IMPLEMENTING ARRANGEMENT #1
BETWEEN THE UNITED STATES DEPARTMENT OF ENERGY AND THE COMMISSARIAT A L'ENERGIE ATOMIQUE OF FRANCE CONCERNING SHARING OF SPECIFIC SCIENCE AND TECHNOLOGY INFORMATION RELATED TO MEGAJOULE-CLASS SOLID STATE LASERS

As part of the Umbrella Agreement between the Department of Energy (DOE) and the Commissariat a l'Energie Atomique (CEA) for Cooperation in Research, Development and Applications of High Energy Lasers and High Energy Laser-Matter Interaction Physics, DOE and CEA have agreed to collaborate in the development of advanced laser systems, components, materials and materials manufacturing technologies for megajoule-class solid state laser facilities.

The Umbrella Agreement continues cooperation on high energy lasers between CEA and DOE, which has been in effect since December 19, 1981.

Although no formal agreement existed between the DOE and CEA for collaboration in megajoule-class laser research and development, both DOE and CEA independently developed advanced solid state laser systems, laser simulation codes, components, materials and materials manufacturing technologies for megajoule-class solid state lasers, with DOE undertaking a larger and more comprehensive effort than CEA. For instance, DOE undertook the construction of the Beamlet laser at Lawrence Livermore National Laboratory (LLNL) to prototype, at near full aperture scale, much of the science and technology of an individual beamlet of a megajoule-class solid state laser. DOE also funded at LLNL continuing development and improvement of a large number of laser physics and optics codes to model and optimize megajoule-class solid state lasers.

In order for DOE and CEA to fully benefit from any proposed joint development activities, it is essential their two programs be at the same level of science and technology with respect to megajoule-class solid state lasers. Under the auspices of the Umbrella Agreement, in order to bring the level of megajoule-class solid state laser science and technology of DOE and CEA on an equal basis, CEA has requested and DOE has agreed to make available to CEA, specific physics and technology information, documentation, and codes developed at LLNL on the megajoule-class laser. DOE declares to the best of its knowledge that the items and information specified in detail below, will allow CEA to continue its cooperation with DOE on megajoule-class laser science and technology at an equal level. In exchange for this information and assistance CEA will provide a total compensation of $18M to DOE via LLNL. The specific items to be delivered by DOE via LLNL to CEA are described in detail below and fall into two categories. The first category includes those

items for transfer before October 1, 1994, in exchange for a payment of $3M and the second category includes those items for transfer after October 1, 1994, in exchange for a payment of $15M.

DOE and CEA agree to make available to each other all relevant information generated during the performance of each task carried out under this Implementing Arrangement, including information which is protected as intellectual property or is business confidential.

The Party that receives the information shall have the right to freely use, and to have used, such information for future megajoule-class solid state laser facilities in the U.S. and in France. In the event that commercial manufacturers of a Party are provided information furnished under this Implementing Arrangement, such manufacturers shall be required to execute non-disclosure agreements to prevent further dissemination of such information.

Each Party having the right to use third party business confidential information under this Implementing Arrangement shall use its best efforts to obtain from the third party the right for the other Party to use such business confidential information for the performance of activities under this Implementing Arrangement and for the manufacture of components for future megajoule-class solid state laser facilities in the U.S. and in France, as appropriate.

Articles 6 and 10 and the Annex of the Umbrella Agreement are hereby incorporated by reference.

The confidentiality, use and non-disclosure rights and obligations of the Implementing Arrangement shall survive any termination of this Implementing Arrangement for a period of five years.

The following items are designated for transfer from DOE through LLNL to CEA during the time period of August through September, 1994, in exchange for the transfer from CEA to DOE via LLNL of $3M for these items:

I. Transfer of CHAINOP code and operating assistance

The CHAINOP family of rapid laser design exploration and optimization codes consists of three versions: a Macintosh version written in QuickBASIC, an optimizer-shell-embedded Macintosh version written largely in FORTRAN, and a combined PC-workstation version written in C. The CHAINOP codes are very fast, but they get speed by only doing propagation very approximately. They are not appropriate for detailed laser system design or analysis. Correct use of any CHAINOP version requires experience with large laser designs, and an extensive database of relevant input information,

The first code has already been transferred in source and object format to CEL-V, where it is operating correctly. Operating assistance is being supplied by LLNL. The second code has been sent in source form, less the detailed supplier proprietary cost algorithms specific to that version. The third code was put on the CEL-V unclassified Sun network in source format in May, but is not yet operational due to problems with the Sun C compiler. LLNL will resolve these problems and get the C version operating by August. LLNL will check the code for correct operation by making demonstration runs.

