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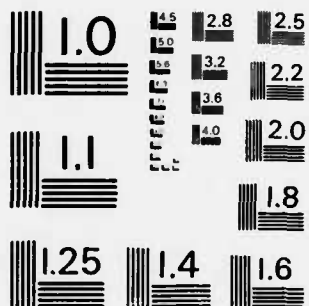
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TECHNICAL REPORT RH-CR-83-6

A SURVEY OF ELECTRIC LASER CODES

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U.S. ARMY MISSILE COMMAND

Redstone Arsenal, Alabama 35898

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report summarizes information gathered on a survey conducted by the Lockheed-Huntsville Research & Engineering Center under Tasks I and II, Contract DAAH01-80-C-1289, on available computer codes which can be used to analyze electric laser devices. The laser systems include CO, CO ₂ , and excimers, operating in either the CW or pulsed modes. Technical areas surveyed include kinetics, optics, and gas dynamics.		

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FOREWORD

This report summarizes information gathered on a survey conducted by the Lockheed-Huntsville Research & Engineering Center under Tasks I and II, Contract DAAH01-80-C-1289, for the U. S. Army Missile Command, Redstone Arsenal, Alabama. This work was monitored by T. A. Barr, Jr. The period of performance covered by this report was from 1 July 1980 to 30 November 1980.

The author acknowledges many valuable conversations, assistance and encouragement provided by T. A. Barr, Jr., and J. Thoenes, as well as many others throughout this work. The author is also grateful to T. G. Roberts for his efforts in making publication of this report possible.

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1. INTRODUCTION

Computer modeling has contributed greatly toward development of advanced technologies such as lasers and is expected to play an even more important role in the future. This is true as the computer models become more realistic, computation costs decrease, and as the number of design parameters increases, making optimization by laboratory search almost impossible.

Through the years, many computer codes have been developed for the analysis of laser systems and their components. Most of these codes are in the public domain, and individuals who wish to obtain copies of these codes can usually do so. However, due to the large number of codes available, selection of a proper code to fit the individual's need may be a difficult task.

Each computer code has been developed with its own purpose and its inherent limitations. Depending on the phenomena included, and the details of treatment of these phenomena, applicability of different codes vary. There are simple codes for laboratory data analysis. There are detailed engineering design codes. There are also systems codes which provide an end-to-end analysis. An understanding of the capabilities and limitations inherent in each computer code is thus important to the prospective user.

Besides the analytical treatment of the various phenomena involved in the code, the prospective user will require certain general information on how to use the code. The computer language used, the core memory requirement and the computer run time all influence the suitability of using a specific code.

To alleviate this difficulty, laser computer codes were surveyed. As part of the Army High Energy Laser 6.1 effort, a survey of laser propagation codes was performed in 1979 by J. P. Reilly of W. J. Schafer Associates, Inc. This survey was published by D. W. Howgate, C. M. Bowden, and T. G. Roberts (editors), in "New Laser Concepts Evaluation—Review," MIRADCOM

Technical Report DRCPM-HEL-79-4, Redstone Arsenal, Alabama, in February 1979. Unfortunately, the distribution of this report was limited to Government agencies only. An excellent survey of Continuous Wave Chemical Laser codes was performed by C. Wiggins, D. Mansell, P. Ulrich, and J. Walsh, and was published as "Chemical Laser Code Survey," BDM/TAC-79-769-TR-R1, BDM Corporation, Albuquerque, New Mexico, July 1980. More recently, two additional surveys were performed for electric laser codes and for pulsed chemical laser codes. The survey of electric laser codes reported herein, and the pulsed chemical laser code survey performed by Melvin Epstein and Robert R. Giedt of the Aerospace Corporation, were part of the Army High Energy Laser 6.1 effort.

In this study, we surveyed the industry for available codes which can contribute to the analysis of electric laser devices. The laser systems treated include CO, CO₂ and excimers, operating in either the CW or pulsed modes. The initiation may be self-sustained, E-beam initiated or UV-initiated. The flow system may either be open system, closed system or closed cycle. Technical areas surveyed thus include kinetics, optics, and gas dynamics.

Section 2 presents a general description of a high power electric laser system and its key components. The technical areas covered in this survey are then delineated. Section 3 presents a summary of the survey and its results. A general classification of the codes surveyed is also attempted. Section 4 presents the detailed return of all surveyed codes. Section 5 contains the references.

Participation in these surveys was voluntary, and therefore some existing codes may not be included. Also, as was pointed out by A. Garscadden in a private communication, references to the data banks and overview publications are not included. The reader may find many interesting references in the Selected Bibliography, Page 113.

This survey complements other previous code surveys covering areas of laser beam propagation (Ref. 1), chemical laser devices (Ref. 2), and pulsed chemical lasers (Ref. 3).

2. PREPARING THE SURVEY

2.1 COMPONENTS OF AN ELECTRIC LASER SYSTEM

A high power electric laser system can be delineated into different components as shown schematically in Fig. 1. The portion included in this survey is enclosed in the box entitled "Laser Device." It contains such components as gas supply and preparation subsystem, injector and mixing subsystem, cavity resonator, exhaust treatment and recirculation system, acoustic attenuation subsystem and electric power supply subsystem. Computer codes which can be used to provide analysis for processes and phenomena occurring in one or all of the above mentioned components are subjects of this survey.

2.2 AREAS OF COVERAGE

A set of questionnaires was prepared to cover the technical areas of interest as well as information related to computer usage. A format similar to that used in Ref. 2 was adapted for use in this survey. Survey questions were grouped under the four headings of General Information; Optics; Kinetics; and Gasdynamics. Many of the questions used in the BDM survey are retained in this study.

Under the heading of GENERAL INFORMATION, questions are asked that relate to the purpose, unique capability, and limitations of the code. Questions are asked that relate to the availability of the code and its supporting documentation, as well as its computer compatibility. A key contact at the code residing organization is defined who may or may not be the originator of the code. No special effort was expended to identify the originators on all the codes surveyed, although in many cases it was necessary to communicate with the originators in order to obtain technical details about the code.

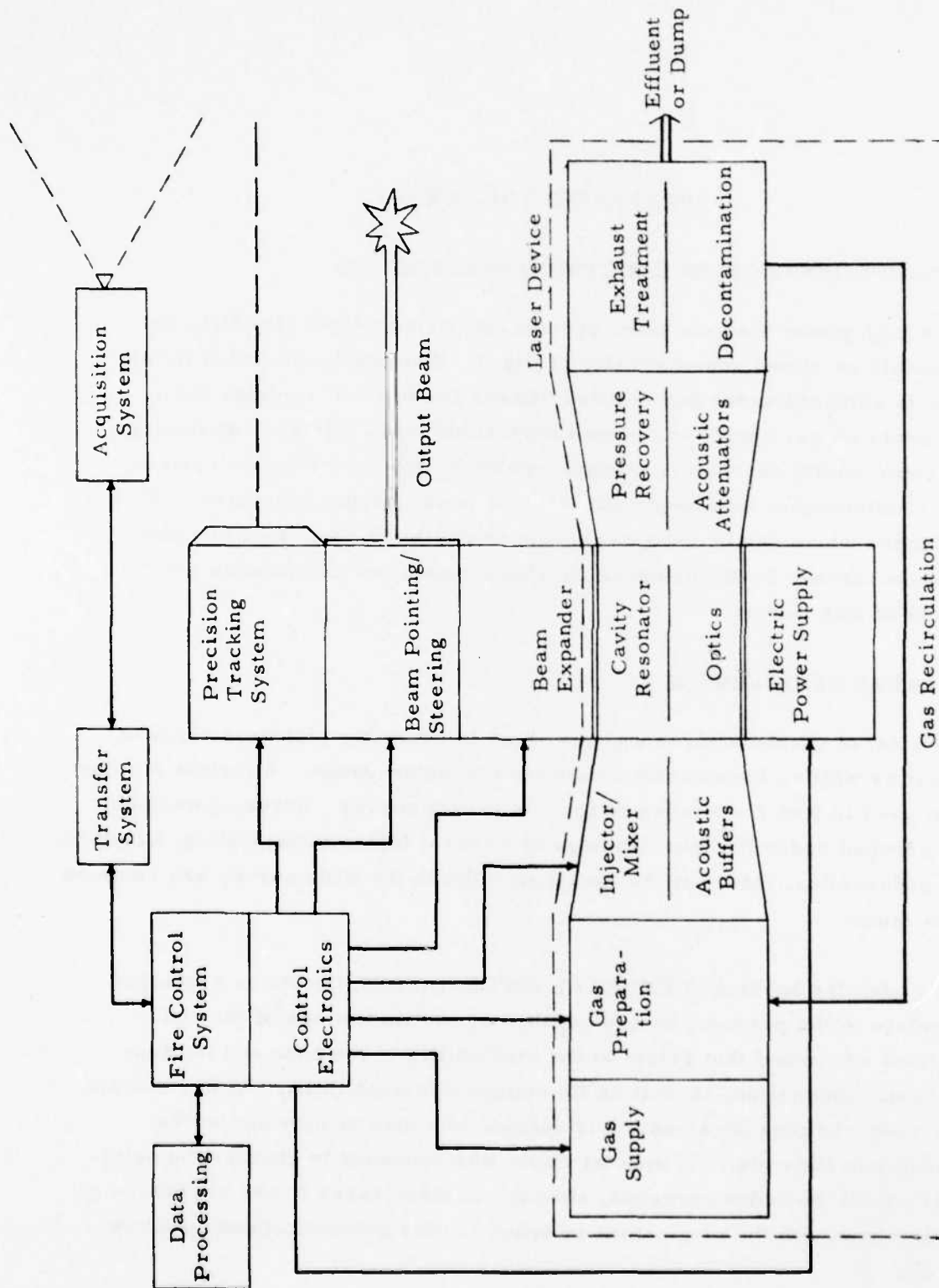


Fig. 1 - High Power Electric Laser System Components

Following the GENERAL INFORMATION section are questions grouped according to the technical areas covered by the code. Thus, a code return may contain any or all of the questions under Optics, Kinetics and Gasdynamics.

The questions under the heading of OPTICS deal primarily with the treatment of wave propagation within the laser resonator. Questions used in Ref. 2 were retained if they applied to the electric laser configurations.

The questions under the heading of KINETICS deal primarily with the treatment of plasma dynamics, lasing kinetics, and power extraction processes. Boltzmann codes used for electron energy distribution calculation and energy deposition codes for E-Beam systems are also included.

Questions under the heading of GASDYNAMICS deal primarily with the treatment of gas flow through the system and its interaction with the various components. The treatment of viscous mixing in the cavity, the acoustic propagation and its attenuation for a pulsed system, and pressure drops through the recirculation system are all included in this category.

3. A SUMMARY OF ELECTRIC LASER CODE SURVEY

3.1 INFORMATION GATHERING

A list of survey recipients was compiled from information obtained from several sources including the Army Missile Command, Naval Research Laboratory, Air Force Weapons Laboratory, and Air Force Wright Aeronautical Laboratories. This initial list of recipients was supplemented with additional names and organizations as the survey progressed, making a total of 55 organizations identified as survey recipients. These organizations include government laboratories, academic institutions, and private industries throughout the country. After having identified one or two individuals at each organization as the contact point for the survey, questionnaires were sent to all the identified organizations.

Phone conversations and personal visits to some survey recipients followed the initial mailing in order to speed up the survey return, to discuss fine points on the survey, and to clarify questions on the returned questionnaires. In spite of all these followup activities, returns of the survey were slow. After much effort, 42 returned questionnaires were obtained. These returns, after being reviewed and retyped, are presented in Section 4. A summary of the survey results is given in the following subsection, in which an attempt is made to classify these codes.

3.2 A CLASSIFICATION OF SURVEYED CODES

Forty-two of the electric laser related codes that were surveyed are generally classified as follows:

<u>Classification of Codes</u>	<u>No. of Codes</u>
LASER KINETICS	21
General excimer laser code	5
Specific excimer laser code	3
CO ₂ laser code coupled to physical optics	2
CO ₂ laser code	7
General vibrational-rotational laser code	1
CO laser code	3
PLASMA KINETICS CODE	6
ELECTRON KINETICS CODE	6
PULSE FORMING NETWORK CODE	1
LASER GASDYNAMICS	7
Cavity gasdynamics	4
Closed cycle gasdynamics	3
GENERAL OPTICS	<u>1</u>
Total	42

A brief summary of all the codes surveyed is given in Table 1. Detailed returns of all codes are given alphabetically in Section 4. In the succeeding paragraphs, summaries for the different classes of codes are given.

The laser kinetics codes calculate the upper and lower state populations for the given lasing transition under the operating condition. The code may either be programmed to accept only a specific lasing transition or it may be more general in order to accept different reaction mechanisms from input data. Depending on its complexities, the code may contain mechanisms for the calculation of plasma kinetics, energy deposition, power extraction and gasdynamics. Most codes treat at least the Fabry-Perot resonator, a few (TDFI-EDL and UNSEDL2) have coupled physical optics which can treat other types of resonators as well. The laser kinetics codes are summarized in Table 2, where the applicable gas systems, the type of operation, and initiation method included in each code are listed. Also listed are comments related to specific features of the code.

The plasma kinetics codes deal with energy deposition into the cavity gas for either an E-beam discharge (E-BEAM TRANSPORT, EBAM2, and EBM2D) or discharge only (DENSITY, HGX80 and KINBOLTZ). Some may also be coupled to the pulse forming electric circuits (e.g., EBEAM2).

The electron kinetics codes are used to calculate the electron energy distribution function by solving the Boltzmann equation. Transport properties are then obtained from the distribution function. These codes are usually linked to the plasma kinetics codes or the lasing kinetics codes, thus forming a coupled code. Because of the different types of collision processes treated, the usage of these codes is thus considered case dependent.

The pulse forming network (PFN) codes provide electric current for the discharge pulse. Since the gas properties in the laser cavity affect the outside current, the analysis of PFN is usually coupled with the plasma kinetics codes for energy deposition calculation.

The gasdynamics codes are classified as either a cavity gasdynamics code or a closed cycle system gasdynamics. The cavity gasdynamics code treats the cavity gas medium homogeneity as the result of flow mixing in the

cavity, the acoustic wave generation due to the pulsed operation or non-uniform energy deposition. The system gasdynamics codes deal specifically with thermodynamics of closed gas systems. It provides transient analysis as well as steady state solution for the flow loop. The gas-dynamics codes are summarized in Table 3 where the flow equations used and the special features treated are listed.

Of all the codes surveyed, only two have physical optics coupled with the lasing kinetics. This might be the result that many an analysis has been done with separate kinetics and optics codes. Extensive survey of optics codes as applied to resonator analysis and design has been conducted by BDM (Ref. 2) for chemical lasers. No duplication is intended in this study. A general optical system optimization code (ILLOPT) is included in this report.

Table 1
SUMMARY OF ELECTRIC LASER CODE SURVEY

This table summarizes the 42 codes surveyed. Listed under each code is information pertaining to; the residing organization; the key contact; the principal purpose of the code; available documentation; and comments. Detailed returns of all codes are given alphabetically in Section 4.

Table 1
SUMMARY OF ELECTRIC LASER CODE SURVEY

Code Name	Residing Organization Key Contact	Principal Purpose of Code	Code Classification	Documentation*	Comment
BACPR	Joint Inst. for Laboratory Astrophysics A. V. Phelps (303) 492-7850	To predict electron transport, excitation, and ionization coefficients from cross-section data	Electron Kinetics	T, U, L, RP	
BMLASE	Westinghouse R&D Center Lyle Taylor (412) 327-5833	To model the laser kinetics of a pulsed 14 μm and 16 μm CO_2 laser, and to predict its performance	Laser Kinetics (CO_2)	T	P
BOLTZ	AFWAL CPT Gary L. Duke (513) 255-2923	To predict electron transport properties, excitation pumping rates from given E/N and cross-section data	Electron Kinetics	U	
CCUBE	U. of Alabama in Huntsville Gerald R. Karr (205) 895-6330	To compute flow properties throughout a closed circulator for a steady state CW laser	System Gas Dynamics	RP	
COLASE	Westinghouse R&D Center Lyle Taylor (412) 256-5833	To model the laser kinetics of a pulsed, electric discharge CO laser, and to predict its performance	Laser Kinetics (CO)	T, U	
DENSITY	AFWAL CPT Gary L. Duke (513) 255-2923	To determine the time dependent species concentration voltage, and current in an XeCl laser plasma	Plasma Kinetics (XeCl)	None	Time-Depend. Discharge Model
E-Beam Transport	R&D Associates T. K. Tio (213) 822-1715 X 448	To model the E-Beam transport in the 2-D discharge gap of an EDL under prescribed E-field and B-field	Plasma Kinetics	T, U, L	2-D E-Beam Model
EBEAM	MICOM Arthur Werkheiser (205) 876-8161	To compute time history of CO_2 electric laser power output for E-Beam lasers	Laser Kinetics (CO_2)	L, U	
EBEAM2	MICOM Arthur Werkheiser (205) 876-8161	To compute time history of E-Beam gun and sustainer voltage and current from a given power supply	Plasma Kinetics	In Preparation	Time-Depend. E-Beam Model
EBM2D	MICOM Arthur Werkheiser (205) 876-8161	To compute 2-D distribution of electron density, E-field, and power deposited in an electric laser cavity for a given potential difference and current	Plasma Kinetics (CO_2)	T	2-D E-Beam Model
EDLAMP	Lockheed-Huntsville Jürgen Thoenes (205) 837-1800	To predict cavity performance of an E-Beam controlled EDL	Laser Kinetics (CO_2) Coupled with Gasdynamics	T, U	
EDLNOD	AFWAL CPT Robert F. Walter (505) 844-1786	To predict small signal gain and energy extraction for CO_2 EDLs	Laser Kinetics (CO_2)	L, RP	

* T = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

(Continued)

Table 1 (Continued)

Code Name	Residing Organization Key Contact	Principal Purpose of Code	Code Classification	Documentation*	Comment
EDLSL	AFWL A. T. Gavrielides (505) 844-4691	To model the kinetics of photon production by a glow discharge in an EDL cavity	Laser Kinetics (CO ₂)	None	
EED	Tetra Corp. Henry J. Happ, III (505) 256-3595	To solve the steady state electron distribution function using the Boltzmann equation	Electron Kinetics	T, U, L	
ELECT	Northrop R&T Center William B. Lacina (213) 377-4811 X 362	To provide an analysis of electron kinetics for an arbitrary gas mixture (possibly including excited species) as a function of electric field	Electron Kinetics	T, U, L	
ELENDIF	AFWL CPT Gary L. Duke (513) 255-2923	To compute electron distribution function, mean electron energy drift velocity, and rate coefficient	Electron Kinetics	T, U, L	
ETRANV	Air Force Institute of Technology LTC William F. Bailey (513) 255-2012	To provide time dependent solution of master equation for vibrational energy exchange for modeling of vibrational-rotational laser systems	Laser Kinetics (General)	RP	
FREESL	R&D Associates Peter Crowell (505) 844-3013	To compute development of free shear layer at interface of primary cavity flow and secondary injected beam duct flow in a confined channel	Cavity Gas Dynamics	T, L	
GALERK	Joint Inst. for Lab. Astrophysics L. C. Pitchford** (303) 492-8255	To predict electron transport and excitation-ionization coefficients from cross-section data	Electron Kinetics	L, RP	
HGX80	United Technologies Research Center William L. Nighan (203) 727-7596	To compute laser discharge properties in electrically excited rare-gas halide and mercury-halide lasers	Plasma Kinetics (Excimers)	L, RP	Discharge Model
ILLOPT	Westinghouse R&D Center Johanna Schruben (412) 256-3611	Illumination evaluation and optimization of optical systems	General Optics	T	P
KINBOLTZ	Tetra Corp. Henry J. Happ, III (505) 256-3595	To compute the time dependent population levels in upper and lower states from rate equations	Plasma Kinetics (Excimers)	U, L	Time-Depend. Discharge Model
KINETIC	Lawrence Livermore Laboratory W. Lowell Morgan (415) 422-6289	To model the basic laser kinetics for E-Beam pumped and discharge lasers	Laser Kinetics (Excimers)	L	
KRF	TRW Jeanette Betta (213) 536-1453	To model KrF lasers and amplifiers	Laser Kinetics (KrF)	L	P
LAGAD	Westinghouse R&D Center Martin J. Pechersky (412) 256-7353	To compute non-steady gas-dynamics resulting from discharge heating and flow loop heat exchanger in a closed cycle system	System Gas Dynamics	L	P

*T = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

**Now at Sandia Laboratory.

(Continued)

Table 1 (Continued)

Code Name	Residing Organization Key Contact	Principal Purpose of Code	Code Classification	Documentation*	Comment
LASER	Northrop R&T Center William B. Lacina (213) 377-4811 X 362	General laser kinetics synthesis and analysis for a broad class of transient, electrically excited laser systems	Laser Kinetics (Excimers)	T, U, L	
LASIM	Westinghouse R&D Center L. E. Kline (412) 256-7552	Simulation of UV initiated self-sustained discharge pumped XeF lasers	Laser Kinetics (XeF)	L, RP	
MOC	U. of Alabama in Huntsville C. C. Shih (205) 895-6330	To compute transient flow associated with sudden energy deposition characteristic of pulsed laser operations	Cavity Gas Dynamics	RP	
NRL LASER	Naval Research Lab. Louis J. Palumbo (202) 767-2255	Modeling of a variety of high power gas lasers. Mostly rare gas halides	Laser Kinetics (Excimers)	T, L, RP	
OPTEX	Westinghouse R&D Center Dennis Suhre (412) 256-7353	To predict the lasing outputs for the 10 μ m P(14) and P(18) lines for a pulsed TEA laser	Laser Kinetics (CO ₂)	T	P
POSEIDON	Poseldon Research James H. Morris (213) 341-9172	To model 1-D flow and acoustics in laser cavity and acoustic attenuation subsystem. (A 2-D version also exists.)	Cavity Gas Dynamics	T, RP	
PSI LASER	Physical Science, Inc. Paul Lewis (617) 933-8500 also Raymond Taylor (617) 546-7798	A series of general kinetics codes for cavity gain and power output calculations	Laser Kinetics (Excimers)	RP	
REDAC	Rocketdyne E. Wheatley (213) 709-7136	To model PFN performance	PFN	U	P
STROBE	R&D Associates Bruce Masson (505) 243-5609	To model beam duct, cavity acoustics	Cavity Gas Dynamics	T, L	
SUPER-SONIC	Northrop R&T Center William B. Lacina (213) 377-4811 X 362	Analysis of an electrically excited supersonic flow CO laser	Laser Kinetics (CO)	T, U, L	
IDFI-EDL	Lockheed-Huntsville Jürgen Thoenes (205) 837-1800	To estimate performance trends of a CW EDL with unstable resonator	Laser Kinetics (CO ₂)	T, U	Coupled Optics Kinetics and Gas Dynamics
TEA	Westinghouse R&D Center Lyle Taylor (412) 256-5833	To model the laser kinetics of a pulsed 10.6 μ m CO ₂ laser and to predict its performance	Laser Kinetics (CO ₂)	T, U	
TELSAT	R&D Associates Earl White (505) 844-8446	To study steady state and transient thermodynamic and fluid dynamic system performance	System Gas Dynamics	T, L, RP	

* T = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

(Continued)

Table 1 (Concluded)

Code Name	Residing Organization Key Contact	Principal Purpose of Code	Code Classification	Documentation*	Comment
UNSEDL2	AFWL CPT Ted Salvi (505) 844-0256	Time dependent behavior of CW CO ₂ EDL with mode-media instability	Laser Kinetics (CO ₂)	T, U, L	Coupled Optics, Kinetics and Gas Dynamics
UVLZR	Los Alamos Sci. Lab. Arthur E. Greene (505) 667-7799	To study kinetics of rare gas halide lasers, design more efficient PFNs	Laser Kinetics (Excimer)	RP	Coupled to PFN
VIBKIN	Boeing Aerospace Co. Donald J. Nelson (206) 773-1498	To model the kinetics of an electric discharge pumped supersonic CO laser	Laser Kinetics (CO)	T, U, L	
XENON	U. of Illinois T. DeTemple (217) 333-3094	Synthesis of E-Beam initiated Ar-Xe laser	Laser Kinetics (Excimer)	RP	

* T = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

Table 2
SUMMARY OF LASER KINETICS CODES

This table summarizes the 21 laser kinetics codes surveyed. Listed under each code are information pertaining to: gas systems treated; type of operation; method of initiation treated in each code as well as comments.

