASIBILITY OF THE CONCEPT IS BEING DETERMINED BY CONDUCTING SPECIFIC EXPERIMENTS AND THEORETICAL ANALYSES ON GAS DISCHARGE PHYSICS ON EXISTING SMALL SCALE HARDWARE TO DETERMINE THE OPERATING CHARACTERISTICS AND LIFETIME CHARACTERISTICS OF THE CONCEPT. WHEN SUCCESSFUL, THIS SWITCH WOULD BENEFIT SPACE BASED AND AIRBORNE PULSE POWER SYSTEMS BY SUBSTANTIALLY REDUCING THEIR TOTAL SYSTEM WEIGHT AND COST FOR REPETITIVE OPERATION. COMMERCIAL APPLICATION WOULD BE ORIENTED PRIMARILY TO INDUSTRIAL LASER SWITCHING AND DISCHARGE MACHINING FOR REMOTE OR PORTABLE APPLICATION OF PULSE POWER WHERE RESUPPLY IS DIFFICULT.

TETRA CORP
4905 HAWKINS ST NE
ALBUQUERQUE, NM 87109
CONTRACT NUMBER:
WILLIAM M MOENY
TITLE:
PULSED POWER INSTRUMENTATION USING FIBER OPTIC TECHNOLOGY
TOPIC# 5 OFFICE: IDENT#: 30724

MODERN PULSED POWER WEAPONS SYSTEMS PLACE SIGNIFICANT DEMANDS ON INSTRUMENTATION FOR CURRENT AND VOLTAGE MEASUREMENT AND TRIGGER CONTROL. CONVENTIONAL INSTRUMENTATION BECOMES VIRTUALLY IMPOSSIBLE TO USE IN THE PRESENCE OF HIGH ELECTRICAL NOISE CHARACTERISTIC OF SUCH SYSTEMS. OPTICAL ISOLATION OF SENSOR AND COMMAND AND CONTROL SIGNALS IS REQUIRED FOR EFFECTIVE OPERATION OF THESE PULSED POWER WEAPONS SYSTEMS. SIMPLE, RELIABLE, FIBER-OPTIC PULSED-POWER INSTRUMENTATION

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SYSTEMS ARE BEING DEVELOPED THAT ARE ANTICIPATED TO PROVIDE NEAR GIGAHZ RESPONSE FOR VOLTAGE AND CURRENT MEASUREMENTS AND LOW JITTER COMMAND AND CONTROL SIGNALS. THE OBJECTIVE IS TO DEVELOP FIBER OPTIC VOLTAGE AND CURRENT INSTRUMENTATION SYSTEMS WITH LINEAR OUTPUT AND 1 NANOSECOND RISE TIME. THE FEASIBILITY IS BEING DETERMINED OF DEVELOPING SUCH HIGH FREQUENCY VOLTAGE AND CURRENT MEASUREMENT SYSTEMS FOR PULSED POWER APPLICATIONS. THE STATE-OF-THE-ART AND POTENTIAL FOR FUTURE DEVELOPMENT FOR LASER DIODES AND RECEIVERS IS BEING SURVEYED AND THE FEASIBILITY OF THE APPROACH IS BEING EXAMINED BY CONDUCTING PULSED POWER MEASUREMENTS AT LOWER FREQUENCY RESPONSE. FIBER OPTIC INSTRUMENTATION SYSTEMS ARE BEING FABRICATED AND TESTED ON A HIGH VOLTAGE (450 KV) PULSED POWER DEVICE AND A REPETITIVE (50 HZ) PULSED LASER (40 KW AVERAGE INPUT POWER) TO DETERMINE THE ISSUES WITH THE TECHNOLOGY.

THERMACORE INC
780 EDEN RD
LANCASTER, PA 17601
CONTRACT NUMBER:
JOHN R HARTENSTINE
TITLE:
HEAT PIPES FOR SODIUM SULFUR BATTERIES
TOPIC# 5 OFFICE: IDENT#: 30562

THE INCREASE IN SPACECRAFT POWER REQUIREMENTS HAS MADE THE SODIUM-SULFUR BATTERY A LIKELY CANDIDATE AS A SUPPORTING ENERGY STORAGE CELL. THERMAL MANAGEMENT OF THE SODIUM-SULFUR BATTERY IS REQUIRED DUE TO ITS CYCLIC OPERATION WHILE IN AN ON-ORBIT MODE. INSUFFICIENT THERMAL MANAGEMENT CAN REDUCE BATTERY EFFICIENCY AND CAUSE POSSIBLE DAMAGE TO SURROUNDING ELECTRONIC EQUIPMENT. VARIABLE CONDUCTANCE TITANIUM/POTASSIUM HEAT PIPES MAY PROVIDE EFFICIENT, PASSIVE THERMAL MANAGEMENT OF SODIUM-SULFUR BATTERIES IN DISCHARGE AND RECHARGE MODES, WITHOUT LARGE WEIGHT PENALTIES. A PROTOTYPE VARIABLE CONDUCTANCE HEAT PIPE (VCHP) AND A FULL SCALE THERMAL MANAGEMENT PACKAGE ARE BEING DEVELOPED FOR SODIUM-SULFUR BATTERIES INCORPORATING THE TITANIUM/POTASSIUM VCHP. DESIGN PARAMETERS OF A TITANIUM/POTASSIUM VCHP ARE BEING DEFINED FOR USE IN SODIUM-SULFUR BATTERIES, PROTOTYPE AND FULL SCALE. A PROTOTYPE TITANIUM/POTASSIUM VCHP IS BEING DESIGNED, FABRICATED, AND TESTED. A THERMAL MANAGEMENT SYSTEM IS BEING DESIGNED FOR SODIUM-SULFUR

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BATTERIES INCORPORATING THE PROTOTYPE VCHP DESIGN AS IS THE SUPPORTING HARDWARE REQUIRED FOR INTEGRATION WITH THE BATTERY. WHEN SUCCESSFUL, THIS EFFORT WILL RESULT IN THE INTEGRATION OF TITANIUM/POTASSIUM VARIABLE CONDUCTANCE HEAT PIPES INTO POWER SYSTEMS WHICH USE SODIUM-SULFUR BATTERIES.