LLNL has already supplied extensive assistance in the compilation and operation of these codes, and has supplied many input data files for use in exploring design alternatives. This assistance will continue to be supplied as appropriate throughout FY 1994.

II. Transfer of PROP92

The PROP92 family of codes consists of the PROP1 1-dimensional FFT code, the HANK 1-dimensional radial-symmetry Hankel transform code, and the PROP2 2-dimensional FFT code. These are large, sophisticated codes that require extensive detailed input data and need hours of run time on 30 megaflop computers. LLNL has already transferred the source code to CEL-V, and has discussed a number of code runs in detail with CEL-V personnel in order to increase their understanding of the codes. These runs simulate both the NIF baseline and the "demi-tour", or L-Turn laser configurations. Because of problems with the Sun operating system and compilers, the codes can not be made to run on the Sun systems at CEL-V. It has therefore been agreed that CEL-V will purchase and install a HP 712/80 system to run these and other LLNL codes, since LLNL develops the codes on similar systems. Once this machine is installed, LLNL will compile the codes, check them for correct operation by making demonstration runs, and assist CEL-V in the use of the codes. LLNL expects that assistance will not be completed in FY 1994 and will require support in FY 1995.

III. Transfer of FREQCONV codes and operating assistance

The FREQCONV family of codes consists of a number of programs to calculate the doubling and tripling of laser beams in one-crystal and two-crystal converters. These codes calculate the conversion of beams with spatial amplitude and phase modulation, and with temporal amplitude and phase modulation. LLNL has already transferred the source code to CEL-V, and has discussed a number of code runs in detail with CEL-V personnel in order to increase their understanding of the codes. These runs simulate frequency conversion in the Beamlet and in the NIF baseline. The frequency conversion codes have the same problems with the Sun operating system and compilers that the PROP92 codes have. Once the new HP machine is installed, LLNL will compile the codes, check them for correct operation, and assist CEL-V in the proper use of the codes. LLNL expects that assistance will not be completed in FY

1994 and will require support in FY 1995.

IV. Transfer of amplifier pumping model code and operating assistance

LLNL has transferred the amplifier pumping model used in CHAINOP, PROP92 and other codes to CEL-V in source code form. LLNL has compiled the code and made a satisfactory demonstration run. The code is now ready for use by CEL-V. LLNL will supply assistance in its use as jointly agreed between LLNL and CEL-V personnel.

V. Transfer of YAG graphics library and operating assistance

The YAG graphics library is used by PROP92, and the frequency conversion codes, and by other LLNL laser design codes. LLNL has transferred the source code to CEL-V. The YAG code has the same problems with the Sun operating system and compilers that the PROP92 codes have. Once the new HP machine is installed in FY 1994, LLNL will compile the code, check it for correct operation, and assist CEL-V in the proper use of the code.

VI. NIF Core Science and Technology Plan

One copy of the Core Science and Technology Plan will be provided to CEL-V. The Core Science and Technology Plan is a comprehensive planning document of approximately 400 pages which describes all of the development work that is being scheduled to support the indirect drive ICF program. The plan cover seven major areas of activities: 1) laser technology 2) optic manufacturing 3) target chamber components 4) target diagnostics 5) target design 6) target fabrication and 7) target experiments. In each of these areas the science and technology status is described relative to the performance and cost requirements that are needed for the National Ignition Facility (NIF). Future work that is needed to advance selected technologies is recommended and is detailed in specific work activity descriptions and planning schedules. This includes research and development, test and evaluation, physics and engineering analysis, proto-typing, computer modeling, and other supporting activities. The plan covers a 10 year time span for some activities but emphasizes FY 1995 through FY 1997 to assure that the needs of the NIF Project, which is completing design details during this time, are satisfied.