Table 2
SUMMARY OF LASER KINETICS CODES

Code Name (Org.)	Gas System Treated	Type of Operation	Method(s) of Initiation	Comments
BMLASE (Westinghouse)	CO ₂	Pulsed	Self-Sustained UV-Initiated	
COLASE (Westinghouse)	CO	Pulsed	Self-Sustained UV-Initiated	
EBEAM (MICOM)	CO ₂	Pulsed	E-Beam Self-Sustained	Discharge Non-Uniformity Treated
EDLAMP (Lockheed)	CO ₂	Pulsed, CW	E-Beam Con- trolled	Close Cycle Decontamina- tion Treated
EDLNOD (AFWL)	CO ₂	Pulsed	E-Beam	
EDLSL (AFWL)	CO ₂	Pulsed	Self-Sustained	
ETRANV (AFIT)	CO ₂ , CO HF/DF	Pulsed, CW	E-Beam Self-Sustained	
KINETIC (LLL)	Excimers	Pulsed	E-Beam Self-Sustained UV-Initiated	Boltzmann Solver Included Extensive Graphics
KRF (TRW)	KrF	Pulsed	E-Beam	
LASER (Northrop)	Excimers	Pulsed	E-Beam Self-Sustained UV-Initiated	Boltzmann Solver Included Widely Distributed Code
LASIM (Westinghouse)	XeF	Pulsed	Self-Sustained UV-Initiated	
NRL LASER (NRL)	Excimers	Pulsed, CW	E-Beam Self-Sustained UV-Initiated	Boltzmann Solver Included Reaction Scheme Specified Using Symbolic Names for Reactants and Products
OPTEx (Westinghouse)	CO ₂	Pulsed		10 μ m P(14) and P(18) Lasing Output Predicted
PSI LASER (PSI)	Excimers	Pulsed, CW	E-Beam Self-Sustained	A Series of General Kinetics
SUPERSONIC (Northrop)	CO	Pulsed, CW		1-D Gas Dynamics
TDFI-EDL (Lockheed)	CO ₂	CW	E-Beam	1-D Gas Dynamics, Physical Optics
TEA (Westinghouse)	CO ₂	Pulsed, CW	E-Beam Self-Sustained	

(Continued)

Table 2 (Concluded)

Code Name (Org.)	Gas System Treated	Type of Operation	Method(s) of Initiation	Comments
UNSEDL2 (AFWL)	CO ₂	Pulsed, CW	E-Beam	2-D Gas Dynamics, Physical Optics Coupled to PFN
UVLZR (LASL)	Excimers	Pulsed	UV Preionized Electron Impact Avalanche	
VIBKIN (Boeing)	CO	Pulsed, CW	E-Beam Self-Sustained	
XENON (U. of Ill.)	Ar-Xe	Pulsed	E-Beam Self-Sustained	

Table 3
SUMMARY OF GAS DYNAMICS CODES

This table summarizes the seven gas dynamics codes surveyed. Listed under each code is information pertaining to: level of complexity; type of equations used; coordinate system; flow components treated, and special features.

Table 3
SUMMARY OF GASDYNAMIC CODES

Code Name (Org.)	Level of Complexity	Type of Equations Used	Coordinate System	Flow Components Treated	Special Features Modeled
CCUBE (UAH)	Algebraic Model	Viscous Compressible	1-D	Closed Cycle	HX Compressors Treated
FREESL (RDA)	Finite Difference	Viscous Compressible	2-D	Cavity Flow	Beam Duct Interface Modeled
LAGAD (Westinghouse)	Algebraic (MOC)	Compressible	1-D + Time	Closed Cycle	Single Pulse Acoustic Treated
MOC (UAH)	Finite Difference	Viscous Compressible	1-D + Time	Cavity Flow	Single Pulse Acoustic Treated
POSEIDON (Poseidon)	Finite Difference	Compressible	2-D + Time	Cavity Flow	Repetitive Pulse Acoustic for an Open System Can Be Treated
STROBE (RDA)	Finite Difference	Compressible	3-D + Time	Cavity, Beam Duct	Single Pulse Acoustic Treated
TELSAT (RDA)	Finite Difference	Compressible	1-D + Time	Closed Cycle	HX, Compressors Treated

4. DETAILED RETURN OF SURVEY QUESTIONNAIRES

This section presents in alphabetical order returned questionnaires of the 42 codes surveyed. The questionnaire for each code is organized in the order of GENERAL INFORMATION, KINETICS, GASDYNAMICS, and OPTICS. The information stated herein follows as close as possible to those provided. Since no technical information was provided on ELENDF and REDAC, only general information is reported on these codes.

CODE NAME: BACPR TECHNICAL AREA(S): Electron Kinetics

DEVICE COMPONENTS TREATED: _____

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To predict electron transport, excitation and ionization coefficients from cross-section data.

ASSESSMENT OF CAPABILITIES: A thoroughly tested code used by many laboratories. Useful for mean electron energy from about twice thermal up to values at which energy loss to ionization is about 10% of input. Thoroughly documented.

ASSESSMENT OF LIMITATIONS: Not accurate when inelastic cross-sections are comparable with elastic cross-section or when energy input to ionization is comparable with total input.

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: A. V. Phelps

Organization: Joint Institute for Laboratory Astrophysics

Address: U. of Colorado, Boulder, CO 80309

Phone: (303) 492-7850

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T & RP - L. S. Frost and A.V. Phelps, Phys. Rev. 127, 1621 (1962)

J. Sherman, J. Math. Analysis and Applications 1, 342 (1960).

L, U - P.E. Luft, JILA Information Center Report No. 14, Oct. 30 (1975)

STATUS:

Operational Currently?: X

Under Modification?: _____

Purpose(s): Some modifications have been made since Luft's report.

Ownership?: _____

Proprietary?: _____

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600 & CDC 6400

TRANSPORTABLE?: X

Machine Dependent Restrictions: _____

SELF-CONTAINED?:

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	_____	_____
Typical Job:	_____	_____
Large Job:	_____	_____

Approximate Number of FORTRAN Lines: _____

COMMENTS: _____

KINETICS CODE

CODE NAME: BACPR

1. CODE STRUCTURE

COORDINATE SYSTEM ($\checkmark$): NACartesian: Expanding: KINETICS GRID DIMENSIONALITY ($\checkmark$):1-D: 2-D: Uniform3-D: GAIN REGION SYMMETRY RESTRICTIONS: NAGain Vary Along Optical Axis: Flow Direction: KINETICS MODELED: Pulsed: CW: $\checkmark$ NUMERICAL SCHEME USED IN RATE
CALCULATION ($\checkmark$):Explicit: Implicit: Others (specify): backward prolongationREFERENCE OF METHOD USED: Sherman

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive
Species: 0 Number of Negative
Species: 1 Number of Neutral
Species: ≤ 3 REACTION MECHANISM MODELED ($\checkmark$):

Primary Ionization: (Reference)

E-Beam: Self-Sustained: UV-Initiated: Others (specify):

Secondary Ionization (Reference)

Attachment: Detachment: Ion-Ion Recom-
bination: Charge Transfer: Dissociation/
Recombination: Others (specify): Source of Rate Coefficients Used: VaryingDISCHARGE POWER INPUT MODELED ($\checkmark$):Uniform: $\checkmark$ Non-Uniform: E-Field: $\checkmark$ Others (specify):

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: 0Number of Species: 1 electronsNumber of Reactions: Other Major Species Considered: IMPACT EXCITATION MODELED ($\checkmark$):

(Reference)

Vibrational: $\checkmark$ Electronic: $\checkmark$ Others (specify): rotationENERGY TRANSFER MODES MODELED ($\checkmark$):

(Reference)

V-T: NAV-R: V-V: Others (specify): Lasing Transition: P-Branch: R-Branch: Single Line Model ($\checkmark$): Multi-Line Model ($\checkmark$):

Assumed Rotational Population

Distribution State ($\checkmark$): Equilibrium: Nonequilibrium:

Number of Laser Lines

Modeled: Source of Rate Coefficients Used in Code: LINE PROFILE MODELS ($\checkmark$):Doppler Broadening: NACollisional Broadening: Others (specify):

4. RECIRCULATION CONTAMINANTS

MODELED ($\checkmark$): NAO_x: OH_x: NO_x: HNO_x: Others (specify): REFERENCE FOR REACTION MECHANISM
AND RATES: OTHER UNIQUE FEATURES:

CODE NAME: BMLASE TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Laser Cavity
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To model the laser kinetics of a
pulsed 14 μ m or 16 μ m CO₂ laser and to predict the performance of the laser.

ASSESSMENT OF CAPABILITIES: Can handle gas mixtures of CO₂: N₂: He: H₂O: H₂
at any temperature and pressure, and for any pulse length.

ASSESSMENT OF LIMITATIONS: Is one-dimensional, stable resonators, and assumes
that the rotational and kinetic temperatures are the same.

OTHER UNIQUE FEATURES: The lowest eight vibrational levels are treated exactly,
and the population of the rotational level involved in the lasing is not
assumed to be in equilibrium with the other rotational level populations.

ORIGINATOR/KEY CONTACT:

Name: Lyle Taylor
Organization: Westinghouse Electric Corporation
Address: 1310 Beulah Rd., Pittsburgh, PA 15668
Phone: 412-327-5833

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = Related Publication):

T: W.H. Kaszer, D.W. Feldman, R.B. Feldman, D.R. Suhre, L.H. Taylor, G.L.
Unger, and S.A. Wultzke, "Operational Characteristics of 16 μ m CO₂ Laser,
"Westinghouse Report 80-1C2-OCCOL-R1 (1980).

STATUS:

Operational Currently?: Yes
Under Modification?: No
Purpose(s): _____

Ownership?: Westinghouse
Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): U-1106

TRANSPORTABLE?: Yes
Machine Dependent Restrictions: none

SELF-CONTAINED?: Yes
Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>51400</u>	<u>3600 sec, U-1106</u>
Large Job:		
Approximate Number of FORTRAN Lines:		<u>2080</u>

COMMENTS:

Fabry-Perot Cavity modeled using geometric optics and floating gain.

KINETICS CODE

CODE NAME: BMLASE

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☒ Expanding: ☐KINETICS GRID DIMENSIONALITY (☒):1-D: ☒ 2-D: ☐3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: NoFlow Direction: NoKINETICS MODELED: Pulsed: ☐ CW: ☐NUMERICAL SCHEME USED IN RATE CALCULATION (☒):Explicit: ☐Implicit: ☐Others (specify): Hamming

REFERENCE OF METHOD USED: R.W. Hamming,
Numerical Methods for Engineers and
Scientists, (1962).

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ☐Number of Negative Species: ☐Number of Neutral Species: ☐REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☐Self-Sustained: ☒UV-Initiated: ☒Others (specify): ☐

Secondary Ionization (Reference)

Attachment: ☒Detachment: ☒Ion-Ion Recombination: ☐Charge Transfer: ☐Dissociation/Recombination: ☐Others (specify): ☐Source of Rate Coefficients Used: ☐DISCHARGE POWER INPUT MODELED (☒):Uniform: ☒ Non-Uniform: ☐E-Field: ☐Others (specify): ☐

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO₂Number of Species: 5Number of Reactions: 58Other Major Species Considered: N₂, He, H₂O, H₂IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☒Electronic: ☒Others (specify): ☐ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-I: ☒V-R: ☒V-V: ☒Others (specify): ☐Lasing Transition: P-Branch: ☒R-Branch: ☒Single Line Model (☒): ☐Multi-Line Model (☒): ☒Assumed Rotational Population Distribution State (☒):Equilibrium: ☐Nonequilibrium: ☒Number of Laser Lines Modeled: 4Source of Rate Coefficients Used in Code: ☐LINE PROFILE MODELS (☒):Doppler Broadening: ☒Collisional Broadening: ☒Others (specify): Voigt Profiles are used.

4. RECIRCULATION CONTAMINANTS

MODELED (☒): noneO_x: ☐ OH_x: ☐NO_x: ☐ HNO_x: ☐Others (specify): ☐REFERENCE FOR REACTION MECHANISM AND RATES: ☐OTHER UNIQUE FEATURES: ☐

CODE NAME: BOLTZ TECHNICAL AREA(S): Electron Kinetics
 DEVICE COMPONENTS TREATED: Overall System Characteristics
 PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Given a homogenous isotropic gas mixture with a uniform applied DC field, code calculated the e^- distribution function and thus the forward/reverse excitation pumping rates and the fractional power transfer for each process as well as transport properties. These rates can be used in a kinetics code to determine the time-varying population distribution.
 ASSESSMENT OF CAPABILITIES: Given E/N, and a set of cross-sections, BOLTZ calculates all the above quantities. Code has a variable number of bins for integrating, can include variable number of gases, super-elastic and electron-electron collisions.
 ASSESSMENT OF LIMITATIONS: Number of energy bins & inelastic processes are limited by computer storage. Physical model is valid for fractional ionization up to 10^{-2} and fractional power into ionization and dissociation $\leq 10\%$. Convergence is difficult for superelastic-dominated cases.
 OTHER UNIQUE FEATURES: _____

 ORIGINATOR/KEY CONTACT:
 Name: CPT Gary L. Duke
 Organization: AFWAL/POOC-3
 Address: Wright-Patterson AFB, Dayton, OH 45433
 Phone: (513) 255-2923
 AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): Code is well documented with comment cards (U):
TETRA-TR-78-001."BOLTZ a code to solve the BOLTZMANN Electron Transport Eq " Henry J. Happ, III, Rettig Bennedict, Jr., William P. Bailey, 1978.

 STATUS:
 Operational Currently?: yes
 Under Modification?: no
 Purpose(s): _____

 Ownership?: AFWAL/POOC
 Proprietary?: no
 MACHINE/OPERATING SYSTEM (on which installed): CYBER 175 and CYBER 74
 TRANSPORTABLE?: Probably
 Machine Dependent Restrictions: Programmed in Fortran IV
 SELF-CONTAINED?: yes
 Other Codes Required (name, purpose): none
 ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	50K	10 sec (10 diff E/N's input)
Typical Job:	100K	20 sec (10 diff E/N's input)
Large Job:	150K	9 sec (3 diff E/N's input)
Approximate Number of FORTRAN Lines:		500

COMMENTS: NOTE: BOLTZ is an electron kinetics code, not a gas kinetics code. As yet it is not linked to any other kinetic or chemistry type code.

KINETICS CODE

CODE NAME: BOLTZ

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☒ Expanding: ☐KINETICS GRID DIMENSIONALITY (☒):1-D: ☒ 2-D: ☐3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐Flow Direction: ☐KINETICS MODELED: Pulsed: ☒ CW: ☒NUMERICAL SCHEME USED IN RATE CALCULATION (☒):Explicit: ☐Implicit: ☐Others (specify): REFERENCE OF METHOD USED: Simpson
Integration

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: Number of Negative Species: Number of Neutral Species: electrons only
any numberREACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☐Self-Sustained: ☐UV-Initiated: ☐Others (specify):

Secondary Ionization (Reference)

Attachment: ☐Detachment: ☐Ion-Ion Recombination: ☐Charge Transfer: ☐Dissociation/Recombination: ☐Others (specify): Source of Rate Coefficients Used: DISCHARGE POWER INPUT MODELED (☒):Uniform: ☒ Non-Uniform: ☐E-Field: ☒ E/N inputOthers (specify):

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: Number of Species: Number of Reactions: Other Major Species Considered: Rotational,
attachment, dissociation, ionization
(all impact)IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☐Electronic: ☐Others (specify): ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-T: ☐V-R: ☐V-V: ☐Others (specify): Lasing Transition: P-Branch: ☐R-Branch: ☐Single Line Model (☒): Multi-Line Model (☒): Assumed Rotational Population Distribution State (☒):Equilibrium: ☐Nonequilibrium: ☐Number of Laser Lines Modeled: Source of Rate Coefficients Used in Code: LINE PROFILE MODELS (☒):Doppler Broadening: ☐Collisional Broadening: ☐Others (specify):

4. RECIRCULATION CONTAMINANTS

MODELED (☒): noneO_x: OH_x: NO_x: HNO_x: Others (specify): REFERENCE FOR REACTION MECHANISM AND RATES: OTHER UNIQUE FEATURES:

CODE NAME: CCUBE TECHNICAL AREA(S): Gas Dynamics
DEVICE COMPONENTS TREATED: Cavity, Diffuser, Heat Exchangers, Compressor
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Computes the flow properties throughout
a closed circulator for a steady state cw laser.

ASSESSMENT OF CAPABILITIES: Temperature dependent gas properties are modeled.

ASSESSMENT OF LIMITATIONS: _____

OTHER UNIQUE FEATURES: Can be used to investigate various design configurations.

ORIGINATOR/KEY CONTACT:

Name: G. R. Karr and C. C. Shih
Organization: Mech. Eng. Dept., Univ. of Ala. in Huntsville
Address: Huntsville, AL 35809
Phone: (205) 895-6330, (205) 895-6075, or (205) 895-6145

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = Related Publication): Analysis of Laser Gas Circulation Systems, UAH Report 164,
1975 Shih, Karr, Cleland and Laube.
Shih & Karr, Investigation of Transient Flow and Heating Problems Characteristic
of High Energy Laser Circulation Systems, UAH, Report No. 199, 1977.

STATUS:

Operational Currently?: yes
Under Modification?: yes

Purpose(s): Continuous changing code used to investigate designs of current
interest.

Ownership?: UAH
Proprietary?: _____

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC 1108

TRANSPORTABLE?: yes
Machine Dependent Restrictions: none

SELF-CONTAINED?: _____
Other Codes Required (name, purpose): none

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		order of 100 sec.
Large Job:		
Approximate Number of FORTRAN Lines:		1 box cards

COMMENTS: _____

GAS DYNAMICS CODE

CODE NAME: CCUBE

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ☒ Expanding: ☐

FLUID GRID DIMENSIONALITY (✓):

1-D: ☒

2-D: ☐

3-D: ☐

Time Dependent: ☐

FLOW FIELD MODELED (✓):

Compressible Flow: ☒

Incompressible: ☐

Viscous Flow: ☒

No Flow: ☐

BASIC MODELING APPROACH (✓):

Algebraic: ☒ Integral Method: ☐

Finite Difference: ☐

Others (specify):

REFERENCE FOR APPROACH USED:

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: ☒

Mixture Injection: ☐

Nozzles: ☐

Flow Plates: ☐

Others (specify):

CAVITY INITIAL CONDITION DETERMINED BY (specify): Calculated as steady State.

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: ☐ Closed System: ☐

Closed Cycle: ☒

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: ☐

Ejector System: ☐

Compressor/Fan: ☒

Heat Exchanger: ☒

Gas Make-Up: ☐

Others (specify):

DECONTAMINATION METHOD TREATED (✓):

Scrubber: ☐

Shower: ☐

Catalytic Reactor: ☐

Others (specify):

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: ☐ Repetitive Pulse: ☐

DIMENSIONALITY TREATED (✓):

1-D: ☐ 2-D: ☐ 3-D: ☐

Time-Dependent: ☐

DISTURBANCE MODELED (✓):

Pressure Wave: ☐ Entropy Wave: ☐

Others (specify):

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: ☐

Nonlinear Wave: ☐

Others (specify):

THEORETICAL BASIS: (Reference)

NUMERICAL METHODOLOGY: (Reference)

ACOUSTIC ATTENUATORS CONSIDERED (✓):

Muffler: ☐ Heat Exchanger: ☐

Horn: ☐ Porous Wall: ☐

Others (specify):

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓):

Index of Refraction Variation?: ☐

Other (specify):

OTHER UNIQUE FEATURES:

CODE NAME: COLASE TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Laser Cavity
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To model the laser kinetics of a pulsed, electric discharge CO laser and to predict the performance of the laser. This code is a modification of the code developed for CW lasers by William B. Lacina of the Northrop Corporation.

ASSESSMENT OF CAPABILITIES: Can handle gas mixtures of CO: N₂: Ar: He: Xe: O₂ at any temperature and pressure and excited by an electric discharge.

ASSESSMENT OF LIMITATIONS: The model is one-dimensional, can only model stable resonators, and assumes the same temperature for rotational and kinetic energies.

OTHER UNIQUE FEATURES: Includes superelastic collisions and discharge kinetics, and has sophisticated output formats.

ORIGINATOR/KEY CONTACT:

Name: Lyle Taylor
Organization: Westinghouse Electric Corporation
Address: 1310 Beulah Rd., Pittsburgh, PA 15668
Phone: 412-256-5833

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T: S.A. Wutzke, D.R. Suhre, L.H. Taylor, L.E. Kline, R.R. Mitchell and M.J. Pechersky, "UV Photoionized CO Electric Laser Research", Westinghouse Report 77-9C2-COLAS-R2 (1977).

U: L.H. Taylor and R.R. Mitchell "User's Manual for an Electric Discharge CO Laser Kinetics Code, "Westinghouse Report 77-9C2-COLAS-R1 (1977).

STATUS:

Operational Currently?: no

Under Modification?: no

Purpose(s):

Ownership?: U. S. Government

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): U-1106 and CDC-7600

TRANSPORTABLE?: no

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	340,000	60 sec, CDC-7600
Large Job:		

Approximate Number of FORTRAN Lines: 6878

COMMENTS:

~~Fabry-Perot cavity model using floating gain, geometric optics.~~

KINETICS CODE

CODE NAME: COLASE

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ✓ Expanding: _____

KINETICS GRID DIMENSIONALITY (✓):

1-D: ✓ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: no

Flow Direction: no

KINETICS MODELED: Pulsed: ✓ CW: _____

NUMERICAL SCHEME USED IN RATE CALCULATION (✓):

Explicit: _____

Implicit: _____

Others (specify): Simpson's Rule

REFERENCE OF METHOD USED: _____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 6

Number of Negative Species: 6

Number of Neutral Species: 6

REACTION MECHANISM MODELED (✓):

Primary Ionization: (Reference)

E-Beam: _____

Self-Sustained: ✓

UV-Initiated: ✓

Others (specify): _____

Secondary Ionization (Reference)

Attachment: ✓

Detachment: ✓

Ion-Ion Recombination: _____

Charge Transfer: _____

Dissociation/Recombination: _____

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED (✓):

Uniform: ✓ Non-Uniform: _____

E-Field: _____

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO

Number of Species: 6

Number of Reactions: 10

Other Major Species Considered: _____

N₂, Ar, He, Xe, O₂

IMPACT EXCITATION MODELED (✓):

(Reference)

Vibrational: ✓

Electronic: ✓

Others (specify): _____

ENERGY TRANSFER MODES MODELED (✓):

(Reference)

V-T: ✓

V-R: _____

V-V: ✓

Others (specify): _____

Lasing Transition: P-Branch: ✓

R-Branch: ✓

Single Line Model (✓): _____

Multi-Line Model (✓): ✓

Assumed Rotational Population Distribution State (✓):

Equilibrium: ✓

Nonequilibrium: _____

Number of Laser Lines Modeled: 40

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS (✓):

Doppler Broadening: _____

Collisional Broadening: ✓

Others (specify): _____

4. RECIRCULATION CONTAMINANTS

MODELED (✓): None

O_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: DENSITY TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: None, other than a simple RLC circuit

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Determine the time dependent species concentrations, voltage, and current in XeCl laser plasma. Program is centered around a subroutine DGEAR from the International Mathematics and Science Library (IMSL) for CDC 6600 computers. DGEAR is a subroutine for solving stiff differential equations.