VANGUARD RESEARCH INC
2810 OLD LEE HWY - STE 200
FAIRFAX, VA 22031
CONTRACT NUMBER:
PRESTON MARSHALL
TITLE:
PARAFOIL SUPPORT TO STRATEGIC DEFENSE SENSOR SYSTEMS
TOPIC# 3 OFFICE: IDENT#: 30568

THE OPERATION OF BALLISTIC MISSILE DEFENSE SENSOR SYSTEMS IS DEPENDENT ON BOTH THE PERFORMANCE CHARACTERISTICS OF THE SENSOR COMPONENTS AND THEIR APPROPRIATE PLACEMENT WITHIN THE BATTLE SPACE. A STUDY OF THE DESIGN FOR A NICOLAIDES-WING (N-WING) PARAFOIL-BASED SENSOR SYSTEM, SIMILAR TO AN AIRBORNE OPTICAL SENSOR OR PROBE IS BEING CONDUCTED. THE N-WING PARAFOIL IS A RAM AIR INFLATED WING WHOSE TOTAL STRUCTURAL WEIGHT IS LESS THAN THREE OUNCES PER SQUARE FOOT. THIS LOW WING LOADING IS ANTICIPATED TO ENABLE OPERATION AT MUCH HIGHER ALTITUDE THAN CONVENTIONAL WINGED STRUCTURES. THIS IS EXPECTED TO PROVIDE THE BASIS FOR AN EXTREMELY HIGH (20KM), LONG LOITER SENSOR VEHICLE WHOSE OPERATIONAL CAPABILITY SHOULD GREATLY ENHANCE THE STRATEGIC DEFENSE SYSTEM. THIS SYSTEM, WHEN SUCCESSFUL, WOULD PROVIDE A FLEXIBLE AND LOW COST SENSOR BASING CONCEPT THAT WOULD HAVE SIGNIFICANT SURVIVABILITY, COST, AND OPTIAL PERFORMANCE ADVANTAGES OVER OTHER BASING MODES.

ZTEK CORP
400-2 TOTEN POND RD
WALTHAM, MA 02154
CONTRACT NUMBER:
DR MICHAEL HSU
TITLE:
HIGH PERFORMANCE ZIRCONIA CELLS FOR SPACE POWER APPLICATIONS
TOPIC# 4 OFFICE: IDENT#: 30731

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TO MEET THE POWER REQUIREMENTS OF THE STRATEGIC DEFENSE MISSION, POWER SOURCES WHICH ARE COMPACT AND LIGHT-WEIGHT MUST BE DEVELOPED. THE ZIRCONIA CELL, WHICH HAS BEEN RECOGNIZED FOR ITS POTENTIAL TO OFFER HIGH ENERGY CONVERSION EFFICIENCY, IS EXPECTED TO ACHIEVE A WEIGHT-TO-POWER RATIO BETTER THAN 1 KG/KW AND VOLUME-TO-POWER RATIO, 1 ME3/MW. THE DEVICE IS ADAPTABLE TO A NUCLEAR ENERGY SOURCE IN CONJUNCTION WITH AN ELECTROCHEMICAL-LOOP. COMPOSITE STRUCTURAL TECHNIQUES HAVE BEEN APPLIED TO THE PLANAR CONFIGURATION CELL ASSEMBLY. A ZIRCONIA CELL IS COMPRISED OF ONE ZIRCONIA ELECTROLYTE MEMBRANE AND ONE LIGHTWEIGHT INTERCONNECTOR. IN THIS STUDY, HIGH PERFORMANCE ZIRCONIA ELECTROLYTE MEMBRANES ARE BEING INVESTIGATED. THIN ZIRCONIA ELECTROLYTE MEMBRANES ARE BEING FABRICATED TO MEET SPACE POWER REQUIREMENTS. MECHANICAL PROPERTIES OF THE THIN ELECTROLYTE ARE BEING CHARACTERIZED TO ESTABLISH CONFIDENCE IN ITS MECHANICAL RELIABILITY. ELECTROLYTE MEMBRANES ARE BEING TESTED TO DEMONSTRATE THE CAPABILITY IN HIGH POWER DENSITY OPERATIONS. WHEN SUCCESSFUL, DEVELOPMENT OF ZIRCONIA CELL TECHNOLOGY FOR HIGH PERFORMANCE MILITARY ELECTROCHEMICAL SYSTEMS WOULD ENHANCE THESE SYSTEMS' COMMERCIAL APPLICATIONS IN UTILITY AND INDUSTRIAL POWER GENERATION, CHEMICAL STOCK CONVERSIONS AND HYDROGEN PRODUCTION.

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