VII. NIF Conceptual Design Report

One copy of the complete baseline Conceptual Design Report submitted in fulfillment of Key Decision 0 will be provided to CEL-V. The contents of the CDR, shown in Table 1, are consistent with DOE Order 4700.1. The main body of the CDR (four volumes: Summary, Design Basis and Requirements; Conceptual Design; and Operations, Schedules, Costs and Assessments) is described in Table 2. The six appendices, A-F, include volumes on the Design and Planning Basis [(Criteria and Schedule (3 books), Supporting

Analysis (4 books)], Equipment Drawings (Laser system, Target area, Integrated Computer Controls and Optics), Site and Conventional Facility Drawings, Site Support Facilities, Cost Estimate [(Total Estimated Cost (3 books)], Other Project Costs, Contingency Analysis (2 books), Other supporting Cost Information (2 books), Work Breakdown Structure and Dictionary.

TABLE 2

Chapter	1	*CDR Summary*	Presents a summary of the contents of all NIF CDR chapters, including summary information on the project schedule and cost.
Chapter	2	*Introduction*	Provides a general CDR overview and background information.
Chapter	3	*Scientific Basis*	Describes the scientific premise upon which the NIF design is based.
Chapter	4	*NIF Design Requirements/Criteria*	Includes discussion of mission related requirements, environmental safety and health requirements, assurances (e.g., quality, safeguards, and security), building systems, operation and maintainability requirements, and applicable DOE orders, codes, and standards.
Chapter	5	*Conceptual Design Description*	Contains conceptual design information on the Site and Conventional Facilities (WBS 1.2), Laser System (WBS 1.3), Target Area (WBS 1.4), Integrated Computer Control Systems (WBS 1.5), and Optical Components (WBS 1.6).
Chapter	6	*OPEX-Funded Activities*	Addresses Startup Activities (WBS 1.10), Operations, and ES&H/Supporting R&D (WBS 1.11).
Chapter	7	*Method of Accomplishments*	Describes the methods that will be used to implement the project.
Chapter	8	*Schedule*	Presents the integrated project schedule.
Chapter	9	*Cost*	Summarizes the project cost.
Chapter	10	*Assessments*	Contains project assessments on radiation Protection of workers and the public, safety of the workers and the public, protection of the environment, quality assurance, and decontamination and decommissioning.

After October of 1994, DOE shall make available through LLNL the following items to CEA, and CEA will transfer to DOE via LLNL $15 M for these items:

I. Set of Design Drawings for Beamlet-Phase I

Mechanical, electrical, and optical systems drawings of the entire Beamlet system will be provided as part of this FY 1995 Task. This includes the electrical layout of the capacitor bank, power supplies, transformers, ignition switches and cabling. LLNL will also provide mechanical engineering CAD drawings of the major components on Beamlet and a full system layout in a series of layers that address the various system functions. Mechanical and electrical drawings will be provided for the Pockels cell, amplifiers, spatial filters, optical mounts and system diagnostics. In addition, LLNL will provide a complete set of drawings for all the major optics on the laser system. This will include the optical material, finishing, and coating specifications. This information will be transmitted in the form of files and when appropriate computer disks.

II. Set of Relevant Reports and Technical Memoranda on Beamlet-Phase I

As part of this task LLNL will provide a complete set of reports, notes and technical memoranda dealing with the design, component development, procurement, construction and operation of the Beamlet laser (phase 1). This will include technical memos on the amplifiers, Pockels cell, major optics, diagnostics, the front end, master oscillator, and the control system. In addition LLNL will also provide the system requirements document that describes the performance specifications to which Beamlet was designed. LLNL will also provide formal reports from conferences, internal publications, and journal articles; these will be in a pre-print format. Finally, LLNL will provide a complete set of Beamlet notes that describe in detail, the technical issues that addressed and results from early experiments during component development, design, construction and activation of Beamlet.

III. Beamlet Phase I Performance Data

Beamlet phase I performance data will be provided in the form of presentation material, internal memoranda, and formal reports. The specific performance results will include the following:

(1) LLNL will provide results from 2-pass cavity tests that address the integrated performance of the master oscillator/pulse-forming system, preamplifier section, capacitor bank, amplifiers, spatial filter and beam injection system.

(2) LLNL will provide results from the full 4-pass cavity amplifier tests that include details of the added integrated operation of the beam shaping system, optical switch, cavity spatial filter, cavity diagnostics and beam transport system. LLNL will also provide information on the magnitude of square pulse distortion, spatial and temporal beam shape, cavity gain for 1, 2, 3 and 4 passes, beam modulation

effects caused by wavefront distortion from the optics and the near and far-field images. LLNL will also include information about the performance of the 39 actuator deformable mirror used to correct for low order distortions in the system.