ASSESSMENT OF CAPABILITIES: Currently tracks 7 species, plus voltage and current. Requires 110K of storage, 32K of which is a plotting routine. It takes ~7 sec. to calculate 500 time increments. This really depends upon how stiff the equations are.

ASSESSMENT OF LIMITATIONS: Code is presently awkward to change the number of equations. Code requires data bank of rates.

OTHER UNIQUE FEATURES: The electron kinetic rates are generally calculated by a separate code called BOLTZ which is not yet linked to DENSITY. These rates are interpolated using a SPLINE fit.

ORIGINATOR/KEY CONTACT:

Name: CPT Gary L. Duke

Organization: AFWAL/POOC-3

Address: Wright-Patterson AFB, OH 45433

Phone: (513) 255-2923 or (513) 255-3835

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): None on Density

DGEAR is described in the IMSL description or in:

1. Hindmarch, A.C. "GEAR: Ordinary Differential Equation System Solver," Lawrence Livermore Lab. Report UCID-30001, Rev. 3, Dec '74.
2. GEAR, C.W. Numerical Initial Value Problems in Ordinary Differential Eqs, Prentice-Hall, Engelwood Cliffs, New Jersey, 1971.

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): To increase the number of species, update rates, and link to BOLTZ. code. Also want to make the code have a variable time step dependent upon the voltage change.

Ownership?: U.S. Government

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600 in FORTRAN

TRANSPORTABLE?: yes, if IMSL is available.

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose): DGEAR involves still differntial equations.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	110K	3 sec
Typical Job:	110K	7 sec (500 time increments)
Large Job:	110K	20 sec

Approximate Number of FORTRAN Lines: 450 excluding DGEAR

COMMENTS:

KINETICS CODE

CODE NAME: DENSITY

1. CODE STRUCTURE

COORDINATE SYSTEM ($\checkmark$):Cartesian: $\checkmark$ Expanding: _____KINETICS GRID DIMENSIONALITY ($\checkmark$):1-D: $\checkmark$ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: $\checkmark$ CW: _____NUMERICAL SCHEME USED IN RATE
CALCULATION ($\checkmark$):

Explicit: _____

Implicit: _____

Others (specify): DGEARREFERENCE OF METHOD USED: See description
in Available Documentation

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive
Species: 2Number of Negative
Species: 2Number of Neutral
Species: 3REACTION MECHANISM MODELED ($\checkmark$):

Primary Ionization: (Reference)

E-Beam: _____

Self-Sustained: $\checkmark$ only Townsend ionization

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: $\checkmark$

Detachment: _____

Ion-Ion Recombination: $\checkmark$

Charge Transfer: _____

Dissociation/
Recombination: $\checkmark$

Others (specify): _____

Source of Rate Coefficients Used: _____

Current literatureDISCHARGE POWER INPUT MODELED ($\checkmark$):

Uniform: _____ Non-Uniform: _____

E-Field: _____

Others (specify): LRC circuit

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: XeClNumber of Species: 1Number of Reactions: 2Other Major Species Considered:
Xe*, Xe⁺, Xe₂, Cl⁻, HCl ($\gamma=1$)IMPACT EXCITATION MODELED ($\checkmark$):

(Reference)

Vibrational: $\checkmark$ HClElectronic: $\checkmark$ Xe

Others (specify): _____

ENERGY TRANSFER MODES MODELED ($\checkmark$):

(Reference)

V-I: $\checkmark$ Collisional relaxation rateV-R: _____ const.

V-V: _____

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model ($\checkmark$): _____Multi-Line Model ($\checkmark$): _____Assumed Rotational Population
Distribution State ($\checkmark$):

Equilibrium: _____

Nonequilibrium: _____

Number of Laser Lines 1

Modeled: _____

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS ($\checkmark$):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS
MODELED ($\checkmark$): noneO_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM
AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: E-Beam Transport TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Discharge gap including the foil, cathode, and the anode
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The code is developed to model the E-beam transport in the 2-D discharge gap of an EDL under prescribed E-field and B-field.
It computes the E-beam energy deposition distribution. When it is coupled to the PLASMA TRANSPORT CODE, accurate E-field and ionization distributions can be obtained.

ASSESSMENT OF CAPABILITIES: Although this code was written for the beam-electron energies between 5 to 500 keV, the energy range can be extended by adding more loss mechanisms and changing the cross sections. Discharge geometry can also be altered.

ASSESSMENT OF LIMITATIONS: At the present time, discharge cavities with dielectric flow plate and E-beam shield cannot be handled; field penetration in the region between the foil and the cathode is ignored.

OTHER UNIQUE FEATURES: Semi-analytical and semi-empirical formulas will be used to speed up the computation. Provision will be made for estimating the space charge arising from thermalization of the backscattered E-beam..

ORIGINATOR/KEY CONTACT:

Name: T.K. Tio
Organization: R & D Associated
Address: P.O. Box 9695, Marina del Rey, CA 90291
Phone: (213) 822-1715 ext. 448

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): Permission from AFWL is required to obtain the following documents.

1. EDL Discharge Modeling Status Report (T)
2. LASL Monte-Carlo Electron Transport Codes, Pts. I & II (Flow Charts)
3. Using the LASL Monte-Carlo Electron Transport Codes (U,L)

STATUS:

Operational Currently?: not ready

Under Modification?: yes

Purpose(s): To speed up the code by incorporating semi-analytic and semi-empirical formulas; to sample the space charges arising from the backscattered E-beam.

Ownership?: RDA

Proprietary?: Permission from AFWL is required.

MACHINE/OPERATING SYSTEM (on which installed): CRAY-1

TRANSPORTABLE?: yes

Machine Dependent Restrictions: Core size, FORTRAN Language

SELF-CONTAINED?:

Other Codes Required (name, purpose): Poisson equation solver is required to iterate for the E-field.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	200,000	250 (for 1,000 particles)
Typical Job:	200,000	1,250 (for 5,000 particles)
Large Job:	200,000	2,500 (for 10,000 particles)

Approximate Number of FORTRAN Lines: 12,000

COMMENTS:

KINETICS CODE

CODE NAME: E-Beam Transport

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ☒ Expanding: _____

KINETICS GRID DIMENSIONALITY (✓):

1-D: _____ 2-D: ☒

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: _____ CW: _____

NUMERICAL SCHEME USED IN RATE CALCULATION (✓):

Explicit: _____

Implicit: _____

Others (specify): _____

REFERENCE OF METHOD USED: _____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: _____

Number of Negative Species: _____

Number of Neutral Species: _____

REACTION MECHANISM MODELED (✓):

Primary Ionization: (Reference)

E-Beam: ☒

Self-Sustained: _____

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: _____

Detachment: _____

Ion-Ion Recombination: _____

Charge Transfer: _____

Dissociation/Recombination: ☒

Others (specify): _____

Source of Rate Coefficients Used: _____

AERL's experimental values

DISCHARGE POWER INPUT MODELED (✓):

Uniform: _____ Non-Uniform: ☒

E-Field: ☒

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: _____

Number of Species: _____

Number of Reactions: _____

Other Major Species Considered: _____

IMPACT EXCITATION MODELED (✓):

(Reference)

Vibrational: _____

Electronic: _____

Others (specify): _____

ENERGY TRANSFER MODES MODELED (✓):

(Reference)

V-T: _____

V-R: _____

V-V: _____

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model (✓): _____

Multi-Line Model (✓): _____

Assumed Rotational Population Distribution State (✓):

Equilibrium: _____

Nonequilibrium: _____

Number of Laser Lines

Modeled: _____

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS (✓):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS MODELED (✓):

O_x: _____ OH_x: _____

NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: EBEAM TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Laser Cavity, Lasing Gas, Electrical Power
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Compute time history of electric laser output power output for EBEAM or axial lasers. Input requires electric power input, laser cavity specifications, and gas species and densities.

ASSESSMENT OF CAPABILITIES: The code is compact and fast. Output values compare favorably with experimental values.

ASSESSMENT OF LIMITATIONS: Kinetics are approximated to speed the computations. Therefore, gas species limited to CO₂, He, N₂, and water vapor.

OTHER UNIQUE FEATURES: Gain spike values are computed.

ORIGINATOR/KEY CONTACT:

Name: Arthur Werkheiser
Organization: U. S. Army Missile Command
Address: DRSMI-RHA Directed Energy Directorate, Redstone Arsenal, AL 35898
Phone: (205) 876-8161

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): Formal documentation being assembled. Informally, there is available listing and user's manual.

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): Attempting a two-dimensional representation of the output.

Ownership?: U. S. Army

Proprietary?: NO

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: yes

Machine Dependent Restrictions: _____

SELF-CONTAINED?:

Other Codes Required (name, purpose): no

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>30K</u>	<u>10 sec</u>
Large Job:		
Approximate Number of FORTRAN Lines:		<u>500</u>

COMMENTS: _____

KINETICS CODE

CODE NAME: EBEAM

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):

Cartesian: ☒ Expanding: ☐

KINETICS GRID DIMENSIONALITY (☒):

1-D: ☒ 2-D: ☐

3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐

Flow Direction: ☐

KINETICS MODELED: Pulsed: ☒ CW: ☐

NUMERICAL SCHEME USED IN RATE CALCULATION (☒):

Explicit: ☐

Implicit: ☒

Others (specify): ☐

REFERENCE OF METHOD USED: ☐

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ☐

Number of Negative Species: ☐

Number of Neutral Species: ☐

REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☒

Self-Sustained: ☒

UV-Initiated: ☐

Others (specify): ☐

Secondary Ionization (Reference)

Attachment: ☒

Detachment: ☐

Ion-Ion Recombination: ☒

Charge Transfer: ☐

Dissociation/Recombination: ☒

Others (specify): ☐

Source of Rate Coefficients Used: ☐

DISCHARGE POWER INPUT MODELED (☒):

Uniform: ☐ Non-Uniform: ☐

E-Field: ☐

Others (specify): all three can be selected.

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO₂

Number of Species: 3

Number of Reactions: ☐

Other Major Species Considered: ☐

IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☐

Electronic: ☐

Others (specify): not explicitly defined

ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-T: ☐

V-R: ☒

V-V: ☒

Others (specify): not explicitly defined

Lasing Transition: P-Branch: ☐

R-Branch: ☐

Single Line Model (☒): ☒

Multi-Line Model (☒): ☐

Assumed Rotational Population Distribution State (☒):

Equilibrium: ☐

Nonequilibrium: ☒

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: ☐

LINE PROFILE MODELS (☒):

Doppler Broadening: ☐

Collisional Broadening: ☐

Others (specify): ☐

4. RECIRCULATION CONTAMINANTS MODELED (☒):

O_x: ☐ OH_x: ☐

NO_x: ☐ HNO_x: ☐

Others (specify): not specified

REFERENCE FOR REACTION MECHANISM AND RATES: ☐

OTHER UNIQUE FEATURES: ☐

CODE NAME: EBEAM2 TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Power Supply

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Given power supply specifications for an E-Beam laser, computes the E-Beam gun and sustainer voltage and current time history. Gas species and densities are also inputted.

ASSESSMENT OF CAPABILITIES: Provides a graphical display of current and voltage for each of the two electrical systems in a pulsed E-beam laser.

ASSESSMENT OF LIMITATIONS: Restricted to CO₂, N₂ and HE Gas Systems. Laser outputted not computed.

OTHER UNIQUE FEATURES: was used in a comparison between theory and experiment. Easily showed gas rate coefficient dependencies.

ORIGINATOR/KEY CONTACT:

Name: Arthur Werkheiser

Organization: US Army Missile Command

Address: DRSMI-RHA, Directed Energy Directorate, Redstone Arsenal, AL 35898

Phone: (205) 876-8161

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): Under preparation.

STATUS:

Operational Currently?: yes

Under Modification?: no

Purpose(s): _____

Ownership?: US Army

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): DEC PDP 11/34

TRANSPORTABLE?: no

Machine Dependent Restrictions: Requires a Tektronics 4012 terminal

SELF-CONTAINED?:

Other Codes Required (name, purpose): Requires Tektronics Plot 10 Software

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>25K</u>	
Large Job:		
Approximate Number of FORTRAN Lines:		<u>300</u>

COMMENTS: _____

KINETICS CODE

CODE NAME: EBEAM2

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: _____ Expanding: _____

KINETICS GRID DIMENSIONALITY (✓):

1-D: _____ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: ☒ CW: _____

NUMERICAL SCHEME USED IN RATE CALCULATION (✓):

Explicit: _____

Implicit: ☒

Others (specify): _____

REFERENCE OF METHOD USED: _____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: _____

Number of Negative Species: _____

Number of Neutral Species: _____

REACTION MECHANISM MODELED (✓):

Primary Ionization: (Reference)

E-Beam: ☒

Self-Sustained: _____

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: ☒

Detachment: ☒

Ion-Ion Recombination: ☒

Charge Transfer: _____

Dissociation/Recombination: _____

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED (✓):

Uniform: _____ Non-Uniform: ☒

E-Field: _____

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: 1

Number of Species: 3

Number of Reactions: _____

Other Major Species Considered: _____

IMPACT EXCITATION MODELED (✓):

(Reference)

Vibrational: ☒

Electronic: ☒

Others (specify): _____

ENERGY TRANSFER MODES MODELED (✓):

(Reference)

V-T: ☒

V-R: ☒

V-V: ☒

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model (✓): _____

Multi-Line Model (✓): _____

Assumed Rotational Population Distribution State (✓):

Equilibrium: _____

Nonequilibrium: _____

Number of Laser Lines Modeled: _____

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS (✓):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS

MODELED (✓): none

O_x: _____ OH_x: _____

NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: EBM2D TECHNICAL AREA(S): Kinetics
 DEVICE COMPONENTS TREATED: Laser Cavity, Gas
 PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: EBM2D Computes a 2-dimensional distribution of electron density, electric field, and power deposited within a laser cavity for a given potential difference and current density for electric lasers.
 ASSESSMENT OF CAPABILITIES: Computes using attachment coefficient, Townsend avalanche, and recombination coefficients. A fast, compact code.
 ASSESSMENT OF LIMITATIONS: Reiterates 6 times in computing one distribution. Does not give a time history. Restricted to a few species.
 OTHER UNIQUE FEATURES: Makes use of cavity symmetry. Includes several empirical approximations to speed the calculations. Presupposes an EBEAM laser.
 ORIGINATOR/KEY CONTACT:
 Name: Arthur Werkheiser
 Organization: U.S. Army Missile Command
 Address: DRSMI-RHA Directed Energy Directorate, Redstone Arsenal, AL 35898
 Phone: (205) 876-8161
 AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): E-Beam Spreading and Resulting Field Variations in CO₂ Laser Plasmas, Cason, C., Perkins, J.F. and Werkheiser, A.H., AIAA Journal, Vol. 15, No. 8, Aug. 1977, pp. 1079 - 1083 (T)
 STATUS:
 Operational Currently?: yes
 Under Modification?: yes
 Purpose(s): Combining this with EBEAM to produce a two-dimensional time history.
 Ownership?: US Army
 Proprietary?: no
 MACHINE/OPERATING SYSTEM (on which installed): CDC 6600
 TRANSPORTABLE?: yes
 Machine Dependent Restrictions: no
 SELF-CONTAINED?:
 Other Codes Required (name, purpose):
 ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>30K</u>	<u>15 sec</u>
Large Job:		
Approximate Number of FORTRAN Lines:		<u>400</u>

 COMMENTS:

KINETICS CODE

CODE NAME: EBM2D

1. CODE STRUCTURE

COORDINATE SYSTEM ($\checkmark$):Cartesian: $\checkmark$ Expanding: _____KINETICS GRID DIMENSIONALITY ($\checkmark$):1-D: _____ 2-D: $\checkmark$

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: _____ CW: _____

NUMERICAL SCHEME USED IN RATE CALCULATION ($\checkmark$):

Explicit: _____

Implicit: $\checkmark$

Others (specify): _____

REFERENCE OF METHOD USED: _____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: _____

Number of Negative Species: _____

Number of Neutral Species: _____

REACTION MECHANISM MODELED ($\checkmark$):

Primary Ionization: (Reference)

E-Beam: $\checkmark$

Self-Sustained: _____

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: $\checkmark$ Detachment: $\checkmark$ Ion-Ion Recombination: $\checkmark$

Charge Transfer: _____

Dissociation/Recombination: $\checkmark$

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED ($\checkmark$):Uniform: $\checkmark$ Non-Uniform: _____

E-Field: _____

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO_2

Number of Species: 3

Number of Reactions: _____

Other Major Species Considered: _____

IMPACT EXCITATION MODELED ($\checkmark$):

(Reference)

Vibrational: _____

Electronic: _____

Others (specify): _____

ENERGY TRANSFER MODES MODELED ($\checkmark$):

(Reference)

V-T: _____

V-R: _____

V-V: _____

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model ($\checkmark$): $\checkmark$ Multi-Line Model ($\checkmark$): _____Assumed Rotational Population Distribution State ($\checkmark$):Equilibrium: $\checkmark$

Nonequilibrium: _____

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS ($\checkmark$):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS MODELED ($\checkmark$): none O_x : _____ OH_x : _____ NO_x : _____ HNO_x : _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

KINETICS CODE

CODE NAME: EDLAMP

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):

Cartesian: ☐ Expanding: ☐

KINETICS GRID DIMENSIONALITY (☒):

1-D: ☒ 2-D: ☐

3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐

Flow Direction: ☒

KINETICS MODELED: Pulsed: ☒ CW: ☒

NUMERICAL SCHEME USED IN RATE CALCULATION (☒):

Explicit: ☒

Implicit: ☒

Others (specify):

REFERENCE OF METHOD USED:

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: Arbitrary

Number of Negative Species: Arbitrary

Number of Neutral Species: Arbitrary

REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☒

Self-Sustained: ☐

UV-Initiated: ☐

Others (specify):

Secondary Ionization (Reference)

Attachment: ☒

Detachment: ☒

Ion-Ion Recombination: ☒

Charge Transfer: ☒

Dissociation/Recombination: ☒

Others (specify):

Source of Rate Coefficients Used:

DISCHARGE POWER INPUT MODELED (☒):

Uniform: ☒ Non-Uniform: ☐

E-Field: ☒

Others (specify):

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO₂

Number of Species: Arbitrary

Number of Reactions: Arbitrary

Other Major Species Considered:

N₂, He, O₂, H₂, CO

IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☒

Electronic: ☒

Others (specify): Ionization

ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-T: ☒

V-R: ☐

V-V: ☒

Others (specify):

Lasing Transition: P-Branch: ☒

R-Branch: ☒

Single Line Model (☒): ☒

Multi-Line Model (☒): ☐

Assumed Rotational Population Distribution State (☒):

Equilibrium: ☒

Nonequilibrium: ☐

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code:

LINE PROFILE MODELS (☒):

Doppler Broadening: ☒

Collisional Broadening: ☒

Others (specify):

Combination (Voigt Profile)

4. RECIRCULATION CONTAMINANTS

MODELED (☒):

O_x: ☒ OH_x: ☒

NO_x: ☒ HNO_x: ☒

Others (specify):

REFERENCE FOR REACTION MECHANISM AND RATES:

OTHER UNIQUE FEATURES:

GAS DYNAMICS CODE

CODE NAME: EDLAMP

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: _____ Expanding: _____

FLUID GRID DIMENSIONALITY (✓):

1-D: ✓

2-D: _____

3-D: _____

Time Dependent: _____

FLOW FIELD MODELED (✓):

Compressible Flow: ✓

Incompressible: _____

Viscous Flow: _____

No Flow: _____

BASIC MODELING APPROACH (✓):

Algebraic: _____ Integral Method: _____

Finite Difference: ✓

Others (specify): _____

REFERENCE FOR APPROACH USED: _____

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: _____

Mixture Injection: _____

Nozzles: _____

Flow Plates: _____

Others (specify): _____

CAVITY INITIAL CONDITION DETERMINED
BY (specify): given P, T, U, Equil.
concentrations

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: ✓ Closed System: _____

Closed Cycle: ✓

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: _____

Ejector System: _____

Compressor/Fan: _____

Heat Exchanger: ✓

Gas Make-Up: ✓

Others (specify): Heat exchanger modeled
via specified drop in T. Make-up
modeled by adjusting mixture
composition.

DECONTAMINATION METHOD TREATED (✓):

Scrubber: ✓

Shower: _____

Catalytic Reactor: ✓

Others (specify): Scrubber/Catalytic
reactor modeled by adjusting mixture
composition.

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: _____ Repetitive Pulse: _____

DIMENSIONALITY TREATED (✓):

1-D: _____ 2-D: _____ 3-D: _____

Time-Dependent: _____

DISTURBANCE MODELED (✓):

Pressure Wave: _____ Entropy Wave: _____

Others (specify): _____

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: _____

Nonlinear Wave: _____

Others (specify): _____

THEORETICAL BASIS: (Reference) _____

NUMERICAL METHODOLOGY: (Reference) _____

ACOUSTIC ATTENUATORS CONSIDERED (✓):

Muffler: _____ Heat Exchanger: _____

Horn: _____ Porous Wall: _____

Others (specify): _____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓):

Index of Refraction Variation?: _____

Other (specify): _____

OTHER UNIQUE FEATURES: _____

CODE NAME: EDLNOD TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Cavity
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Small signal gain and energy
extraction for CO₂ EDL's.

ASSESSMENT OF CAPABILITIES: Both versions of this code have demonstrated good
agreement with experimental data from Humdinger, ABEL, and the AFWL
Pulsar Device.

ASSESSMENT OF LIMITATIONS: The energy extraction routine is not based on physical
optics principles, so predictions are of limited utility. The code assumes uniform
electric field and electron density.

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: CPT Robert F. Walter
Organization: AFWL/AREP
Address: Kirtland AFB, NM 87117
Phone: 505-844-1786

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = Related Publication): L

RP: AFWL TR-74-216
J. Appl. Phys. 46, 3566, Aug. 1975

STATUS:

Operational Currently?: yes
Under Modification?: yes
Purpose(s): Provide voltage and current input waveforms of
arbitrary temporal profile.

Ownership?: US AirForce
Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CRAY-1 , CDC 6600

TRANSPORTABLE?: yes
Machine Dependent Restrictions: _____

SELF-CONTAINED?:

Other Codes Required (name, purpose): IDHHANK - Boltzmann Equation Code required
to calculate electron excitation rates.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>(200,000)</u>	<u>2 sec. on CRAY</u>
Large Job:		

Approximate Number of FORTRAN Lines: _____

COMMENTS: _____

KINETICS CODE

CODE NAME: EDLNOD

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: _____ Expanding: _____

KINETICS GRID DIMENSIONALITY (✓):

1-D: ☒ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: ☒ CW: _____

NUMERICAL SCHEME USED IN RATE CALCULATION (✓):

Explicit: ☒

Implicit: _____

Others (specify): _____

REFERENCE OF METHOD USED: AFWL TR-74-216,
J. Appl. Phys. 46, 3566, Aug. 1975

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 0

Number of Negative Species: 1

Number of Neutral Species: 4

REACTION MECHANISM MODELED (✓):

Primary Ionization: (Reference)

E-Beam: ☒

Self-Sustained: _____

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: _____

Detachment: _____

Ion-Ion Recombination: _____

Charge Transfer: _____

Dissociation/Recombination: _____

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED (✓):

Uniform: ☒ Non-Uniform: _____

E-Field: _____

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: 1

Number of Species: 4

Number of Reactions: _____

Other Major Species Considered: _____

IMPACT EXCITATION MODELED (✓):

(Reference)

Vibrational: ☒

Electronic: _____

Others (specify): _____

ENERGY TRANSFER MODES MODELED (✓):

(Reference)

V-I: ☒

V-R: _____

V-V: ☒

Others (specify): _____

Lasing Transition: P-Branch: ☒

R-Branch: _____

Single Line Model (✓): ☒

Multi-Line Model (✓): _____

Assumed Rotational Population Distribution State (✓):

Equilibrium: ☒

Nonequilibrium: _____

Number of Laser Lines

Modeled: 1

Source of Rate Coefficients Used in Code:

AFWL TR-74-216

LINE PROFILE MODELS (✓):

Doppler Broadening: ☒

Collisional Broadening: ☒

Others (specify): _____

4. RECIRCULATION CONTAMINANTS MODELED (✓): none

O_x: _____ OH_x: _____

NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: EDLSL TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: CO₂/H₂ or He/ N₂ EDL Cavity Kinetics
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Models the Kinetics of photon production by a glow discharge in an EDL cavity containing CO₂, N₂ and H₂ or He using the 6-temperature model of AVCO written by Dr. A.T. Gavrielides of the AFWL.

ASSESSMENT OF CAPABILITIES: A fast and simple algorithm which does not account for E-beam spreading, has no optics in it, and assumes a constant average N_e which is an input.

ASSESSMENT OF LIMITATIONS: Has been anchored to other codes such as that of Lockheed and has shown agreement within 10-15%.

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: A. T. Gavrielides
Organization: AFWL/LRE
Address: Kirtland AFB, N.M. 87106
Phone: (505) 844-4691

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): none
This is an "in-house" code used by a limited number of people.

STATUS:

Operational Currently?: yes
Under Modification?: _____
Purpose(s): _____

Ownership?: AFWL/LRE
Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600/ CYBER 176
NOSBE operating system

TRANSPORTABLE?: marginally

Machine Dependent Restrictions: Was written for CDC and is not in ANSI Fortran

SELF-CONTAINED?:

Other Codes Required (name, purpose): Requires DISSPLA package and a library differential equation solver.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>4992</u>	<u>20 sec</u>
Large Job:		

Approximate Number of FORTRAN Lines: 150

COMMENTS: _____

KINETICS CODE

CODE NAME: EDLSL

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☐ Expanding: ☐KINETICS GRID DIMENSIONALITY (☒):1-D: ☐ 2-D: ☒3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐Flow Direction: ☒KINETICS MODELED: Pulsed: ☒ CW: ☐NUMERICAL SCHEME USED IN RATE
CALCULATION (☒):Explicit: ☐Implicit: ☒

Others (specify): _____

REFERENCE OF METHOD USED: AVCO 6-temp
model programmed by Dr. A.T. Gavrielide
of the AFWL.

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive
Species: 0Number of Negative
Species: 0Number of Neutral
Species: 3REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☐Self-Sustained: ☒ AERL Kinetics HandbookUV-Initiated: ☐

Others (specify): _____

Secondary Ionization (Reference)

Attachment: ☐Detachment: ☐Ion-Ion Recombination: ☐Charge Transfer: ☐Dissociation/
Recombination: ☐

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED (☒):Uniform: ☒ Non-Uniform: ☐E-Field: ☐

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO_2

Number of Species: 3

Number of Reactions: 6

Other Major Species Considered: _____

IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☐Electronic: ☐

Others (specify): _____

ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-T: ☒V-R: ☒ AVCO HandbookV-V: ☒

Others (specify): _____

Lasing Transition: P-Branch: ☒R-Branch: ☐Single Line Model (☒): ☒Multi-Line Model (☒): ☐Assumed Rotational Population
Distribution State (☒):Equilibrium: ☒Nonequilibrium: ☐Number of Laser Lines
Modeled: 1

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS (☒):Doppler Broadening: ☒Collisional Broadening: ☐

Others (specify): _____

4. RECIRCULATION CONTAMINANTS
MODELED (☒): none O_x : ☐ OH_x : ☐ NO_x : ☐ HNO_x : ☐

Others (specify): _____

REFERENCE FOR REACTION MECHANISM
AND RATES: _____OTHER UNIQUE FEATURES: Gain switch spike
computed.

plotting capability.

CODE NAME: EED, also called BOLTZ TECHNICAL AREA(S): Electron Kinetics

DEVICE COMPONENTS TREATED: NA

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: EED solves for the steady-state electron distribution function using the Boltzmann Equation. Elastic, Inelastic and Super-elastic interactions are considered, as well as electron-electron interactions.

ASSESSMENT OF CAPABILITIES: Very general. It will consider any gas as long as cross-section data for that gas are available. If no super-elastics or electron-electron interactions are included, the code is very fast.

ASSESSMENT OF LIMITATIONS: The electron-electron interactions are somewhat untested and it's not clear if the formulation is correct. If superelastics are included, the method is slow. Also, if superelastics are included a lot of core memory is required.

OTHER UNIQUE FEATURES: Very easy to use, clear output, very little machine-dependent features. Input is checked for consistency and validity.

ORIGINATOR/KEY CONTACT:

Name: Henry Happ

Organization: Tetra Corp.

Address: 1325 San Mateo, SE, Albuquerque, NM 87108

Phone: (505) 256-3595

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

Boltz: A code to solve the Boltzmann Electron Transport Equation, Tetra TR-78-001 (T,U)

Listings are available upon request.

STATUS:

Operational Currently?: yes

Under Modification?:

Purpose(s):

Ownership?: U. S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600 or 176, CRAY-1

TRANSPORTABLE?: Almost

Machine Dependent Restrictions: How the machine orders its display code. Problem only occurs in one or two lines of code. Also, write statements use A8 formats.

SELF-CONTAINED?: /Finally, NAMELIST is used.

Other Codes Required (name, purpose): none

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	32533 *	
Typical Job:	232433	
Large Job:	232533	
Approximate Number of FORTRAN Lines:		2400

COMMENTS: * If superelastics are to be included, a large array of size (256,256) is used. References to this array can be removed if superelastics are not used.

KINETICS CODE

CODE NAME: EED

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ☒ Expanding: ☐

KINETICS GRID DIMENSIONALITY (✓):

1-D: ☒ 2-D: ☐

3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐

Flow Direction: ☐

KINETICS MODELED: Pulsed: ☐ CW: ☐

NUMERICAL SCHEME USED IN RATE CALCULATION (✓):

Explicit: ☒

Implicit: ☐

Others (specify):

REFERENCE OF METHOD USED: Thomson, Smith & Davies, "Boltz: A Code...", Computer Phys. Comm., V.11, p. 369-383, 1976

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species:

Number of Negative Species:

Number of Neutral Species:

REACTION MECHANISM MODELED (✓):

Primary Ionization: (Reference)

E-Beam: ☐

Self-Sustained: ☐

UV-Initiated: ☐

Others (specify):

Secondary Ionization (Reference)

Attachment: ☐

Detachment: ☐

Ion-Ion Recombination: ☐

Charge Transfer: ☐

Dissociation/Recombination: ☐

Others (specify):

Source of Rate Coefficients Used:

DISCHARGE POWER INPUT MODELED (✓):

Uniform: ☐ Non-Uniform: ☐

E-Field: ☐

Others (specify):

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species:

Number of Species:

Number of Reactions:

Other Major Species Considered:

IMPACT EXCITATION MODELED (✓):

(Reference)

Vibrational: ☐

Electronic: ☐

Others (specify):

ENERGY TRANSFER MODES MODELED (✓):

(Reference)

V-I: ☐

V-R: ☐

V-V: ☐

Others (specify):

Lasing Transition: P-Branch: ☐

R-Branch: ☐

Single Line Model (✓): ☐

Multi-Line Model (✓): ☐

Assumed Rotational Population Distribution State (✓):

Equilibrium: ☐

Nonequilibrium: ☐

Number of Laser Lines

Modeled:

Source of Rate Coefficients Used in Code:

LINE PROFILE MODELS (✓):

Doppler Broadening: ☐

Collisional Broadening: ☐

Others (specify):

4. RECIRCULATION CONTAMINANTS MODELED (✓):

O_x: OH_x:

NO_x: HNO_x:

Others (specify):

REFERENCE FOR REACTION MECHANISM AND RATES:

OTHER UNIQUE FEATURES:

CODE NAME: ELECT TECHNICAL AREA(S): Electron Kinetics
DEVICE COMPONENTS TREATED: Laser cavity; electrical excitation
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To provide an analysis of electron kinetics for an arbitrary gas mixture (possibly including excited species) as a function of electric field by numerical solution of the Boltzmann equation.

ASSESSMENT OF CAPABILITIES: Code provides for electron-molecule, momentum transfer, superelastic, and electron-electron collisions; quasisteady state approximation retains dn/dt term for electron creation or loss from external ionization, secondary ionization, attachment, recombination, etc.
ASSESSMENT OF LIMITATIONS: No significant limitations.

OTHER UNIQUE FEATURES: Code is more general than most, inasmuch as there are few limitations on scattering processes, electron-electron collisions are included, superelastic collisions are included, and the analysis can be generated for an arbitrary number of species or reactions. User-oriented, flexible input/output characteristics.

ORIGINATOR/KEY CONTACT:

Name: William B. Lacina
Organization: Northrop Research and Technology Center
Address: One Research Park, Palos Verdes Peninsula, CA 90274
Phone: (213) 377-4811 Ext. 362

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

"Theoretical Modeling of Molecular and Electron Kinetic Processes.
Vol. I: Theoretical Formulation of Analysis and Description of Computer
Programs. Vol. II: Fortran Computer Program Listings, " Northrop Rept.
#NRTC-79-7R, January 1979 (T,U,L)

STATUS:

Operational Currently?: yes
Under Modification?: no
Purpose(s): _____

Ownership?: Northrop Research & Tech./William B. Lacina
Proprietary?: No. Public Domain

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: yes
Machine Dependent Restrictions: yes (word size)

SELF-CONTAINED?: yes

Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	_____	_____
Typical Job:	_____	_____
Large Job:	_____	_____

Approximate Number of FORTRAN Lines: 4,000

COMMENTS:

NOTE: The actual Boltzmann subroutines (without the main program ELECT and miscellaneous I/O routines) are shorter, and could be easily extracted from this code for usage elsewhere.

KINETICS CODE

CODE NAME: ELECT

1. CODE STRUCTURE

COORDINATE SYSTEM ($\checkmark$):

Cartesian: _____ Expanding: _____

KINETICS GRID DIMENSIONALITY ($\checkmark$):

1-D: _____ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: _____ CW: _____

NUMERICAL SCHEME USED IN RATE CALCULATION ($\checkmark$):

Explicit: _____

Implicit: _____

Others (specify): _____

REFERENCE OF METHOD USED: _____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: _____

Number of Negative Species: _____

Number of Neutral Species: _____

Arbitrary

"

"

REACTION MECHANISM MODELED ($\checkmark$):

Primary Ionization: (Reference)

E-Beam: $\checkmark$ Self-Sustained: $\checkmark$ UV-Initiated: $\checkmark$

Others (specify): _____

Secondary Ionization (Reference)

Attachment: $\checkmark$ Detachment: $\checkmark$ Ion-Ion Recombination: $\checkmark$ Charge Transfer: $\checkmark$ Dissociation/Recombination: $\checkmark$

Others (specify): _____

Source of Rate Coefficients Used: _____

MiscellaneousDISCHARGE POWER INPUT MODELED ($\checkmark$):Uniform: $\checkmark$ Non-Uniform: _____E-Field: $\checkmark$ Others (specify): E-beam or other

3. LASING KINETICS MODEL

GENERAL (specify): N.A.

Lasing Species: _____

Number of Species: _____

Number of Reactions: _____

Other Major Species Considered: _____

IMPACT EXCITATION MODELED ($\checkmark$):

(Reference)

Vibrational: _____

Electronic: _____

Others (specify): _____

ENERGY TRANSFER MODES MODELED ($\checkmark$):

(Reference)

V-T: _____

V-R: _____

V-V: _____

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model ($\checkmark$): _____Multi-Line Model ($\checkmark$): _____Assumed Rotational Population Distribution State ($\checkmark$):

Equilibrium: _____

Nonequilibrium: _____

Number of Laser Lines

Modeled: _____

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS ($\checkmark$):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS MODELED ($\checkmark$): noneO_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: ELENDIF TECHNICAL AREA(S): Electron Kinetics
DEVICE COMPONENTS TREATED: _____
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Time Dependent Boltzmann Code

ASSESSMENT OF CAPABILITIES: (1) Backward prolongation (using a multi-step, variable stepsize integration algorithm); (2) Matrix solution of the steady-state Boltzmann equation including superelastic processes; (3) Time dependent relaxation calculation of the distribution function.

ASSESSMENT OF LIMITATIONS: _____

OTHER UNIQUE FEATURES: In addition to computing the electron energy distribution function, the code computes mean electron energy, drift velocity, characteristic energy, inelastic and superelastic rate coefficients, and energy flow rates for the processes being included in the calculation.

ORIGINATOR/KEY CONTACT:

Name: CPT Gary L. Duke
Organization: AFWAL/POOC-3
Address: Wright-Patterson AFB, Dayton, OH
Phone: (513) 255-2923

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T.U.L.: "ELENDIF": A Computer Program That Solves the Boltzmann Equation for a Partially Ionized Gas", JILA Information Center Report #19 by William L. Morgan, June 1979.

STATUS:

Operational Currently?: Yes
Under Modification?: NO
Purpose(s): _____

Ownership?: _____

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): _____

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: Programmed in Fortran IV

SELF-CONTAINED?: _____

Other Codes Required (name, purpose): none

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>120K</u>	<u>15 Sec</u>
Large Job:		

Approximate Number of FORTRAN Lines: 1200

COMMENTS:

NOTE: ELENDIF was brought to us by MAJ R.D. Franklin from Lawrence Lab. He has since moved on and although the code is operational it is not currently being used.

CODE NAME: ETRANV TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: _____

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Time dependent solution of master equation for vibrational energy exchange. Used in modeling of vibrational-rotational laser systems (CO₂, CO, HF, DF).

ASSESSMENT OF CAPABILITIES: Time dependent or steady state solutions of state populations (200), with capability to treat five (5) different molecular species. Capable of being linked to solution of collisional Boltzmann equation

ASSESSMENT OF LIMITATIONS: Uncertainty in rate (V-V and V-T) scaling with respect to vibrational state and translational temperature.

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: Wm. F. Bailey

Organization: AFIT/ENP A.F. Institute of Technology, Physics Dept.

Address: Bldg. 640, Area B, Wright-Patterson AFB, Ohio 45433

Phone: 513-255-2012

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

"Collision Induced Dissociation of Diatomic Molecules",

AFAPL-TR-78-105, Nov. 1978 (RP)

STATUS:

Operational Currently?: X

Under Modification?: _____

Purpose(s): _____

Ownership?: U.S.A.F.

Proprietary?: _____

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: X

Machine Dependent Restrictions: _____

SELF-CONTAINED?: X

Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	_____	_____
Typical Job:	_____	_____
Large Job:	_____	_____
Approximate Number of FORTRAN Lines: _____		

COMMENTS: _____

KINETICS CODE

CODE NAME: ETRANV

1. CODE STRUCTURE

COORDINATE SYSTEM (Cartesian: ☐ Expanding: ☒KINETICS GRID DIMENSIONALITY (1-D: ☐ 2-D: ☐3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐Flow Direction: ☐KINETICS MODELED: Pulsed: ☒ CW: ☒NUMERICAL SCHEME USED IN RATE CALCULATION (Explicit: ☒Implicit: ☐Others (specify): REFERENCE OF METHOD USED:

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: Number of Negative Species: Number of Neutral Species: REACTION MECHANISM MODELED (Primary Ionization: (Reference)E-Beam: ☒Self-Sustained: ☒UV-Initiated: ☐Others (specify):

Secondary Ionization (Reference)

Attachment: ☒Detachment: ☒Ion-Ion Recombination: ☐Charge Transfer: ☐Dissociation/Recombination: ☒Others (specify): Source of Rate Coefficients Used: DISCHARGE POWER INPUT MODELED (Uniform: ☒ Non-Uniform: ☐E-Field: ☐Others (specify):

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species:	} variable
Number of Species:	
Number of Reactions:	
Other Major Species Considered:	

IMPACT EXCITATION MODELED ((Reference)Vibrational: ☒Electronic: ☐Others (specify): ENERGY TRANSFER MODES MODELED ((Reference)V-T: ☒V-R: ☐V-V: ☒Others (specify): Lasing Transition: P-Branch: ☒R-Branch: ☒Single Line Model (☒): ☒Multi-Line Model (☒): ☒Assumed Rotational Population Distribution State (☒):Equilibrium: ☒Nonequilibrium: ☐Number of Laser Lines Modeled: ☒ Variable

Source of Rate Coefficients Used in Code: SSH

LINE PROFILE MODELS (☒):Doppler Broadening: ☐Collisional Broadening: ☒Others (specify):

4. RECIRCULATION CONTAMINANTS

MODELED (☒): noneO_x: OH_x: NO_x: HNO_x: Others (specify): REFERENCE FOR REACTION MECHANISM AND RATES: OTHER UNIQUE FEATURES:

CODE NAME: FREESL TECHNICAL AREA(S): Gas Dynamics

DEVICE COMPONENTS TREATED: Cavity-Beam Duct Interface

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Compute development of free shear layer at interface of primary cavity flow and secondary injected beam duct flow, in a confined channel.

ASSESSMENT OF CAPABILITIES: Determines penetration of beam duct gas into cavity - diffusion of CO₂ into beam duct - velocity and species concentration profiles across shear layer and optical path difference.

ASSESSMENT OF LIMITATIONS: Determination of streamwise velocity at lower boundary requires solution of elliptic problem and is unknown within the context of the parabolic shear layer equations -- both zero shear and zero velocity boundary conditions used to bound problem.

OTHER UNIQUE FEATURES: Shear layer edge conditions determined through influence of shear layer displacement thickness on inviscid cavity flow. Unequal diffusion coefficients used in conjunction with binary diffusion approximation.

ORIGINATOR/KEY CONTACT:

Name: Peter Crowell

Organization: RDA

Address: ATO 9377 Int. Airport, Albuquerque, NM 87119

Phone: 505-844-3013

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T,L , RDA Report No. 80-A/K-21-O.1143

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): Improved turbulence model (2 eq. model) current version uses eddy viscosity model.

Ownership?: RDA

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CRAY-1

TRANSPORTABLE?: yes

Machine Dependent Restrictions: none

SELF-CONTAINED?:

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		500-600 sec on cray using 150 mesh
Large Job:		points and 200 marching steps

Approximate Number of FORTRAN Lines: _____

COMMENTS: _____

GAS DYNAMICS CODE

CODE NAME: FREESL

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: _____ Expanding: ✓

FLUID GRID DIMENSIONALITY (✓):

1-D: _____

2-D: ✓

3-D: _____

Time Dependent: _____

FLOW FIELD MODELED (✓):

Compressible Flow: ✓

Incompressible: _____

Viscous Flow: ✓

No Flow: _____

BASIC MODELING APPROACH (✓):

Algebraic: _____ Integral Method: _____

Finite Difference: ✓

Others (specify): _____

REFERENCE FOR APPROACH USED: Thin
Shear Layer equations

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: N₂-CO₂-He

Mixture Injection: N₂

Nozzles: _____

Flow Plates: _____

Others (specify): Beam duct injection
into cavity is N₂

CAVITY INITIAL CONDITION DETERMINED
BY (specify): assumed initial profiles

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: _____ Closed System: _____

Closed Cycle: _____

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: _____

Ejector System: _____

Compressor/Fan: _____

Heat Exchanger: _____

Gas Make-Up: _____

Others (specify): _____

DECONTAMINATION METHOD TREATED (✓):

Scrubber: _____

Shower: _____

Catalytic Reactor: none

Others (specify): _____

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: _____ Repetitive Pulse: _____

DIMENSIONALITY TREATED (✓):

1-D: _____ 2-D: _____ 3-D: _____

Time-Dependent: _____

DISTURBANCE MODELED (✓):

Pressure Wave: _____ Entropy Wave: _____

Others (specify): _____

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: _____

Nonlinear Wave: _____

Others (specify): _____

THEORETICAL BASIS: (Reference) _____

NUMERICAL METHODOLOGY: (Reference) _____

ACOUSTIC ATTENUATORS CONSIDERED (✓):

Muffler: _____ Heat Exchanger: _____

Horn: _____ Porous Wall: _____

Others (specify): _____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓):

Index of Refraction Variation?: yes

Other (specify): Optical path

difference computed across

shear layer

OTHER UNIQUE FEATURES: _____

CODE NAME: GALERK TECHNICAL AREA(S): Electron Kinetics

DEVICE COMPONENTS TREATED: _____

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To predict electron transport and excitation-ionization coefficients from cross-section data.

ASSESSMENT OF CAPABILITIES: For the first time provides practical means of taking into account properly the effects of large inelastic cross-sections, such as that for vibrational excitation of N₂ or CO.

ASSESSMENT OF LIMITATIONS: Requires large computer, e.g., used only on CRAY I so far; requires user to adjust grid and to iterate solutions in presence of ionization.

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: L. C. Pitchford (originator)

Organization: to 11/28/80 J.I.L.A.

After 1/1/81-Sandia Laboratories

Address: U. of Colorado, Boulder, CO 80309

Albuquerque, NM

Phone: (303) 492-8255

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

L, RP - L.C. Pitchford, S.V. O'Neil, V.R. Rumble, Jr.,
Phys. Rev. A (in press) 1980.

STATUS:

Operational Currently?: X

Under Modification?: X

Purpose(s): To allow operation on CDC 7600 using external memory.

Ownership?: Joint Institute of Laboratory Astrophysics under support from AFAPL.

Proprietary?: _____

MACHINE/OPERATING SYSTEM (on which installed): CRAY I

TRANSPORTABLE?: to other CRAY I's

Machine Dependent Restrictions: _____

SELF-CONTAINED?:

Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	_____	_____
Typical Job:	_____	<u>5 sec. on CRAY I</u>
Large Job:	_____	_____

Approximate Number of FORTRAN Lines: _____

COMMENTS: _____

KINETICS CODE

CODE NAME: GALERK

1. CODE STRUCTURE

COORDINATE SYSTEM (✓): NA

Cartesian: _____ Expanding: _____

KINETICS GRID DIMENSIONALITY (✓):

1-D: _____ 2-D: ✓

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: _____ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (✓):

Explicit: _____

Implicit: _____

Others (specify): Matrix inversion

REFERENCE OF METHOD USED: Pitchford et al
Phys. Rev. A (in press) 1980

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 0

Number of Negative Species: 1 electrons

Number of Neutral Species: ≤ 3

REACTION MECHANISM MODELED (✓):

Primary Ionization: (Reference)

E-Beam: _____

Self-Sustained: ✓

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: _____

Detachment: _____

Ion-Ion Recombination: _____

Charge Transfer: _____

Dissociation/Recombination: _____

Others (specify): Collisional

Ionization

Source of Rate Coefficients Used:
Crosssections from Phelps (unpublished)

DISCHARGE POWER INPUT MODELED (✓):

Uniform: ✓ Non-Uniform: _____

E-Field: ✓

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: _____

Number of Species: 1 electrons

Number of Reactions: _____

Other Major Species Considered: _____

IMPACT EXCITATION MODELED (✓):

(Reference)

Vibrational: _____

Electronic: _____

Others (specify): Rotation

ENERGY TRANSFER MODES MODELED (✓): NA

(Reference)

V-T: _____

V-R: _____

V-V: _____

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model (✓): _____

Multi-Line Model (✓): _____

Assumed Rotational Population Distribution State (✓):

Equilibrium: _____

Nonequilibrium: _____

Number of Laser Lines Modeled: _____

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS (✓): NA

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS MODELED (✓): NA

O_x: _____ OH_x: _____

NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: HGX80 TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: laser/discharge cavity
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Computation of laser/discharge properties
in electrically excited rare-gas halide and mercury-halide lasers.