(3) Results from booster amplifier tests will also be provided as part of this task. This includes results on temporal and spatial beam shape, near and far-field beam profiles, output energies, wavefront quality and output energies. The output energy will be measured as a function of pulse widths from about 0.2 ns up to 8 ns and system explosion fraction of 0.2.

(4) Finally, results from 3w conversion experiments at full Beamlet operating fluence will be provided.

IV. Access to Beamlet for U/L-Turn and Beam Transport experiments and testing of NIF/MJL Optics and Components

The Beamlet scientific, engineering, and technical staff will work with their counterparts from CEL-V to conduct three joint experiments on Beamlet:

(1) a test of the U-turn/L-turn, switch concept;

(2) testing of lw high-reflectivity, high-damage-threshold mirrors to be used in the output transport section of both the NIF and MJP lasers;

(3) "ride-along" experiments of various MJL optics.

V. Drawings of the Beamlet Plasma Electrode Pockels Cell (PEPC)

Mechanical, electrical, and optical systems drawings of the Beamlet PEPC will be provided as part of this task. This includes the electrical layout of the Pockels cell pulsed power system and details of the computer control system. The mechanical engineering drawings will include the Pockels cell housing, electrodes, vacuum system, mounting hardware and crystal holder. LLNL will also provide a complete set of optical drawings and specifications for the KDP crystal and the fused silica windows used on the PEPC.

VI. Relevant Reports and Technical Memoranda on the Beamlet PEPC

This task will provide for a set of reports, notes and technical memoranda dealing with the design, component development, procurement, construction and operation of the Beamlet PEPC. This will include information on Pockels cell performance during component development activities, construction of the full Beamlet Pockels cell and it's integration onto Beamlet. The information will include data on the extinction ratio, timing, extinction uniformity across the full aperture, damage threshold, and wavefront modulation caused by machining marks on the KDP crystal. In addition, LLNL will provide copies of formal reports and conference proceedings and journal

articles that document results from this work. These latter reports will be provided in pre-print form.

VII. Results of Amplifier Design Calculations and use of LLNL Amplifier Design Codes

LLNL will assist CEL-V in performing the necessary design calculations for the MJP amplifier design. In the case that both NIF and MJP converge on an identical design, this activity will primarily consist of providing all relevant information on the NIF/MJP amplifier design CEL-V. In the case that the NIF and MJP amplifier design is different, LLNL will perform the necessary calculations and optimizations for the MJP amplifier concept.

VIII. Relevant Reports and Technical Memoranda on Multisegment Amplifier Tests and Measurements

As part of this task LLNL will provide a set of reports, notes and technical memoranda dealing with the design, component development, procurement, construction and operation of the Beamlet laser amplifiers. In addition, LLNL will provide results from early tests that are being done as part of the NIF amplifier development activities. In regards to Beamlet, the data LLNL provides will be from tests of the MSA-2 amplifier, built as a part of the Beamlet component development work. LLNL will also provide notes on the Beamlet "1 x 2" prototype amplifier assembled prior to the main Beamlet construction. LLNL will also provide results in the form of internal memoranda and reports from amplifier characterization tests that were done on Beamlet in the fall of FY 1994. These results include measurement of gain coefficients, gain uniformity, beam steering and beam depolarization for the 2 x 2 Beamlet amplifier configuration. LLNL will also provide gain and gain distribution data as a function of explosion fraction from 0.15 to 0.3 for groups of one, two, and five consecutive amplifier modules.

IX. Relevant Information Developed to Date on Advanced Laser Glass and Rapid Growth of KDP and KD*P Crystals

Relevant information developed up to the date of signing of the Supplemental Agreement will be provided, in the form of technical memoranda and reports on the composition and manufacturing processes of advanced Nd-doped laser glass and on the rapid growth of KDP and KD*P. This information will be provided in a manner consistent with existing contractural agreements with third parties and on-going patent disclosure procedures.

This Implementing Arrangement becomes effective upon the latter date of signature.

FOR THE DEPARTMENT OF ENERGY
OF THE UNITED STATES OF AMERICA

NOV. 19, 1994

FOR THE COMMISSARIAT A
L'ENERGIE ATOMIQUE OF
FRANCE

Le 19/11/94