ASSESSMENT OF CAPABILITIES: Capable of quantitative calculation of excited
state and ion densities and electric discharge properties.

ASSESSMENT OF LIMITATIONS: Restricted to spatially uniform, volume dominated
media.

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: William L. Nighan
Organization: United Technologies Research Center MS 90
Address: East Hartford, CT 06108
Phone: (203) 727-7596

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = Related Publication): L, RP

STATUS:

Operational Currently?: x
Under Modification?: _____
Purpose(s): _____

Ownership?: UTRC
Proprietary?: yes

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC 1100/81A

TRANSPORTABLE?: yes, FORTRAN
Machine Dependent Restrictions: none

SELF-CONTAINED?: no *
Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>55K</u>	<u>approximately 10 sec</u>
Large Job:		

Approximate Number of FORTRAN Lines: 1800

COMMENTS: * HGX80 requires Runge-Kutta routine from Sperry's MATHPACK, UTRC
interpolation routines (TEBAR, SPLEVL and SPLINE), and UTRC code FU79 for the
computation of electron distribution functions and electron rate coefficients.

KINETICS CODE

CODE NAME: HGX80

1. CODE STRUCTURE

COORDINATE SYSTEM ($\checkmark$):Cartesian: $\checkmark$ Expanding: _____KINETICS GRID DIMENSIONALITY ($\checkmark$):1-D: $\checkmark$ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: $\checkmark$ CW: _____NUMERICAL SCHEME USED IN RATE
CALCULATION ($\checkmark$):

Explicit: _____

Implicit: $\checkmark$

Others (specify): _____

REFERENCE OF METHOD USED: Modified Runge-
Kutta S. Gill, Proc. Cambridge Philos.
Soc. Vol 47, pp 96-108 (1951).

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive
Species: 6Number of Negative
Species: 2Number of Neutral
Species: 9REACTION MECHANISM MODELED ($\checkmark$):

Primary Ionization: (Reference)

E-Beam: $\checkmark$ Self-Sustained: $\checkmark$

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: $\checkmark$ Detachment: $\checkmark$ Ion-Ion Recom-
bination: $\checkmark$ Charge Transfer: $\checkmark$ Dissociation/
Recombination: $\checkmark$

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED ($\checkmark$):Uniform: $\checkmark$ Non-Uniform: _____E-Field: $\checkmark$

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: rare gas/mercury halide

Number of Species: _____

Number of Reactions: _____

Other Major Species Considered: _____

IMPACT EXCITATION MODELED ($\checkmark$):

(Reference)

Vibrational: _____

Electronic: $\checkmark$

Others (specify): _____

ENERGY TRANSFER MODES MODELED ($\checkmark$):

(Reference)

V-T: _____

V-R: _____

V-V: _____

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model ($\checkmark$): _____Multi-Line Model ($\checkmark$): _____Assumed Rotational Population
Distribution State ($\checkmark$):

Equilibrium: _____

Nonequilibrium: _____

Number of Laser Lines
Modeled: _____

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS ($\checkmark$):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS
MODELED ($\checkmark$): noneO_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM
AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: ILLOPT TECHNICAL AREA(S): Optics
DEVICE COMPONENTS TREATED: Optical Systems
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE:
Illumination evaluation and optimization.

ASSESSMENT OF CAPABILITIES:
Evaluates intensity patterns of very general optical systems.

ASSESSMENT OF LIMITATIONS:
Geometrical optics only, ray-tracing, no diffraction.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: Johanna Schruben
Organization: Westinghouse R&D Center
Address: Pittsburgh, PA 15235
Phone: 412-256-3611

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T: T. P. Vogl, et al., "Semiautomatic design of illuminating systems",
Applied Optics 11 (1972) 1087-1090.

STATUS:

Operational Currently?: Yes
Under Modification?: No
Purpose(s):

Ownership?: Westinghouse
Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed):
UNIVAC 1108

TRANSPORTABLE?: no
Machine Dependent Restrictions: yes

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600) (UNIVAC)
Small Job:	<u>90,000K</u>	<u>60</u>
Typical Job:		<u>120</u>
Large Job:		<u>3600</u>

Approximate Number of FORTRAN Lines:

COMMENTS:

OPTICS CODE

CODE NAME: ILLOPT

1. CODE STRUCTURE

BASIC TYPE (✓):

Physical Optics: _____

Geometrical: ✓

Constant Gain: _____ Floating Gain: _____

FIELD (POLARIZATION) REPRESENTATION (✓):

Scalar: ✓

Vector: _____

COORDINATE SYSTEM (✓):

Cartesian: ✓

Expanding (specify): _____

TRANSVERSE GRID DIMENSIONALITY (specify):

One-Dimensional: _____

Two-Dimensional: ✓

FIELD SYMMETRY RESTRICTIONS?: _____

MIRROR SHAPE(S) ALLOWED (✓):

Square: _____

Rectangular: _____

Circular: _____

Elliptical: _____

Strip: _____

Arbitrary: ✓

CONFIGURATION FLEXIBILITY (✓):

Fixed, Single Resonator Geometry: _____

Fixed, Multiple Resonator Geometries: _____

Modular, Multiple Resonator Geometries: _____

Others (describe): Arbitrary

2. PROPAGATION TECHNIQUE

(✓ all that apply):

Fresnel Integral Algorithms: _____

With Kernel _____

Averaging: _____

Gaussian Quadrature: _____

Fast Fourier Transform (FFT): _____

Fast Hankel Transform (FHT): _____

Gardner-Fresnel-Kirchhoff (GFK): _____

Others (specify): Ray Trace

Finite Difference Algorithms

Method (specify): _____

CONVERGENCE (✓):

Technique: _____

Power Comparison: _____

Field Comparison: _____

Others (specify): _____

Acceleration Algorithms Used?: _____

Technique: _____

MULTIPLE EIGENVALUE/EIGENVECTOR EXTRACTOR ALGORITHMS (✓):

Prony: _____

Others (specify): _____

3. RESONATOR MODELING FEATURES

GENERAL CAPABILITIES:

Stability (✓):

Stable Resonators: _____

Unstable Resonators: _____

Type (✓)

Standing Wave: _____

Traveling Wave (Ring): _____

Reverse Traveling Wave: _____

Branch (✓):

Positive: _____

Negative: _____

Optical Element Models Included (✓):

Flat Mirrors: _____

Spherical Mirrors: _____

Cylindrical Mirrors: _____

Telescopes: _____

Scraper Mirrors: _____

Deformable Mirrors: _____

Spatial Filters: _____

Gratings (specify type): _____

Other Elements (specify): _____

PRINCIPAL RESONATOR GEOMETRIES MODELED (Please List): _____

OPTICS CODE

(Concluded)

CODE NAME: ILLOPT

GAIN MODELS (✓):

Bare Cavity Only: _____
 Simple Saturated Gain: _____
 Detailed Model (See
 Section 3 in Kinetics Code) _____

BARE CAVITY FIELD MODIFIER MODELS (✓):

Mirror Tilt: ✓ _____
 Mirror Decentration: ✓ _____
 Aberrations/Thermal
 Distortion: _____
 Arbitrary: _____
 Selected (specify): _____
 Reflectivity Loss: ✓ _____
 Output Coupler Edges
 Rolled: _____
 Serrated: _____
 Other: _____

LOADED CAVITY FIELD MODIFIER MODELS (✓):

Refractive Index
 Variation: _____
 Gas Absorption: _____
 Overlapped Beams (for
 flux updating): _____
 Number of Overlaps
 Allowed: _____
 Others: _____

4. FAR FIELD MODELS (✓):

Beam Steering Removal: _____
 Optimal Focal Search: _____
 Beam Quality: _____
 Atmospheric Propagation
 Effects: _____
 Others: _____

BEAM CONTROL SYSTEM MODELED (✓):

Pointer/Tracker
 Subsystem: _____
 Beam Jitter: _____
 Autoalignment: _____
 Target Model:
 Motion: _____ Effects: _____

OTHER UNIQUE FEATURES (e.g., Beam/Mode
 Rotation, Extra-Cavity Adaptive Optics, Multipath/
 Parasitic Effect, Beam Director Elements, etc.):

CODE NAME: KINBOLTZ TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: NA

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Given a set of reactions and reaction rates, the code will compute the time-dependent population levels in upper and lower states. A Boltzmann code is used to compute the reaction rates. Although it is set for Mercury-Xenon, it is constructed in a general fashion to allow for other elements.

ASSESSMENT OF CAPABILITIES: Very general and very modular. If the desired reactions are included, and cross-sections for the gases are available, the code will calculate the time-dependent population levels.

ASSESSMENT OF LIMITATIONS: NAMLIST is used for input, though this could be changed. It is fairly fast. For power out calculations, the user must supply the equations. The code is basically a linear diff. eqn. system solver.

OTHER UNIQUE FEATURES: Very modular. The Boltzmann code package and the integration package can be changed with a minimum of code changes. Input is checked for consistency and validity. Output is very clear.

ORIGINATOR/KEY CONTACT: Henry Happ

Name: _____

Organization: Tetra Corp.

Address: 1325 San Mateo, SE, Albuquerque, NM 87108

Phone: (505) 256-3595

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

Kinboltz: A Mercury-Xenon Kinetics Code (U)

Listings are available upon request.

STATUS:

Operational Currently?: yes

Under Modification?: _____

Purpose(s): _____

Ownership?: U. S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600 or 176

TRANSPORTABLE?: Almost

Machine Dependent Restrictions: Formats are A8 or A10 for Hollerith Characters. NAMLIST is used.

SELF-CONTAINED?:

Other Codes Required (name, purpose): Runge-Kutta Integrator. Can be supplied with the package.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>45000</u>	
Large Job:		

Approximate Number of FORTRAN Lines: 1000 Kinetics + 2400 Boltz = 3500 lines

COMMENTS: 12 K Kinetics Code + 32 K Boltz

KINETICS CODE

CODE NAME: KINBOLTZ

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☒ Expanding: _____KINETICS GRID DIMENSIONALITY (☒):1-D: ☒ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: ☒ CW: _____NUMERICAL SCHEME USED IN RATE
CALCULATION (☒):Explicit: ☒

Implicit: _____

Others (specify): _____

REFERENCE OF METHOD USED: Thomson,
Smith & Davies, "Boltz: A code...",
Computer Phys. Comm., V.11, p. 369-383, 1976

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive
Species: user-definedNumber of Negative
Species: " "Number of Neutral
Species: " "REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☒ User-definedSelf-Sustained: ☒ " "

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: User-defined

Detachment: _____

Ion-Ion Recom-
bination: _____

Charge Transfer: _____

Dissociation/
Recombination: _____

Others (specify): _____

Source of Rate Coefficients Used: The user

is responsible for providing the coefficient

DISCHARGE POWER INPUT MODELED (☒):Uniform: ☒ Non-Uniform: _____

E-Field: _____

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: User-definedNumber of Species: user-definedNumber of Reactions: User-defined

Other Major Species Considered: _____

IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☒ user-definedElectronic: ☒ " "

Others (specify): _____

ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-T: ☒ user-definedV-R: ☒ " "V-V: ☒ " "

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model (☒): _____Multi-Line Model (☒): _____Assumed Rotational Population
Distribution State (☒):

Equilibrium: _____

Nonequilibrium: _____

Number of Laser Lines

Modeled: _____

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS (☒):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS
MODELED (☒):O_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM
AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: KINETIC TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: None
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: This code is used for basic laser kinetics calculations for e-beam pumped lasers (it can treat discharge lasers also).

ASSESSMENT OF CAPABILITIES: It performs kinetics calculations using either a Maxwellian electron distribution (Te computed internally) or with an electron distribution computed by a subroutine that solves the Boltzmann equation. It will also perform amplifier calculations.

ASSESSMENT OF LIMITATIONS: _____

OTHER UNIQUE FEATURES: The code has very extensive graphics (some of which can be interactive) output

ORIGINATOR/KEY CONTACT:

Name: W. Lowell Morgan
Organization: Lawrence Livermore Laboratory
Address: Box 808, L-472, Livermore, CA 94505
Phone: (415) 422-6289

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): In general, none. I'll provide a listing

The Boltzmann solver is documented as JILA Information Center Report #19, Univ. of Colorado, Boulder, CO.

STATUS:

Operational Currently?: yes
Under Modification?: less so as time goes on
Purpose(s): _____

Ownership?: _____
Proprietary?: _____

MACHINE/OPERATING SYSTEM (on which installed): CRAY 1A

TRANSPORTABLE?: perhaps

Machine Dependent Restrictions: core size and run time, as the code is optimized for vector calculations on the CRAY

SELF-CONTAINED?:

Other Codes Required (name, purpose): MAXRATE - uses cross-section data to create a table of rates vs. electron temperature.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>120K decimal</u>	<u>14 sec CRAY $\approx$ 30 sec 7600*</u>
Large Job:	<u>260K decimal</u>	<u>60 sec CRAY $\approx$ 12 min 7600**</u>

Approximate Number of FORTRAN Lines: 5500

COMMENTS: * The kinetics only takes a few seconds, the remainder is graphics (this is the Maxwellian version) ** This is the version that includes solution of the Boltzmann equation for electrons.

KINETICS CODE

CODE NAME: KINETIC

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☐ Expanding: ☐KINETICS GRID DIMENSIONALITY (☒):1-D: ☒ 2-D: ☐3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐Flow Direction: ☐KINETICS MODELED: Pulsed: ☒ CW: ☐NUMERICAL SCHEME USED IN RATE CALCULATION (☒):Explicit: ☐Implicit: ☒Others (specify):

REFERENCE OF METHOD USED: Gear

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: Arbitrary

Number of Negative Species: "

Number of Neutral Species: 10

REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☒Self-Sustained: ☒UV-Initiated: ☒

Others (specify): fission fragments

Secondary Ionization (Reference)

Attachment: ☒Detachment: ☒Ion-Ion Recombination: ☒Charge Transfer: ☒Dissociation/Recombination: ☒Others (specify):

Source of Rate Coefficients Used: cross sections

DISCHARGE POWER INPUT MODELED (☒):Uniform: ☒ Non-Uniform: ☒E-Field: ☒Others (specify):

3. LASING KINETICS MODEL

we have studied

GENERAL (specify): Xe_2^* , KrF, ArF,

Lasing Species: anything: XeF, Xe Cl

Number of Species: 30

Number of Reactions: 100

Other Major Species Considered: IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☒Electronic: ☒Others (specify): ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-T: ☒V-R: ☐V-V: ☒Others (specify): Lasing Transition: P-Branch: ☐R-Branch: ☐Single Line Model (☒): ☒Multi-Line Model (☒): ☐Assumed Rotational Population Distribution State (☒):Equilibrium: ☒Nonequilibrium: ☐Number of Laser Lines Modeled: Source of Rate Coefficients Used in Code: LINE PROFILE MODELS (☒):Doppler Broadening: ☐Collisional Broadening: ☐Others (specify): 4. RECIRCULATION CONTAMINANTS MODELED (☒): none O_x : OH_x : NO_x : HNO_x : Others (specify): REFERENCE FOR REACTION MECHANISM AND RATES:

OTHER UNIQUE FEATURES: The code is very general, all information concerning specific problems is in the data set.

CODE NAME: KRF TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: _____
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Modeling KRF lasers and amplifiers.

ASSESSMENT OF CAPABILITIES: Handles gas deposition, kinetics, absorption, lasing in Fabry-Perot cavity.

ASSESSMENT OF LIMITATIONS: Specific code for KRF

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: Jeanette Betts
Organization: TRW DSSG
Address: 1 Space Park, Redondo Beach, CA 90278
Phone: 213-536-1453

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

L

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): _____

Ownership?: TRW

Proprietary?: yes-developed under IR&D

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 174

TRANSPORTABLE?: yes

Machine Dependent Restrictions: _____

SELF-CONTAINED?: yes

Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	<u>FL-50500</u>	<u>42 sec Cyber 174</u>
Typical Job:	_____	_____
Large Job:	_____	_____

Approximate Number of FORTRAN Lines: _____

COMMENTS: _____

KINETICS CODE

CODE NAME: KRF

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☐ Expanding: ☐KINETICS GRID DIMENSIONALITY (☒):1-D: ☒ 2-D: ☐3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☒Flow Direction: ☐KINETICS MODELED: Pulsed: ☒ CW: ☐NUMERICAL SCHEME USED IN RATE CALCULATION (☒):Explicit: ☐Implicit: ☐Others (specify): REFERENCE OF METHOD USED: Modified Trainor

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 6Number of Negative Species: 1Number of Neutral Species: 17REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☒Self-Sustained: ☐UV-Initiated: ☐Others (specify):

Secondary Ionization (Reference)

Attachment: ☐Detachment: ☐Ion-Ion Recombination: ☐Charge Transfer: ☐Dissociation/Recombination: ☐Others (specify): Source of Rate Coefficients Used:
literature-several sourcesDISCHARGE POWER INPUT MODELED (☒):Uniform: ☐ Non-Uniform: ☐E-Field: ☐Others (specify):

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: KrFNumber of Species: 24Number of Reactions: 92Other Major Species Considered: Ar⁺, ArF, F⁻, Ar^{*}, Kr^{*}, F₂IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☐Electronic: ☒Others (specify): ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-I: ☐V-R: ☐V-V: ☐Others (specify): Lasing Transition: P-Branch: ☐R-Branch: ☐Single Line Model (☒): Multi-Line Model (☒): Assumed Rotational Population Distribution State (☒):Equilibrium: ☐Nonequilibrium: ☐Number of Laser Lines Modeled: Source of Rate Coefficients Used in Code: LINE PROFILE MODELS (☒):Doppler Broadening: ☐Collisional Broadening: ☐Others (specify): 4. RECIRCULATION CONTAMINANTS MODELED (☒):O_x: ☐ OH_x: ☐NO_x: ☐ HNO_x: ☐Others (specify): REFERENCE FOR REACTION MECHANISM AND RATES: OTHER UNIQUE FEATURES:

CODE NAME: LAGAD TECHNICAL AREA(S): Gas Dynamics
DEVICE COMPONENTS TREATED: Laser Cavity & Flow Loop
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Compute non-steady gas dynamics
resulting from discharge heating & flow loop heat exchanger & blower
requirements.

ASSESSMENT OF CAPABILITIES: Fast running - computes initial conditions using
shock tube theory & wave propagation by method of characteristics.

ASSESSMENT OF LIMITATIONS: Constant gas properties, i.e. Cp, Cv, γ

OTHER UNIQUE FEATURES: Calcomp Plot of Wave Diagram

ORIGINATOR/KEY CONTACT:

Name: Martin J. Pechersky
Organization: Westinghouse R&D Center
Address: 1310 Beulah Road, Pgh, PA 15235
Phone: 412-256-7353

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = Related Publication):

Listing is proprietary, no other documentation

STATUS:

Operational Currently?: Yes
Under Modification?: _____
Purposes: _____

Ownership: Westinghouse
Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC-1108

TRANSPORTABLE?: yes

Machine Dependent Restrictions: _____

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>22411</u>	<u>17 sec - UNIVAC-1108</u>
Large Job:		
Approximate Number of FORTRAN Lines:	<u>800</u>	

COMMENTS: _____

GAS DYNAMICS CODE

CODE NAME: LAGAD

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ✓ Expanding: _____

FLUID GRID DIMENSIONALITY (✓):

1-D: ✓

2-D: _____

3-D: _____

Time Dependent: _____

FLOW FIELD MODELED (✓):

Compressible Flow: ✓

Incompressible: _____

Viscous Flow: _____

No Flow: _____

BASIC MODELING APPROACH (✓):

Algebraic: ✓ Integral Method: _____

Finite Difference: _____

Others (specify): Method of Characteristics

REFERENCE FOR APPROACH USED: _____

Text's of Shapiro & Rudinger

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: _____

Mixture Injection: _____

Nozzles: _____

Flow Plates: _____

Others (specify): _____

CAVITY INITIAL CONDITION DETERMINED BY (specify): Code

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: _____ Closed System: _____

Closed Cycle: ✓

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: _____

Ejector System: _____

Compressor/Fan: ✓

Heat Exchanger: ✓

Gas Make-Up: _____

Others (specify): _____

DECONTAMINATION METHOD TREATED (✓):

Scrubber: _____

Shower: _____

Catalytic Reactor: _____

Others (specify): _____

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: ✓ Repetitive Pulse: _____

DIMENSIONALITY TREATED (✓):

1-D: ✓ 2-D: _____ 3-D: _____

Time-Dependent: _____

DISTURBANCE MODELED (✓):

Pressure Wave: ✓ Entropy Wave: _____

Others (specify): Hot gas clearing*

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: _____

Nonlinear Wave: ✓

Others (specify): _____

THEORETICAL BASIS: (Reference) _____

NUMERICAL METHODOLOGY: (Reference) _____

ACOUSTIC ATTENUATORS CONSIDERED (✓):

Muffler: _____ Heat Exchanger: _____

Horn: _____ Porous Wall: *

Others (specify): _____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓):

Index of Refraction Variation?: _____

Other (specify): _____

OTHER UNIQUE FEATURES:

*Auxillary code to compute
in flow acoustic damping

CODE NAME: LASER TECHNICAL AREA(S): Kinetics
 DEVICE COMPONENTS TREATED: Laser Cavity
 PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: General laser kinetics synthesis and analysis. Coupled system of molecular kinetics, plasma kinetics, external discharge, circuit, and optical radiative extraction for a spatially homogeneous medium. Applicable to a broad class of transient, electrically excited laser systems. User-oriented, flexible input/output structure, well documented.
 ASSESSMENT OF CAPABILITIES: This code synthesizes, from an arbitrary list of molecular kinetics reactions and species, a completely coupled laser kinetics analysis. Molecular kinetics subroutines for an arbitrary reaction scheme are translated automatically into FORTRAN source code and coupled to plasma kinetics, optical fields, etc.
 ASSESSMENT OF LIMITATIONS: Applicable to transient analysis of electrically excited laser system. Developed in connection with rare gas halide excimer lasers (e.g. KrF). Capability is quite comprehensive and general.

OTHER UNIQUE FEATURES: Program automatically synthesizes its own molecular kinetics source code for execution. Secondary electron collisions are automatically linked to electron kinetics analysis provided by numerical solution of Boltzmann equation. Boltzmann analysis contains superelastic/electron-electron/inelastic/mom.transfer.

ORIGINATOR/KEY CONTACT:

Name: William B. Lacina
 Organization: Northrop Research & Technology Center
 Address: One Research Park, Palos Verdes Peninsula, CA 90274
 Phone: (213) 377-4811 ext. 362

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): "Theoretical Modelling of Molecular and Electron Kinetic Processes, Vol. I: Theoretical Formulation of Analysis and Description of Computer Programs. Vol. II: Fortran Computer Program Listings, " Northrop Rept. #NRTC-79-7R, January 1979. (T,U,L)

STATUS:

Operational Currently?: yes
 Under Modification?: no
 Purpose(s): Modifications by other users may be in progress.

Ownership?: Northrop Research & Tech./William B. Lacina
 Proprietary?: Public Domain

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: yes

Machine Dependent Restrictions: Yes (CDC word size)

SELF-CONTAINED?: yes

Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>200,000</u>	
Large Job:		
Approximate Number of FORTRAN Lines:		<u>6,000</u>

COMMENTS: _____

KINETICS CODE

CODE NAME: LASER

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: NA Expanding: _____

KINETICS GRID DIMENSIONALITY (✓):

1-D: ✓ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: no

Flow Direction: _____

KINETICS MODELED: Pulsed: ✓ CW: _____

NUMERICAL SCHEME USED IN RATE CALCULATION (✓):

Explicit: ✓

Implicit: ✓

Others (specify): rate constants from input, and from Boltzmann plasma calculations.

REFERENCE OF METHOD USED: _____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: arb.

Number of Negative Species: arb.

Number of Neutral Species: arb.

REACTION MECHANISM MODELED (✓):

Primary Ionization: (Reference)

E-Beam: ✓

Self-Sustained: ✓

UV-Initiated: ✓

Others (specify): reasonably arbitrary.

Secondary Ionization (Reference)

Attachment: ✓

Detachment: ✓

Ion-Ion Recombination: ✓

Charge Transfer: ✓

Dissociation/Recombination: ✓

Others (specify): _____

Source of Rate Coefficients Used: _____

miscellaneous

DISCHARGE POWER INPUT MODELED (✓):

Uniform: ✓ Non-Uniform: _____

E-Field: ✓

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: ONE

Number of Species: arbitrary

Number of Reactions: arbitrary

Other Major Species Considered: _____

IMPACT EXCITATION MODELED (✓):

(Reference)

Vibrational: ✓

Electronic: ✓

Others (specify): _____

ENERGY TRANSFER MODES MODELED (✓):

(Reference)

V-T: _____

V-R: _____

V-V: _____

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model (✓): _____

Multi-Line Model (✓): _____

Assumed Rotational Population Distribution State (✓):

Equilibrium: _____

Nonequilibrium: _____

Number of Laser Lines Modeled: _____

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS (✓):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS

MODELED (✓): none

O_x: _____ OH_x: _____

NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: LASIM TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: _____
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: _____
Simulation of UV initiated, self-sustained discharge - pumped XeF lasers.

ASSESSMENT OF CAPABILITIES: _____
Predicts discharge & laser operation - physical description of experimental system is used. Circuit - discharge interaction is modeled.

ASSESSMENT OF LIMITATIONS: _____
Spatially uniform plasma/laser model.

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: L.E. Kline
Organization: Westinghouse R&D
Address: 1310 Beulah Road, Pittsburgh, PA 15235
Phone: 412-256-7552

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

L, RP: "Formation, Quenching & Absorption Processes in Self-Sustained Discharge Pumped XeF Laser" L.E. Kline, L.J. Denes, S. G. Leslie, and R.R. Mitchell. Proc. Int'l Conf. on Lasers 1978, Orlando, FL (RP)

STATUS:

Operational Currently?: Yes
Under Modification?: _____
Purpose(s): _____

Ownership?: Gov't contract
Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC-1100

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: _____

SELF-CONTAINED?:

Other Codes Required (name, purpose): Boltzman Solver is required to calculate electron excitation rates vs. E/P

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	_____	_____
Typical Job:	<u>~10K</u>	<u>< 10 sec</u>
Large Job:	_____	_____
Approximate Number of FORTRAN Lines:	_____	<u>600</u>

COMMENTS: _____

CODE NAME: MOC TECHNICAL AREA(S): Gas Dynamics
DEVICE COMPONENTS TREATED: Cavity
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Computes the transient flow associated with sudden energy deposition that is characteristic of pulsed laser operation.

ASSESSMENT OF CAPABILITIES: _____

ASSESSMENT OF LIMITATIONS: Shock wave interaction with solid boundaries not modeled.

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: C. C. Shih and G. R. Karr
Organization: Mech. Eng. Dept., Univ. of Ala. in Huntsville
Address: Huntsville, AL 35809
Phone: (205) 895-6330, (205) 895-6075

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): C. C. Shih, G. R. Karr, J. F. Perkins, Investigation of Transient Flow and Heating Problems Characteristics of High Energy Laser Gas Circulation Systems, UAH Research Report No. 219, March 1979.

STATUS:

Operational Currently?: X

Under Modification?: X

Purpose(s): Intend to look at wave interaction with acoustic attenuators

Ownership?: UAH

Proprietary?: _____

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC 1108

TRANSPORTABLE?: yes

Machine Dependent Restrictions: none

SELF-CONTAINED?: yes

Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		order of 100 sec.
Typical Job:		
Large Job:		
Approximate Number of FORTRAN Lines: _____		

COMMENTS: _____

GAS DYNAMICS CODE

CODE NAME: MOC

I. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ✓ Expanding: _____

FLUID GRID DIMENSIONALITY (✓):

1-D: ✓

2-D: _____

3-D: _____

Time Dependent: ✓

FLOW FIELD MODELED (✓):

Compressible Flow: ✓

Incompressible: _____

Viscous Flow: ✓

No Flow: _____

BASIC MODELING APPROACH (✓):

Algebraic: ✓ Integral Method: _____

Finite Difference: ✓

Others (specify): _____

REFERENCE FOR APPROACH USED: _____

Method of Characteristics

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: ✓

Mixture Injection: _____

Nozzles: _____

Flow Plates: _____

Others (specify): _____

CAVITY INITIAL CONDITION DETERMINED BY (specify): given

3. EXHAUST RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: ✓ Closed System: _____

Closed Cycle: _____

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: ✓

Ejector System: _____

Compressor Fan: _____

Heat Exchanger: _____

Gas Make-Up: _____

Others (specify): _____

DECONTAMINATION METHOD TREATED (✓):

Scrubber: _____

Shower: _____

Catalytic Reactor: _____

Others (specify): _____

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: ✓ Repetitive Pulse: _____

DIMENSIONALITY TREATED (✓):

1-D: ✓ 2-D: _____ 3-D: _____

Time-Dependent: ✓

DISTURBANCE MODELED (✓):

Pressure Wave: ✓ Entropy Wave: ✓

Others (specify): _____

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: ✓

Nonlinear Wave: ✓

Others (specify): _____

THEORETICAL BASIS: (Reference) _____

Method of Characteristics

NUMERICAL METHODOLOGY: (Reference) _____

Finite Difference

ACOUSTIC ATTENUATORS CONSIDERED (✓):

Muffler: _____ Heat Exchanger: _____

Horn: _____ Porous Wall: _____

Others (specify): none

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓):

Index of Refraction Variation?: _____

Other (specify): Fractional density gradient ($\Delta\rho/\rho$)

OTHER UNIQUE FEATURES: _____

NRL Laser Kinetics

CODE NAME: Code (Unofficial) TECHNICAL AREA(S): Kinetics
 DEVICE COMPONENTS TREATED: Laser Cavity; Chemical Kinetics electrical circuit;
 PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: /electron kinetics
Modeling of a variety of high power gas lasers. Mostly rare gas halides.
Some non-lasing applications such as modeling of absorption in pure rare
gases and isotope separation kinetics.

ASSESSMENT OF CAPABILITIES: Highly flexible; Has been easily adapted to a wide
variety of physical systems. Easily portable from one computer to another.
No convergence problems with chemical kinetics integrator. Coupled external
circuit.

ASSESSMENT OF LIMITATIONS: Spatially homogeneous (zero-dimensional) approximation
for kinetics. E-beam ionization rate provided as external waveform.
Secondary electron kinetics (time-dependent).

OTHER UNIQUE FEATURES: Reaction scheme specified using symbolic names for
reactants and products. Output provides detailed and useful description
of kinetics and lasing.

ORIGINATOR/KEY CONTACT:

Name: Louis J. Palumbo
 Organization: Laser Physics Branch, Code 6540
 Address: Naval Research Laboratory, Washington, DC 20375
 Phone: (202) 767-2255

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
 RP = Related Publication):

(T, RP): T. H. Johnson, L.J. Palumbo and A.M. Hunter, II, "Kinetics Simulation
of High-Power Gas Lasers", IEEE J. Quant. Electron., Vol. QE-15,
No. 5, pp. 289-301, (May 1979).

(L): Originator supplies listings and tape copies on request. (Listing is
well commented) (SEE ATTACHED SHEET)

STATUS:

Operational Currently?: Yes (several versions)

Under Modification?: yes

Purposers): Modifications are underway to make code more user oriented
and to make more efficient use of computer memory.

Ownership?: No (developed on U.S. Gov't time-available to public)

Proprietary?: No (earlier versions have been sent to private industrial labs

MACHINE/OPERATING SYSTEM (on which installed): Texas Instruments - Advanced Scientific
Computer (ASC). Also was successfully adapted to IBM-370.

TRANSPORTABLE?: Reasonably

Machine Dependent Restrictions: Some versions contain ENCODE/DECODE statements,
these are currently being replaced. Code is more efficient on a vectorizing

SELF-CONTAINED?: Yes / Fortran compiler.

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	<u>~90,000 32-bit words</u>	<u>60</u>
Typical Job:	<u>150,000 " " "</u>	<u>120</u>
Large Job:	<u>~250,000 " " "</u>	<u>600</u>
Approximate Number of FORTRAN Lines:		<u>6000</u>

COMMENTS: Very simple time-dependent lasing computation for a Fabry-Perot
cavity using constant gain, geometric optics.

AVAILABLE DOCUMENTATION con't:

CODE NAME: NRL Laser Kinetics Code

(U, L): Being written - will be published as an NRL Memorandum Report
by L. J. Palumbo (early 1981) (perhaps a series of memo reports).

(RP): Several papers involving interpretation of experimental results using
a model published mostly in Appl. Phys. Lett. 1977-1980.

KINETICS CODE

CODE NAME: NRL LASER

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: _____ Expanding: _____

KINETICS GRID DIMENSIONALITY (✓):

1-D: ✓ 2-D: _____

3-D: _____ Spatially homogeneous (Zero-D)

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____ (sometimes)

Flow Direction: no flowKINETICS MODELED: Pulsed: ✓ CW: ✓

NUMERICAL SCHEME USED IN RATE

CALCULATION (✓):

Explicit: ✓

Implicit: _____

Others (specify): Runge-Kutta-Treanor

Method for stiff diff. eq.s _____

REFERENCE OF METHOD USED: C.E. Treanor
Math. Comput. Vol. 20, p 39 (1966)

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 0-15 typicalNumber of Negative Species: 0-5 typicalNumber of Neutral Species: 5-50 typical

REACTION MECHANISM MODELED (✓):

Primary Ionization: (Reference)

E-Beam: ✓ external waveform forSelf-Sustained: ✓ /ionization rateUV-Initiated: ✓Others (specify): E-beam sustained as well as pure e-beam pumped.

Secondary Ionization (Reference)

Attachment: ✓Detachment: ✓Ion-Ion Recombination: ✓Charge Transfer: ✓Dissociation/Recombination: ✓

Others (specify): _____

Source of Rate Coefficients Used: mostly open literature

DISCHARGE POWER INPUT MODELED (✓):

Uniform: ✓ Non-Uniform: _____E-Field: ✓Others (specify): external circuit coupled to kinetics.

Electron kinetics are modeled either by

solving the steady state Boltzmann

transport equation or by a time-dependent but greatly simplified rate-equation method.

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: ✓Number of Species: 10-50 typicalNumber of Reactions: 10-200 typical

Other Major Species Considered: _____

IMPACT EXCITATION MODELED (✓):

(Reference)

Vibrational: ✓Electronic: ✓

Others (specify): _____

ENERGY TRANSFER MODES MODELED (✓):

(Reference)

V-I: ✓V-R: ✓ unusually small forV-V: ✓ the systems modeled

Others (specify): _____

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model (✓): ✓Multi-Line Model (✓): ✓

Assumed Rotational Population

Distribution State (✓):

Equilibrium: ✓

Nonequilibrium: _____

Number of Laser Lines

Modeled: 1 or 2Source of Rate Coefficients Used in Code: mostly open literature

LINE PROFILE MODELS (✓):

Doppler Broadening: none

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS
MODELED (✓): noneO_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM
AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: OPTEX TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Laser Cavity
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The lasing outputs for the 10 μ m P(14) and P(18) lines are predicted as a function of the individual cavity lengths for a pulsed TEA laser

ASSESSMENT OF CAPABILITIES: The ratio of energies contained in the two transitions was verified experimentally.

ASSESSMENT OF LIMITATIONS: The predicted pulse shapes are questionable.

OTHER UNIQUE FEATURES: A Gaussian mode pattern was used instead of a plane wave.

ORIGINATOR/KEY CONTACT:

Name: Dennis Suhre
Organization: Westinghouse Research
Address: 1310 Beulah Road, Pittsburgh, PA 15235
Phone: 412-256-7353

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T: D.R. Suhre, "Analysis of a Multiple Wavelength CO₂ Laser," Westinghouse Report 80-1C2-OPTEX-P1, May 1980.

STATUS:

Operational Currently?: No
Under Modification?: No
Purpose(s): _____

Ownership?: Westinghouse
Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC 1100

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: _____

SELF-CONTAINED?:

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600) (UNIVAC 1100)
Small Job:		5
Typical Job:		10
Large Job:	<u>reasonable</u>	20
Approximate Number of FORTRAN Lines:		<u>150</u>

COMMENTS: _____

KINETICS CODE

CODE NAME: OPTEX

1. CODE STRUCTURE

COORDINATE SYSTEM ($\checkmark$):Cartesian: _____ Expanding: $\checkmark$ KINETICS GRID DIMENSIONALITY ($\checkmark$):1-D: _____ 2-D: $\checkmark$

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: $\checkmark$ CW: _____NUMERICAL SCHEME USED IN RATE
CALCULATION ($\checkmark$):Explicit: $\checkmark$

Implicit: _____

Others (specify): _____

REFERENCE OF METHOD USED: IEEE J.
Quant. Electron. QE-9, 139 (1973)

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive
Species: _____ 0Number of Negative
Species: _____ 0Number of Neutral
Species: _____ 3REACTION MECHANISM MODELED ($\checkmark$):

Primary Ionization: (Reference)

E-Beam: _____

Self-Sustained: _____

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: _____

Detachment: _____

Ion-Ion Recombination: _____

Charge Transfer: _____

Dissociation/
Recombination: _____

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED ($\checkmark$):Uniform: $\checkmark$ Non-Uniform: _____

E-Field: _____

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO₂Number of Species: 3 (CO₂, N₂, He)

Number of Reactions: _____

Other Major Species Considered: _____

IMPACT EXCITATION MODELED ($\checkmark$):

(Reference)

Vibrational: $\checkmark$ Sov. J. Quantum
Electron. 4, 843

Electronic: _____ (197)

Others (specify): _____

ENERGY TRANSFER MODES MODELED ($\checkmark$):V-T: $\checkmark$ IEEE J. Quant. Electron.
QE-9, 139 (1973)

V-R: _____

V-V: $\checkmark$ IEEE J. Quant. Electron.
QE-9, 139 (1973)

Others (specify): _____

Lasing Transition: P-Branch: $\checkmark$

R-Branch: _____

Single Line Model ($\checkmark$): _____Multi-Line Model ($\checkmark$): $\checkmark$

Assumed Rotational Population

Distribution State ($\checkmark$):Equilibrium: $\checkmark$

Nonequilibrium: _____

Number of Laser Lines

Modeled: 2

Source of Rate Coefficients Used in Code:

Rev. Mod. Phys. 41, 26 (1969)

LINE PROFILE MODELS ($\checkmark$):

Doppler Broadening: _____

Collisional Broadening: $\checkmark$

Others (specify): _____

4. RECIRCULATION CONTAMINANTS
MODELED ($\checkmark$): NoneO_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM
AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: POSEIDON* TECHNICAL AREA(S): Gas Dynamics
DEVICE COMPONENTS TREATED: Laser Cavity; Acoustic Attenuation Subsystem
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The code is used to model one-dimensional flow and acoustics in the laser cavity and the acoustic attenuation subsystem. This is used to predict recovery time of the medium within the laser cavity to a specified homogeneity. A two-dimensional version also exists.

ASSESSMENT OF CAPABILITIES: The code has demonstrated stable and accurate numerical solutions to unsteady flow problems characterized by both strong shock waves and weak acoustic level waves with extremely small numerical diffusion (no artificial viscosity is required).

ASSESSMENT OF LIMITATIONS: Boundary layer phenomena are not simulated and two-dimensional version has high noise floor.

OTHER UNIQUE FEATURES: Any type of gas at any temperature may be employed. Any number of repetitive pulses may be specified. System geometry may be altered at will. The code incorporates: compressibility, nonlinearity, heat transfer, bulk resistance, and mass transport through the side walls. Reflections off of a sudden expansion downstream of the laser cavity incorporate

ORIGINATOR/KEY CONTACT: /two-dimensional gas dynamics to account for the shape of the /opening
Name: James H. Morris
Organization: Poseidon Research
Address: 9550 Owensmouth Avenue, Chatsworth, CA 91311
Phone: (213) 341-9172

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T = Poseidon Research Reports: #8, #16, #21, #22, #32
RP = Boris, J.P. and Book, D. L. 1971 Flux Corrected Transport.
I. Shasta, A Fluid Transport Algorithm That Works.
Journal of Computational Physics 11, pp. 38-69 (1973)

STATUS:

Operational Currently?: yes
Under Modification?: no
Purpose(s):

Ownership?: Poseidon Research
Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CRAY I

TRANSPORTABLE?: Yes
Machine Dependent Restrictions: None

SELF-CONTAINED?: Yes
Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	200,000	20 sec., CRAY I
Large Job:		

Approximate Number of FORTRAN Lines: 2000

COMMENTS: *Name generated for identification purposes.

GAS DYNAMICS CODE

CODE NAME: POSEIDON

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ☒ Expanding: ☐

FLUID GRID DIMENSIONALITY (✓):

1-D: ☒

2-D: ☒

3-D: ☐

Time Dependent: ☒

FLOW FIELD MODELED (✓):

Compressible Flow: ☒

Incompressible: ☐

Viscous Flow: ☐

No Flow: ☐

BASIC MODELING APPROACH (✓):

Algebraic: ☐ Integral Method: ☐

Finite Difference: ☒

Others (specify):

REFERENCE FOR APPROACH USED:

SHASTA Algorithm

Boris & Book, J. Comp. Physics II, 38-69

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: ☐

Mixture Injection: ☒

Nozzles: ☐

Flow Plates: ☒

Others (specify):

CAVITY INITIAL CONDITION DETERMINED
BY (specify): S.S. isentropic flow relations
and initial over-temperature distribution

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: ☒ Closed System: ☐

Closed Cycle: ☐

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: ☐

Ejector System: ☐

Compressor/Fan: ☐

Heat Exchanger: ☐

Gas Make-Up: ☐

Others (specify):

1D: Sudden expansion boundary
condition

2D: Open

DECONTAMINATION METHOD TREATED (✓):

Scrubber: ☐

Shower: ☐

Catalytic Reactor: ☐

Others (specify): None

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: ☒ Repetitive Pulse: ☒

DIMENSIONALITY TREATED (✓):

1-D: ☒ 2-D: ☒ 3-D: ☐

Time-Dependent: ☐

DISTURBANCE MODELED (✓):

Pressure Wave: ☒ Entropy Wave: ☒

Others (specify):

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: ☐

Nonlinear Wave: ☒

Others (specify):

THEORETICAL BASIS: (Reference)

Poseidon Research Report No. 16

NUMERICAL METHODOLOGY: (Reference)

ACOUSTIC ATTENUATORS CONSIDERED (✓):

Muffler: ☒ Heat Exchanger: ☒

Horn: ☒ Porous Wall: ☒

Others (specify):

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓):

Index of Refraction Variation?: ☒

Other (specify):

OTHER UNIQUE FEATURES:

CODE NAME: PSI LASER * TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Laser Cavity
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: A series of codes for general kinetic calculations, D₂/HCl, Kr₂, Xe₂, KrF, CO etc.
Calculate cavity gain and powerout for a Fabry-Perot Resonator

ASSESSMENT OF CAPABILITIES: One-dimensional in time, and one-dimensional in space.

ASSESSMENT OF LIMITATIONS: _____

OTHER UNIQUE FEATURES: Fluid Dynamics can be modeled separately. Has been used for GDL and Chemical lasers. Output can be used for amplification calculations.

ORIGINATOR/KEY CONTACT:

Name: Paul Lewis or Ray L. Taylor
Organization: Physical Sciences, Inc. Research and Laser Technology, Inc.
Address: 30 Commerce Way, Woburn, MA 01801 6 Frank St., Rockport, MA 01966
Phone: (617) 933-8500 (617) 546-7798

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

RP: PSI TR 19
PSI TR 182

STATUS:

Operational Currently?: X
Under Modification?: _____
Purpose(s): _____

Ownership?: PSI, RLT
Proprietary?: _____

MACHINE/OPERATING SYSTEM (on which installed): Prime 400 easily adaptable to IBM, CDC

TRANSPORTABLE?: _____
Machine Dependent Restrictions: none known

SELF-CONTAINED?:

Other Codes Required (name, purpose): Boltzmann Code. E-Beam source code

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	<u>60K</u>	
Typical Job:		
Large Job:		
Approximate Number of FORTRAN Lines:		<u>1750</u>

COMMENTS:

* Name generated for identification purpose.

KINETICS CODE

CODE NAME: PSI LASER

1. CODE STRUCTURE

COORDINATE SYSTEM (Cartesian: ☒ Expanding: ☐KINETICS GRID DIMENSIONALITY (1-D: ☒ 2-D: ☐3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐Flow Direction: ☒KINETICS MODELED: Pulsed: ☒ CW: ☒NUMERICAL SCHEME USED IN RATE
CALCULATION (Explicit: ☐Implicit: ☒

Others (specify): _____

REFERENCE OF METHOD USED: _____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive
Species: _____Number of Negative
Species: _____Number of Neutral
Species: _____REACTION MECHANISM MODELED (Primary Ionization: (Reference)E-Beam: ☒Self-Sustained: ☒UV-Initiated: ☐

Others (specify): _____

Secondary Ionization (Reference)

Attachment: ☒Detachment: ☒Ion-Ion Recombination: ☒Charge Transfer: ☒Dissociation/
Recombination: ☒

Others (specify): _____

Penning Ionization

Source of Rate Coefficients Used: _____

LiteratureDISCHARGE POWER INPUT MODELED (Uniform: ☒ Non-Uniform: ☒ (time only)E-Field: ☒

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: ArbitraryNumber of Species: Arbitrary, typically <Number of Reactions: ArbitraryOther Major Species Considered: Impurities
discharge lasers.IMPACT EXCITATION MODELED ((Reference)Vibrational: ☒Electronic: ☒

Others (specify): _____

RotationalENERGY TRANSFER MODELS MODELED ((Reference)V-T: ☒V-R: ☐V-V: ☒

Others (specify): _____

Lasing Transition: P-Branch: ☒R-Branch: ☐Single Line Model (☒): ☒Multi-Line Model (☒): ☒Assumed Rotational Population
Distribution State (☒):Equilibrium: ☒Nonequilibrium: ☐

Number of Laser Lines

Modeled: ArbitrarySource of Rate Coefficients Used in Code:
LiteratureTR-182LINE PROFILE MODELS (Doppler Broadening: ☒Collisional Broadening: ☒

Others (specify): _____

Voigt4. RECIRCULATION CONTAMINANTS
MODELED (none $x^{\cdot}$: _____ $OH_x^{\cdot}$: _____ $NO_x^{\cdot}$: _____ $HNO_x^{\cdot}$: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM
AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: REDAC TECHNICAL AREA(S): _____
 DEVICE COMPONENTS TREATED: Pulsed Electrical Power
 PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: model PFN's performance.
This is a general purpose circuit analysis code.

ASSESSMENT OF CAPABILITIES: excellent

ASSESSMENT OF LIMITATIONS: as good as input

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:
 Name: E. Wheatley
 Organization: Rocketdyne Division of Rockwell, M.S. FA-28
 Address: 6633 Canoga Ave., Canoga Pk 91304
 Phone: 213-709-7136

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):
U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. 78.

STATUS:
 Operational Currently?: X
 Under Modification?: _____
 Purpose(s): _____

Ownership?: Rockwell
 Proprietary?: yes

MACHINE/OPERATING SYSTEM (on which installed): CDC

TRANSPORTABLE?: yes
 Machine Dependent Restrictions: _____

SELF-CONTAINED?:
 Other Codes Required (name, purpose): no

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	_____	_____
Typical Job:	_____	_____
Large Job:	_____	_____

Approximate Number of FORTRAN Lines: _____

COMMENTS: _____

CODE NAME: STROBE TECHNICAL AREA(S): Gas Dynamics
DEVICE COMPONENTS TREATED: Cavity, Beam Ducts, Flow Plate
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Beam Duct, Cavity Acoustics

ASSESSMENT OF CAPABILITIES: Multidimensional acoustics caused by non-ideal channels, i.e. beam ducts, standoff distance.

ASSESSMENT OF LIMITATIONS: Incomplete boundary condition formulation at open end, uses constant pressure which is not accurate.

OTHER UNIQUE FEATURES: _____

ORIGINATOR/KEY CONTACT:

Name: B. Masson
Organization: RDA
Address: ATO Box 9377, International Airport, Alb, NM 87119
Phone: (505) 243-5609

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T, L

STATUS:

Operational Currently?: yes
Under Modification?: yes
Purpose(s): Beam Duct Model being improved

Ownership?: RDA

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CRAY I

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?:

Other Codes Required (name, purpose): r Plotter

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	_____	_____
Typical Job:	_____	_____
Large Job:	_____	_____

Approximate Number of FORTRAN Lines: _____

COMMENTS: Report in preparation.

GAS DYNAMICS CODE

CODE NAME: STROBE

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: _____ Expanding: ✓

FLUID GRID DIMENSIONALITY (✓):

1-D: _____

2-D: _____

3-D: ✓

Time Dependent: ✓

FLOW FIELD MODELED (✓):

Compressible Flow: ✓

Incompressible: _____

Viscous Flow: _____

No Flow: _____

BASIC MODELING APPROACH (✓):

Algebraic: _____ Integral Method: _____

Finite Difference: ✓

Others (specify): _____

REFERENCE FOR APPROACH USED: _____

MacCormack

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: _____

Mixture Injection: _____

Nozzles: _____

Flow Plates: ✓

Others (specify): _____

CAVITY INITIAL CONDITION DETERMINED BY (specify): Input

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: ✓ Closed System: _____

Closed Cycle: _____

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: _____

Ejector System: _____

Compressor/Fan: _____

Heat Exchanger: _____

Gas Make-Up: _____

Others (specify): _____

Absorbers

DECONTAMINATION METHOD TREATED (✓):

Scrubber: _____

Shower: _____

Catalytic Reactor: _____

Others (specify): _____

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: ✓ Repetitive Pulse: _____

DIMENSIONALITY TREATED (✓):

1-D: _____ 2-D: _____ 3-D: ✓

Time-Dependent: ✓

DISTURBANCE MODELED (✓):

Pressure Wave: ✓ Entropy Wave: ✓

Others (specify): _____

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: _____

Nonlinear Wave: ✓

Others (specify): _____

THEORETICAL BASIS: (Reference) _____

NUMERICAL METHODOLOGY: (Reference) _____

ACOUSTIC ATTENUATORS CONSIDERED (✓):

Muffler: ✓ Heat Exchanger: _____

Horn: _____ Porous Wall: _____

Others (specify): _____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓):

Index of Refraction Variation?: ✓

Other (specify): _____

OTHER UNIQUE FEATURES: _____

CODE NAME: SUPERSONIC TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Laser cavity
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Analysis of an electrically excited
supersonic flow CO laser.

ASSESSMENT OF CAPABILITIES: Analysis of an electrically excited supersonic CO
laser, with coupled molecular kinetics, plasma kinetics, gas dynamics, and
optical extraction. (Simple one-dimensional models for gas dynamics and
resonator.)

ASSESSMENT OF LIMITATIONS: Simplified treatment of gas dynamics and optical
resonator.

OTHER UNIQUE FEATURES: Provides for multiple lasing transitions, and includes
the effects of resonant self-absorption from overlapping transitions in a high
pressure gas system. Plasma kinetics are provided by Boltzmann equation,
completely coupled to molecular kinetics and optical extraction.

ORIGINATOR/KEY CONTACT:

Name: William B. Lacina
Organization: Northrop Research and Technology Center
Address: One Research Park, Palos Verdes Estates, CA 90274
Phone: (213) 377-4811 ext. 362

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = Related Publication):

"Supersonic Continuous Wave Carbon Monoxide Laser Development, Phase I.
Vol I: CO Laser Kinetics Code. Vol. IV: Rates and Cross Sections, "Northrop
Rept. #NRTC-75-25R, July 1975. #NRTC-75-50R, NRTC-76-18R.
(T,U,L) Miscellaneous papers.

STATUS:

Operational Currently?: yes
Under Modification?: no

Purpose(s):

Ownership?: Northrop Research & Tech./ William B. Lacina
Proprietary?: No. Public Domain

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: yes

Machine Dependent Restrictions: yes

SELF-CONTAINED? YES

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS:

KINETICS CODE

CODE NAME: SUPERSONIC

1. CODE STRUCTURE

COORDINATE SYSTEM ($\checkmark$):

Cartesian: _____ Expanding: _____

KINETICS GRID DIMENSIONALITY ($\checkmark$):1-D: $\checkmark$ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulse: $\checkmark$ CW: $\checkmark$

NUMERICAL SCHEME USED IN RATE

CALCULATION ($\checkmark$):

Explicit: _____

Implicit: _____

Others (specify): _____

REFERENCE OF METHOD USED: _____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: _____

Number of Negative Species: _____

Number of Neutral Species: _____

REACTION MECHANISM MODELED ($\checkmark$):

Primary Ionization: (Reference)

E-Beam: _____

Self-Sustained: _____

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: _____

Detachment: _____

Ion-Ion Recombination: _____

Charge Transfer: _____

Dissociation/Recombination: _____

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED ($\checkmark$):Uniform: $\checkmark$ Non-Uniform: _____E-Field: $\checkmark$

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO/N₂/...XNumber of Species: ~3

Number of Reactions: _____

Other Major Species Considered: _____

IMPACT EXCITATION MODELED ($\checkmark$):

(Reference)

Vibrational: $\checkmark$

Electronic: _____

Others (specify): _____

ENERGY TRANSFER MODES MODELED ($\checkmark$):

(Reference)

V-T: $\checkmark$

V-R: _____

V-V: $\checkmark$

Others (specify): _____

Lasing Transition: P-Branch: $\checkmark$

R-Branch: _____

Single Line Model ($\checkmark$): _____Multi-Line Model ($\checkmark$): $\checkmark$

Assumed Rotational Population

Distribution State ($\checkmark$):Equilibrium: $\checkmark$

Nonequilibrium: _____

Number of Laser Lines

Modeled: ≤ 25

Source of Rate Coefficients Used in Code: Misc.

LINE PROFILE MODELS ($\checkmark$):

Doppler Broadening: _____

Collisional Broadening: $\checkmark$

Others (specify): _____

4. RECIRCULATION CONTAMINANTS

MODELED ($\checkmark$): noneO_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

AD-A132 352

A SURVEY OF ELECTRIC LASER CODES(U) LOCKHEED MISSILES
AND SPACE CO INC HUNTSVILLE AL HUNTSVILLE R.. F C WANG
JUN 83 LMSC-HREC-TR-D784124 DRSMI/RH-CR-83-6

1/2

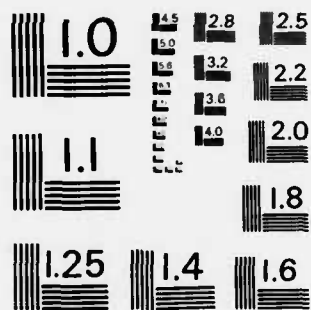
UNCLASSIFIED

DAAH01-80-C-1289

F/G 20/5

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CODE NAME: TDFI-EDL TECHNICAL AREA(S): Optics, Kinetics, Gas Dynamics
DEVICE COMPONENTS TREATED: Cavity
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Estimate performance trends of C^w
EDL with unstable resonator.

ASSESSMENT OF CAPABILITIES: Two-Dimensional Fresnel integral (cylindrical optics)
code coupled to detailed EDL plasma kinetics code including E-Beam and discharge
model.

ASSESSMENT OF LIMITATIONS: Cavity analysis restricted to cylindrical mirror
configurations.

OTHER UNIQUE FEATURES: Fully coupled kinetics and wave optics code.

ORIGINATOR/KEY CONTACT:

Name: Jurgen Thoenes

Organization: Lockheed-Huntsville Research & Engineering Center

Address: 4800 Bradford Dr., Huntsville, AL 35807

Phone: (205) 837-1800 ext. 416

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = Related Publication): J. Thoenes, S.C. Kurzius, M.L. Pearson "EDL Performance
Model, Part I - Theory and User's Guide", U.S. Army Missile Command,
TR RG-CR-75-2, June 1975. (T & U)

STATUS:

Operational Currently?: yes

Under Modification?:

Purpose(s): Requires updating; not used for several years.

Ownership?: Lockheed-Huntsville

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which Installed):

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: CDC 6600/7600

SELF-CONTAINED?:

Other Codes Required (name, purpose): tron Kinetics

Code

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>210</u>	<u>100</u>
Large Job:		
Approximate Number of FORTRAN Lines:		<u>5100</u>

COMMENTS:

KINETICS CODE

CODE NAME: EDL
(TDFI-EDL)

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ☒ Expanding: ☐

KINETICS GRID DIMENSIONALITY (✓):

1-D: ☒ 2-D: ☐

3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐

Flow Direction: ☒

KINETICS MODELED: Pulsed: ☐ CW: ☒

NUMERICAL SCHEME USED IN RATE CALCULATION (✓):

Explicit: ☒ (flow field)

Implicit: ☒ (kinetics)

Others (specify):

REFERENCE OF METHOD USED:

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: Input

Number of Negative Species: Input

Number of Neutral Species: Input

REACTION MECHANISM MODELED (✓):

Primary Ionization: (Reference)

E-Beam: ☒ same

Self-Sustained: ☐

UV-Initiated: ☐

Others (specify):

Secondary Ionization (Reference)

Attachment: ☒ same

Detachment: ☒

Ion-Ion Recombination: ☒

Charge Transfer: ☒

Dissociation/Recombination: ☒

Others (specify):

Source of Rate Coefficients Used:

DISCHARGE POWER INPUT MODELED (✓):

Uniform: ☒ Non-Uniform: ☐

E-Field: ☒

Others (specify):

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO₂

Number of Species: Input

Number of Reactions: Input

Other Major Species Considered: N₂, He, H₂, O₂

IMPACT EXCITATION MODELED (✓):

(Reference)

Vibrational: ☒ same

Electronic: ☒

Others (specify): Ionization

ENERGY TRANSFER MODES MODELED (✓):

(Reference)

V-T: ☒ same

V-R: ☐

V-V: ☒

Others (specify):

Lasing Transition: P-Branch: ☒

R-Branch: ☐

Single Line Model (✓): ☒

Multi-Line Model (✓): ☐

Assumed Rotational Population Distribution State (✓):

Equilibrium: ☒

Nonequilibrium: ☐

Number of Laser Lines

Modeled: 1

Source of Rate Coefficients Used in Code:

same

LINE PROFILE MODELS (✓):

Doppler Broadening: ☒

Collisional Broadening: ☒

Others (specify): Voigt Function

4. RECIRCULATION CONTAMINANTS MODELED (✓):

O_x: ☒ OH_x: ☒

NO_x: ☒ HNO_x: ☒

Others (specify):

REFERENCE FOR REACTION MECHANISM AND RATES: same

OTHER UNIQUE FEATURES: ADD

GAS DYNAMICS CODE

CODE NAME: EDL

(TDFI-EDL)

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ✓ Expanding: _____

FLUID GRID DIMENSIONALITY (✓):

1-D: ✓

2-D: _____

3-D: _____

Time Dependent: _____

FLOW FIELD MODELED (✓):

Compressible Flow: ✓

Incompressible: _____

Viscous Flow: _____

No Flow: _____

BASIC MODELING APPROACH (✓):

Algebraic: _____ Integral Method: _____

Finite Difference: ✓

Others (specify): _____

REFERENCE FOR APPROACH USED: _____

Euler integration

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: _____

Mixture Injection: _____

Nozzles: _____

Flow Plates: _____

Others (specify): _____

CAVITY INITIAL CONDITION DETERMINED BY (specify): Specified (input)

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: ✓ Closed System: _____

Closed Cycle: ✓

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: _____

Ejector System: _____

Compressor/Fan: _____

Heat Exchanger: _____

Gas Make-Up: _____

Others (specify): Circulator analysis requires specification of temp. and flow velocity as function of time around loop.

DECONTAMINATION METHOD TREATED (✓):

Scrubber: ✓

Shower: _____

Catalytic Reactor: ✓

Others (specify): Modeled by adjusting mix composition

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: _____ Repetitive Pulse: _____

DIMENSIONALITY TREATED (✓):

1-D: _____ 2-D: _____ 3-D: _____

Time-Dependent: _____

DISTURBANCE MODELED (✓):

Pressure Wave: _____ Entropy Wave: _____

Others (specify): _____

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: _____

Nonlinear Wave: _____

Others (specify): _____

THEORETICAL BASIS: (Reference) _____

NUMERICAL METHODOLOGY: (Reference) _____

ACOUSTIC ATTENUATORS CONSIDERED (✓):

Muffler: _____ Heat Exchanger: _____

Horn: _____ Porous Wall: _____

Others (specify): _____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓)

Index of Refraction Variation?: _____

Other (specify): Random noise

OR UNIQUE FEATURES: _____

OPTICS CODE

CODE NAME: FICP
(TDFI-EDL)

1. CODE STRUCTURE

BASIC TYPE (✓):

Physical Optics: FRESNEL INTEGRAL

Geometrical: _____

Constant Gain: _____ Floating Gain: _____

FIELD (POLARIZATION) REPRESENTATION (✓):

Scalar: _____

Vector: ✓

COORDINATE SYSTEM (✓):

Cartesian: ✓

Expanding (specify): _____

TRANSVERSE GRID DIMENSIONALITY (specify):

One-Dimensional: ✓

Two-Dimensional: _____

FIELD SYMMETRY RESTRICTIONS?:

MIRROR SHAPE(S) ALLOWED (✓):

Square: ✓

Rectangular: ✓

Circular: _____

Elliptical: _____

Strip: ✓

Arbitrary: _____

CONFIGURATION FLEXIBILITY (✓):

Fixed, Single Resonator Geometry: ✓

Fixed, Multiple Resonator Geometries: _____

Modular, Multiple Resonator Geometries: _____

Others (describe): _____

2. PROPAGATION TECHNIQUE

(✓ all that apply):

Fresnel Integral Algorithms: ✓

With Kernel Averaging: _____

Gaussian Quadrature: _____

Fast Fourier Transform (FFT): _____

Fast Hankel Transform (FHT): _____

Gardner-Fresnel-Kirchhoff (GFK): _____

Others (specify): _____

Finite Difference Algorithms

Method (specify): _____

CONVERGENCE (✓):

Technique:

Power Comparison: ✓

Field Comparison: ✓

Others (specify): _____

Acceleration Algorithms Used?: _____

Technique: _____

MULTIPLE EIGENVALUE/EIGENVECTOR EXTRACTOR ALGORITHMS (✓):

Prony: _____

Others (specify): _____

3. RESONATOR MODELING FEATURES

GENERAL CAPABILITIES:

Stability (✓):

Stable Resonators: ✓

Unstable Resonators: ✓

Type (✓)

Standing Wave: ✓

Traveling Wave (Ring): _____

Reverse Traveling Wave: _____

Branch (✓):

Positive: _____

Negative: _____

Optical Element Models Included (✓):

Flat Mirrors: _____

Spherical Mirrors: _____

Cylindrical Mirrors: ✓

Telescopes: _____

Scraper Mirrors: ✓

Deformable Mirrors: _____

Spatial Filters: _____

Gratings (specify type): _____

Other Elements (specify): Focusing output mirror

PRINCIPAL RESONATOR GEOMETRIES MODELED (Please List):

Unstable resonator with focused oblique output beam.

OPTICS CODE
(Concluded)

CODE NAME: _____

(1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

GAIN MODELS (✓):

Bare Cavity Only: ✓
Simple Saturated Gain: ✓
Detailed Model (See
Section 3 in Kinetics Code) ✓

BARE CAVITY FIELD MODIFIER MODELS (✓):

Mirror Tilt: ✓
Mirror Decentration: _____
Aberrations/Thermal
Distortion: _____
Arbitrary: _____
Selected (specify): _____
Reflectivity Loss: ✓
Output Coupler Edges
Rolled: _____
Serrated: _____
Other: _____

LOADED CAVITY FIELD MODIFIER
MODELS (✓):

Refractive Index
Variation: _____
Gas Absorption: _____
Overlapped Beams (for
flux updating): _____
Number of Overlaps
Allowed: _____
Others: Random noise option
and starter

4. FAR FIELD MODELS (✓):

Beam Steering Removal: _____
Optimal Focal Search: _____
Beam Quality: _____
Atmospheric Propagation
Effects: _____
Others: Non-Amplified oblique
focused output beam.

BEAM CONTROL SYSTEM MODELED (✓):

Pointer/Tracker
Subsystem: _____
Beam Jitter: _____
Autoalignment: _____
Target Model:
Motion: _____ Effects: _____

OTHER UNIQUE FEATURES (e.g., Beam/Mode
Rotation, Extra-Cavity Adaptive Optics, Multipath/
Parasitic Effect, Beam Director Elements, etc.):

CODE NAME: TEA Laser Kinetics TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Program Laser Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To model the laser kinetics of a pulsed 10.6 μ m CO₂ laser and to predict the performance of the laser.

ASSESSMENT OF CAPABILITIES: Can handle gas mixtures of CO₂: N₂: He: H₂O: H₂ at any temperature and pressure, and pulse lengths from one to twenty microseconds

ASSESSMENT OF LIMITATIONS: Is one-dimensional, can only model stable resonators, cannot handle very short pulses in which Boltzmann equilibrium for the vibrational modes is not a good approximation, and the rotational and kinetic temperatures are the same.

OTHER UNIQUE FEATURES: A six-temperature kinetic model is used which includes E/N-dependent electrical excitation and 29 temperature-dependent collisional relaxation rates.

ORIGINATOR/KEY CONTACT:

Name: Lyle Taylor
Organization: Westinghouse Electric Corporation
Address: 1310 Beulah Rd., Pittsburgh, PA 15668
Phone: 412-256-5833

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T: L.H. Taylor, L.A. Weaver, and R.W. Liebermann, "An Electric Discharge CO₂ Laser Kinetics Model. I. Theoretical Formulation, "Westinghouse Paper 78-1C2-ADLAS-P1 (1978). T: L.H. Taylor and L.A. Weaver, "An Electric Discharge CO₂ Laser Kinetics Model. II. Collisional Rates, "Westinghouse Paper 78-1C2-ADLAS-P2 (1978) U: L.H. Taylor, R.W. Liebermann, and L.A. Weaver, "User's Manual for the Westinghouse Transversely Excited Atmospheric (TEA) CO₂ Laser Kinetics Computer Program, "Westinghouse Report 75-9C2-LASEX-R2 (1975).
STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s): _____

Ownership?: U. S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): U-1106 and CDC-7600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: FORTRAN IV

SELF-CONTAINED?: yes

Other Codes Required (name, purpose): _____

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>14501</u>	<u>7 sec, CDC-7600</u>
Large Job:		
Approximate Number of FORTRAN Lines:	<u>736</u>	

COMMENTS:

Fabry-Perot Cavity modeled using geometric optics with floating gain.

KINETICS CODE

CODE NAME _____

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☒ Expanding: _____KINETICS GRID DIMENSIONALITY (☒):1-D: ☒ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: noFlow Direction: noKINETICS MODELED: Pulsed: ☒ CW: ☒NUMERICAL SCHEME USED IN RATE CALCULATION (☒):

Explicit: _____

Implicit: _____

Others (specify): HammingREFERENCE OF METHOD USED: R. W. Hamming, Numerical Methods for Engineers and Scientists (1962).

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: _____

Number of Negative Species: _____

Number of Neutral Species: _____

REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☒Self-Sustained: ☒UV-Initiated: ☒

Others (specify): _____

Secondary Ionization (Reference)

Attachment: ☒Detachment: ☒

Ion-Ion Recombination: _____

Charge Transfer: _____

Dissociation/Recombination: _____

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED (☒):Uniform: ☒ Non-Uniform: _____

E-Field: _____

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO₂Number of Species: 5Number of Reactions: 29

Other Major Species Considered: _____

He, N₂, H₂O, H₂IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☒Electronic: ☒

Others (specify): _____

ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-T: ☒V-R: ☒V-V: ☒

Others (specify): _____

Lasing Transition: P-Branch: ☒R-Branch: ☒Single Line Model (☒): ☒Multi-Line Model (☒): ☒Assumed Rotational Population Distribution State (☒):Equilibrium: ☒

Nonequilibrium: _____

Number of Laser Lines Modeled: Several

Source of Rate Coefficients Used in Code:

Westinghouse Paper 78-1C2-ADLAS-P2 (1978)LINE PROFILE MODELS (☒):Doppler Broadening: ☒Collisional Broadening: ☒

Others (specify): _____

4. RECIRCULATION CONTAMINANTS MODELED (☒): noneN₂: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

CODE NAME: TELSAT TECHNICAL AREA(S): Gas Dynamics
DEVICE COMPONENTS TREATED: Overall System Characteristics
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Study steady state and transient
Thermodynamic and Fluid Dynamic System Performance.

ASSESSMENT OF CAPABILITIES: 1-D time dependent assessment of thermodynamic and
fluid dynamic performance of laser components and their interactions within
the laser system.

ASSESSMENT OF LIMITATIONS: limited to 1-D problems.

OTHER UNIQUE FEATURES: Developed in "building block" format and easily
adaptable to different systems (i.e. closed or open loop) can also be used
to model non-EDL systems.

ORIGINATOR/KEY CONTACT:

Name: Earl White
Organization: R&D Associates
Address: APO 9377 International Airport Albuquerque, NM 87119
Phone: (505) 844-8446

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = ☒ Related Publication): T, L, RP

STATUS:

Operational Currently?: yes

Under Modification?:

Purpose(s):

Ownership?: R&D Associates

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CRAY-1

TRANSPORTABLE?: yes

Machine Dependent Restrictions: none

SELF-CONTAINED?:

Other Codes Required (name, purpose): none

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>68096 (Version 1)</u>	<u>44 sec</u>
Large Job:	<u>118272 (Version 2)</u>	<u>154 sec</u>

Approximate Number of FORTRAN Lines:

COMMENTS:

GAS DYNAMICS CODE

CODE NAME: TELSAT

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ✓ Expanding: _____

FLUID GRID DIMENSIONALITY (✓):

1-D: ✓

2-D: _____

3-D: _____

Time Dependent: ✓

FLOW FIELD MODELED (✓):

Compressible Flow: ✓

Incompressible: ✓

Viscous Flow: _____

No Flow: _____

BASIC MODELING APPROACH (✓):

Algebraic: _____ Integral Method: _____

Finite Difference: ✓

Others (specify): _____

REFERENCE FOR APPROACH USED: _____

Blackburn-Fluid Power Control

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: ✓

Mixture Injection: _____

Nozzles: _____

Flow Plates: _____

Others (specify): _____

CAVITY INITIAL CONDITION DETERMINED BY (specify): Input

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: _____ Closed System: _____

Closed Cycle: ✓

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: ✓

Ejector System: _____

Compressor/Fan: ✓

Heat Exchanger: ✓

Gas Make-Up: ✓

Others (specify): Nozzles, ducting turbine

DECONTAMINATION METHOD RELATED (✓):

Scrubber: _____

Shower: _____

Catalytic Reactor: _____

Others (specify): _____

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: _____ Repetitive Pulse: _____

DIMENSIONALITY TREATED (✓):

1-D: _____ 2-D: _____ 3-D: _____

Time-Dependent: _____

DISTURBANCE MODELED (✓):

Pressure Wave: _____ Entropy Wave: _____

Others (specify): _____

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: _____

Nonlinear Wave: _____

Others (specify): _____

THEORETICAL BASIS: (Reference) _____

NUMERICAL METHODOLOGY: (Reference) _____

ACOUSTIC ATTENUATORS CONSIDERED (✓):

Muffler: _____ Heat Exchanger: _____

Horn: _____ Porous Wall: _____

Others (specify): _____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO

Index of Refraction Variation?: _____

Other (specify): _____

OTHER UNIQUE FEATURES: _____

CODE NAME: UNSEDL2 TECHNICAL AREA(S): Optics/Kinetics/Gas Dynamics
DEVICE COMPONENTS TREATED: CO₂ EDL
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Time dependent behavior of CW CO₂
EDL with mode media instability.

ASSESSMENT OF CAPABILITIES: 2-D flow + kinetics; FFT optics

ASSESSMENT OF LIMITATIONS: Very expensive to run

OTHER UNIQUE FEATURES: Dynamic Dimensioning

ORIGINATOR/KEY CONTACT:

Name: Ted Salvi
Organization: AFWL/ARAO
Address: Kirtland AFB, NM 87117
Phone: 505-844-0256

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = Related Publication):

U, L

T: Jumper, G.Y., Hines, J.D., and Salvi, T.C. & Riker, J.F.,

"The Dependent Numerical Prediction of CO₂ Electric Discharge
Laser Performance".

STATUS:

Operational Currently?: yes

Under Modification?: no

Purpose(s): Not currently being used

Ownership?: USAF

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600 (Cyber 176)

TRANSPORTABLE?: no

Machine Dependent Restrictions: IO; Assembly language FFT

SELF-CONTAINED?:

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		
Approximate Number of FORTRAN Lines:		<u>10,000</u>

COMMENTS:

KINETICS CODE

CODE NAME: UNSEDL2

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☒ Expanding: _____KINETICS GRID DIMENSIONALITY (☒):1-D: _____ 2-D: ☒

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: Multiple sheetFlow Direction: ☒KINETICS MODELED: Pulsed: ☒ CW: ☒ (Time Dep)NUMERICAL SCHEME USED IN RATE CALCULATION (☒):Explicit: ☒

Implicit: _____

Others (specify): _____

REFERENCE OF METHOD USED: MacCormack's
Fluid Dynamic, extended to kinetics

2. PLASMA KINETICS MODEL Energy levels:

NUMBER OF SPECIES TREATED (specify): E Upper

Number of Positive Species: _____ E lower

Number of Negative Species: _____ E N₂

Number of Neutral Species: _____

REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☒

Self-Sustained: _____

UV-Initiated: _____

Others (specify): _____

Secondary Ionization (Reference)

Attachment: _____

Detachment: _____

Ion-Ion Recombination: _____

Charge Transfer: _____

Dissociation/Recombination: ☒

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED (☒):Uniform: _____ Non-Uniform: ☒

E-Field: _____

Others (specify): _____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO₂ (001)Number of Species: 3Number of Reactions: 6

Other Major Species Considered: _____

IMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☒

Electronic: _____

Others (specify): _____

ENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-I: ☒V-R: ☒V-V: ☒

Others (specify): _____

Lasing Transition: P-Branch: ☒R-Branch: ☒Single Line Model (☒): _____Multi-Line Model (☒): _____Assumed Rotational Population Distribution State (☒):Equilibrium: ☒

Nonequilibrium: _____

Number of Laser Lines

Modeled: 2 (10.6 - 9.28)Source of Rate Coefficients Used in Code: VariousLINE PROFILE MODELS (☒):

Doppler Broadening: _____

Collisional Broadening: ☒

Others (specify): _____

4. RECIRCULATION CONTAMINANTS MODELED (☒):

None

O_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: various

OTHER UNIQUE FEATURES: _____

GAS DYNAMICS CODE

CODE NAME: UNSEDL2

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

Cartesian: ☒ Expanding: _____

FLUID GRID DIMENSIONALITY (✓):

1-D: _____

2-D: ☒ _____

3-D: _____

Time Dependent: ☒ _____

FLOW FIELD MODELED (✓):

Compressible Flow: ☒ _____

Incompressible: _____

Viscous Flow: _____

No Flow: _____

BASIC MODELING APPROACH (✓):

Algebraic: _____ Integral Method: _____

Finite Difference: ☒ _____

Others (specify): actually finite element

REFERENCE FOR APPROACH USED: _____

MacCormack

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (✓):

Mixture Preparation: _____

Mixture Injection: _____

Nozzles: Variable Geometry

Flow Plates: Choked or face plate

Others (specify): _____

CAVITY INITIAL CONDITION DETERMINED
BY (specify): solution of time dependent
equations, no energy input.

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (✓):

Open System: ☒ Closed System: _____

Closed Cycle: _____

EXHAUST SYSTEM FEATURES (✓):

Pressure Recovery: ☒ _____

Ejector System: _____

Compressor/Fan: _____

Heat Exchanger: _____

Gas Make-Up: _____

Others (specify): A recovery pressure
is specified.

DECONTAMINATION METHOD TREATED (✓):

Scrubber: _____

Shower: _____

Catalytic Reactor: _____

Others (specify): _____

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (✓):

Single Pulse: _____ Repetitive Pulse: _____

DIMENSIONALITY TREATED (✓):

1-D: _____ 2-D: _____ 3-D: _____

Time-Dependent: _____

DISTURBANCE MODELED (✓):

Pressure Wave: _____ Entropy Wave: _____

Others (specify): disturbance propagated
by "hydro code" time dependent equations.

WAVE PROPAGATION TREATMENT (✓):

Linear Wave: _____

Nonlinear Wave: _____

Others (specify): _____

THEORETICAL BASIS: (Reference) _____

NUMERICAL METHODOLOGY: (Reference) _____

ACOUSTIC ATTENUATORS CONSIDERED (✓): no

Muffler: _____ Heat Exchanger: _____

Horn: _____ Porous Wall: _____

Others (specify): _____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓):

Index of Refraction Variation?: ☒ _____

Other (specify): gain variation

OTHER UNIQUE FEATURES: _____

OPTICS CODE

CODE NAME: UNSEDL2

1. CODE STRUCTURE

BASIC TYPE (✓):

Physical Optics: ✓Geometrical: Constant Gain: Floating Gain: ✓

FIELD (POLARIZATION) REPRESENTATION (✓):

Scalar: ✓Vector:

COORDINATE SYSTEM (✓):

Cartesian: ✓Expanding (specify): ✓

TRANSVERSE GRID DIMENSIONALITY (specify):

One-Dimensional: Two-Dimensional: ✓ DynamicFIELD SYMMETRY RESTRICTIONS?: no

MIRROR SHAPE(S) ALLOWED (✓):

Square: ✓Rectangular: ✓Circular: ✓Elliptical: Strip: ✓Arbitrary:

CONFIGURATION FLEXIBILITY (✓):

Fixed, Single Resonator Geometry: Fixed, Multiple Resonator Geometries: Modular, Multiple Resonator Geometries: ✓Others (describe):

2. PROPAGATION TECHNIQUE

(✓ all that apply):

Fresnel Integral Algorithms:

With Kernel Averaging: ✓Gaussian Quadrature: Fast Fourier Transform (FFT): ✓Fast Hankel Transform (FHT): Gardener-Fresnel-Kirchhoff (GFK): Others (specify):

Finite Difference Algorithms

Method (specify):

CONVERGENCE (✓):

Technique:

Power Comparison: Field Comparison: ✓Others (specify): Acceleration Algorithms Used?: NoTechnique:

MULTIPLE EIGENVALUE/EIGENVECTOR EXTRACTOR ALGORITHMS (✓):

Prony: Others (specify):

3. RESONATOR MODELING FEATURES

GENERAL CAPABILITIES:

Stability (✓):

Stable Resonators: Unstable Resonators: ✓

Type (✓)

Standing Wave: ✓Traveling Wave (Ring): Reverse Traveling Wave:

Branch (✓):

Positive: ✓Negative:

Optical Element Models Included (✓):

Flat Mirrors: ✓Spherical Mirrors: ✓Cylindrical Mirrors: Telescopes: Scraper Mirrors: ✓Deformable Mirrors: Spatial Filters: Gratings (specify type): Other Elements (specify):

PRINCIPAL RESONATOR GEOMETRIES MODELED (Please List):

Sets up confocal automatically;other resonators can be set up with some additional minor difficulty.

OPTICS CODE

(Concluded)

CODE NAME: UNSEDL2

GAIN MODELS (✓):

Bare Cavity Only: _____
Simple Saturated Gain: _____
Detailed Model (See
Section 3 in Kinetics Code) ✓

BARE CAVITY FIELD MODIFIER MODELS (✓):

Mirror Tilt: _____
Mirror Decentration: _____
Aberrations/Thermal
Distortion: _____
Arbitrary: _____
Selected (specify): ✓
Reflectivity Loss: ✓
Output Coupler Edges
Rolled: _____
Serrated: _____
Other: _____

LOADED CAVITY FIELD MODIFIER
MODELS (✓):

Refractive Index
Variation: ✓
Gas Absorption: ✓
Overlapped Beams (for
flux updating) ✓
Number of Overlaps
Allowed: can be easily set up
Others: _____

4. FAR FIELD MODELS (✓):

Beam Steering Removal: _____
Optimal Focal Search: _____
Beam Quality: ✓
Atmospheric Propagation
Effects: _____
Others: _____

BEAM CONTROL SYSTEM MODELED (✓):

Printer/Tracker
Subsystem: _____
Beam Jitter: _____
Autoalignment: _____
Target Model:
Motion: _____ Effects: _____

OTHER UNIQUE FEATURES (e.g., Beam/Mode
Rotation, Extra-Cavity Adaptive Optics, Multipath/
Parasitic Effect, Beam Director Elements, etc.):

CODE NAME: UVLZR TECHNICAL AREA(S): Kinetics
DEVICE COMPONENTS TREATED: Laser Discharge, PFN
PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Study kinetics of rare gas halide lasers, design more efficient PFN's.

ASSESSMENT OF CAPABILITIES: Code does quite well at describing the electrical characteristics (voltage, current, impedance) of RgH-discharge systems.
In general code also predicts lasing onset well.

ASSESSMENT OF LIMITATIONS: Code assume uniform gain and flux and this is bad.
Therefore it does not accurately predict output energy. Code requires separate electro-kinetics code.

OTHER UNIQUE FEATURES: One version of the code has been modified to provide a gas-phase resistance in code SUPER SCEPTRE. This then permits modelling of nearly any PFN.

ORIGINATOR/KEY CONTACT:

Name: Arthur E. Greene
Organization: T-12, LASL
Address: MS.-569, Los Alamos Scientific Laboratory, Los Alamos, NM 87545
Phone: 505-667-7799

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

RP: A.E. Greene & C.A. Brau, IEEE J.Q.E. 14, 951, 1978

RP: A. E. Greene, C.R. Tallman, W.L. Willis, & C.A. Brau, Proceedings of International Conference on Lasers 1979, 211.

STATUS:

Operational Currently?: X

Under Modification?: X

Purpose(s): Work underway on moving from KrF to XeCl

Ownership?: LASL is funded by DOE

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CDC-7600/LTSS

TRANSPORTABLE?: YES

Machine Dependent Restrictions:

SELF-CONTAINED?: no

Other Codes Required (name, purpose): NOMAD - solves Boltzmann equation to find electron impact pumping rates.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>637</u>	<u>12 sec</u>
Large Job:		
Approximate Number of FORTRAN Lines:		<u>600</u>

COMMENTS:

KINETICS CODE

CODE NAME: UVLZR

1. CODE STRUCTURE

COORDINATE SYSTEM ($\checkmark$):Cartesian: $\checkmark$ Expanding: _____KINETICS GRID DIMENSIONALITY ($\checkmark$):1-D: $\checkmark$ 2-D: _____

3-D: _____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: _____

Flow Direction: _____

KINETICS MODELED: Pulsed: $\checkmark$ CW: _____NUMERICAL SCHEME USED IN RATE
CALCULATION ($\checkmark$):

Explicit: _____

Implicit: $\checkmark$

Others (specify): _____

REFERENCE OF METHOD USED: Gear

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive
Species: 2Number of Negative
Species: 2Number of Neutral
Species: 4REACTION MECHANISM MODELED ($\checkmark$):

Primary Ionization: (Reference)

E-Beam: _____

Self-Sustained: _____

UV-Initiated: _____

Others (specify): Electron impact
avalanche

Secondary Ionization (Reference)

Attachment: $\checkmark$ Detachment: $\checkmark$ Ion-Ion Recombination: $\checkmark$

Charge Transfer: _____

Dissociation/
Recombination: $\checkmark$

Others (specify): _____

Source of Rate Coefficients Used: see
RP on page 1DISCHARGE POWER INPUT MODELED ($\checkmark$):Uniform: $\checkmark$ Non-Uniform: _____E-Field: $\checkmark$ Others (specify): time varying

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: KrF* or RgH*Number of Species: 1Number of Reactions: 1Other Major Species Considered: diluent
Ne or He (or both), F₂ or halogen
donorIMPACT EXCITATION MODELED ($\checkmark$):

(Reference)

Vibrational: _____

Electronic: $\checkmark$

Others (specify): _____

ENERGY TRANSFER MODES MODELED ($\checkmark$):

(Reference)

V-T: _____

V-R: _____

V-V: _____

Others (specify): Rg + H $\rightarrow$ RgH*

Lasing Transition: P-Branch: _____

R-Branch: _____

Single Line Model ($\checkmark$): $\checkmark$ Multi-Line Model ($\checkmark$): _____Assumed Rotational Population
Distribution State ($\checkmark$):

Equilibrium: _____

Nonequilibrium: _____

Number of Laser Lines

Modeled: 1Source of Rate Coefficients Used in Code:
see RP page #1LINE PROFILE MODELS ($\checkmark$):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): _____

4. RECIRCULATION CONTAMINANTS
MODELED ($\checkmark$): noneO_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM
AND RATES: _____OTHER UNIQUE FEATURES: Numerous self-
absorption terms included.

CODE NAME: VIBKIN TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To model the kinetics of the vibration levels of carbon monoxide mixed with helium and argon cooled by supersonic expansion pumped by an electric discharge and unpumped by lasing.

ASSESSMENT OF CAPABILITIES: The model predicts the time histories of the lasing lines which are in very good agreement with pulsed and cw experiments in both small and large scale devices.

ASSESSMENT OF LIMITATIONS: About \$50 cost per case to run.

OTHER UNIQUE FEATURES: Electron energy distribution from Boltzmann Eq. changes as vibration manifold changes. Includes vibration excitations by electron impact from excited levels. Modified Rigrod theory for laser cavity. Temperature dependent VV and VT rates and optical broadening cross sections. One dimensional

ORIGINATOR/KEY CONTACT: /flow eqns. with heat addition. Rotational thermal equilibrium.
 Name: Donald John Nelson, MS 88-46 /Includes CO R-branch resonance effects.
 Organization: The Boeing Aerospace Company
 Address: P.O. Box 3999 Seattle, WA 98124
 Phone: (206) 773-1498

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): The report: AFWL-TR-75-256 Supersonic CO Laser Code (SCOL Code), D.J. Pistores: and D.J. Nelson describes the theory and the comparison of some results with experiments. The report: AFWL-TR-76-5 Supersonic CO Laser Code, Operations Manual, E.G. Cate, D.J. Nelson and D.J. Pistores: describes the usage of the code and contains a source listing.

STATUS:

Operational Currently?: yes

Under Modification?: only slowly

Purpose(s): to continue improving the performance

Ownership?: AFWL and Boeing

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): IBM 360/370/3032 at Boeing, CDC 6600 at AFWL

TRANSPORTABLE?: yes

Machine Dependent Restrictions: A few statements were changed when transferring between IBM and CDC machines.

SELF-CONTAINED?: yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		G 50 CPUSEC for 30 <u>usec</u> pulse
Typical Job:	C100K, L200K, G160K	C 20 CPUSEC G 90 CPUSEC for 60 <u>usec</u> pulse
Large Job:		G 330 CPUSEC for 250 <u>usec</u> pulse
Approximate Number of FORTRAN Lines:		2200

COMMENTS:

KINETICS CODE

CODE NAME: VIBKIN

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☒ Expanding: ☐KINETICS GRID DIMENSIONALITY (☒):1-D: ☒ 2-D: ☐3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐Flow Direction: ☒KINETICS MODELED: Pulsed: ☒ CW: ☒

NUMERICAL SCHEME USED IN RATE

CALCULATION (☒):Explicit: 5th order Runge-Kutta for vibration kineticsImplicit: tridiagonal iteration for electron distribution

Others (specify): _____

REFERENCE OF METHOD USED: _____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: _____

Number of Negative Species: _____

Number of Neutral Species: _____

REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☒ determines electron densitySelf-Sustained: ☒ determines pumping ratesUV-Initiated: ☐

Others (specify): _____

Secondary Ionization (Reference)

Attachment: _____

Detachment: _____

Ion-Ion Recombination: _____

Charge Transfer: _____

Dissociation/Recombination: _____

Others (specify): _____

Source of Rate Coefficients Used: _____

DISCHARGE POWER INPUT MODELED (☒):Uniform: ☒ Non-Uniform: ☐

E-Field: _____

Others (specify): Function of time

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: Carbon MonoxideNumber of Species: 3

Number of Reactions: _____

Other Major Species Considered: Helium and ArgonIMPACT EXCITATION MODELED (☒):

(Reference) *

Vibrational: ☒ 7, 23, 30, 32Electronic: ☐

Others (specify): _____

ENERGY TRANSFER MODES MODELED (☒):

(Reference) *

V-T: ☒ 10V-R: ☐V-V: ☒ 8, 9, 33

Others (specify): _____

Lasing Transition: P-Branch: ☒ R-Branch: resonances withSingle Line Model (☒): ☒Multi-Line Model (☒): ☒Assumed Rotational Population Distribution State (☒):Equilibrium: ☒Nonequilibrium: ☐Number of Laser Lines Modeled: 5 rotational lines on each of 30 vibrational levels.

Source of Rate Coefficients Used in Code: _____

LINE PROFILE MODELS (☒):

Doppler Broadening: _____

Collisional Broadening: _____

Others (specify): Voigt4. RECIRCULATION CONTAMINANTS MODELED (☒): NoneO_x: _____ OH_x: _____NO_x: _____ HNO_x: _____

Others (specify): _____

REFERENCE FOR REACTION MECHANISM AND RATES: _____

OTHER UNIQUE FEATURES: _____

* See reference on AFWL-TR-75-256

CODE NAME: XENON TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: _____

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Synthesis of E-Beam initiated
Ar-Xe laser.

ASSESSMENT OF CAPABILITIES: Calculates saturated power density for an E-Beam
initiated discharge pumped Ar-Xe laser using 10-20 rate equations

ASSESSMENT OF LIMITATIONS: Boltzman code needed to calculate rate constants.

OTHER UNIQUE FEATURES: Collision effect on excited states treated implicitly.

ORIGINATOR/KEY CONTACT:

Name: T. DeTemple

Organization: U. of Ill.

Address: 200 EERL, Urbana, ILL 61801

Phone: 217-333-3094

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and
RP = Related Publication):

S.A. Lawton, J.B. Richards, L.A. Newman, L. Specht, and T.A. DeTemple,

"The High Pressure Neutral Infrared Xenon Laser", J.A.P. Vol. 50, p. 3888-
3898. June 1979. (RP)

S. Lawton and T.A. DeTemple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (RP)

STATUS:

Operational Currently?: no

Under Modification?: _____

Purpose(s): _____

Ownership?: _____

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CYBER 175

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: _____

SELF-CONTAINED?:

Other Codes Required (name, purpose): CALCOMP

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	<u>X</u>	
Large Job:		

Approximate Number of FORTRAN Lines: Few 1000

COMMENTS: _____

KINETICS CODE

CODE NAME: XENON

1. CODE STRUCTURE

COORDINATE SYSTEM (☒):Cartesian: ☒ Expanding: ☐KINETICS GRID DIMENSIONALITY (☒):1-D: ☒ 2-D: ☐3-D: ☐

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ☐Flow Direction: ☐KINETICS MODELED: Pulsed: ☒ CW: ☐NUMERICAL SCHEME USED IN RATE
CALCULATION (☒):Explicit: ☐Implicit: ☒Others (specify): ☐REFERENCE OF METHOD USED: Gear
Method ☐

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive
Species: 5Number of Negative
Species: 1Number of Neutral
Species: 4REACTION MECHANISM MODELED (☒):

Primary Ionization: (Reference)

E-Beam: ☒Self-Sustained: ☒UV-Initiated: ☐Others (specify): ☐

Secondary Ionization (Reference)

Attachment: ☒Detachment: ☐Ion-Ion Recom-
bination: ☐Charge Transfer: ☐Dissociation/
Recombination: ☒Others (specify): ☐Source of Rate Coefficients Used: variousDISCHARGE POWER INPUT MODELED (☒):Uniform: ☒ Non-Uniform: ☐E-Field: ☐Others (specify): ☐

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: XeNumber of Species: 2Number of Reactions: ~40Other Major Species Considered: Molecular
Ions, R.C. MoleculesIMPACT EXCITATION MODELED (☒):

(Reference)

Vibrational: ☐Electronic: ☒Others (specify): Excited StateENERGY TRANSFER MODES MODELED (☒):

(Reference)

V-T: ☐V-R: ☐V-V: ☐Others (specify): ElectronicLasing Transition: P-Branch: ☐R-Branch: ☒Single Line Model (☒): ☒Multi-Line Model (☒): ☐Assumed Rotational Population
Distribution State (☒):Equilibrium: ☐Nonequilibrium: ☐Number of Laser Lines
Modeled: 1Source of Rate Coefficients Used in Code:
VariousLINE PROFILE MODELS (☒):Doppler Broadening: ☐Collisional Broadening: ☐Others (specify): ☐4. RECIRCULATION CONTAMINANTS
MODELED (☒): noneO_x: ☐ OH_x: ☐NO_x: ☐ HNO_x: ☐Others (specify): ☐REFERENCE FOR REACTION MECHANISM
AND RATES: ☐OTHER UNIQUE FEATURES: Corrects for excited
state dependence on electron distribution
function.

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