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INTRODUCTION

This renewal application is filed by GA Technologies Inc. (GA), hereinafter referred to as the Licensee, covering its San Diego operations for a special nuclear material license to acquire, deliver, receive, possess, use, and transfer special nuclear material in compliance with the regulations of Title 10 Code of Federal Regulations Part 70. This application is for renewal of SNM-696. The application is presented in two parts: (1) Part I, Materials License Renewal - Demonstration, and (2) Part II, Materials License Renewal - License Specifications.

Part I, the "Demonstration" document, contains descriptive material, including general information about the applicant, a description of the site, and a discussion under "Present Operations" of current activities involved in the use of special nuclear material. The associated current radiological, nuclear, and materials safeguards policies and procedures are included in the remaining sections of the Demonstration document, with an analysis of postulated accidents and their activity release consequences.

Part II, the document containing "License Specification," describes the principal criteria and minimum capabilities and qualifications required by the license for facilities, equipment, and personnel, and defines the mandatory administrative and technical procedures to be used by the licensee for nuclear, radiological, and materials safeguards. These license conditions are requirements of the license under which activities shall be conducted, and they are subject to change only after prior authorization from the USNRC. Included in Part II are specifications of material license limits and authorized activities.

COPY NO._____

VOLUME I

PART I
DEMONSTRATION VOLUME
SNM-696 MATERIAL LICENSE RENEWAL
GENERAL ATOMICS
SAN DIEGO SITE

Submitted November 1989

U. S. Nuclear Regulatory Commission

Docket No. 70-734

1. GENERAL INFORMATION

General Atomics (GA), the licensee, hereby requests renewal of License SNM-696, Docket 70-734. This application is for a special nuclear materials license covering the GA facilities at San Diego, California. A renewal of 10 years is requested.

General Atomics, is a California corporation with headquarters located at 10955 John Jay Hopkins Drive, San Diego, California 92138. Under this license, the licensee operates the facilities located on its main site at 10955 John Jay Hopkins Drive, and on its Sorrento Valley site with entrance at 11220 Flintkote Avenue and 3483 Dunhill Street, San Diego, California 92138. Small amounts of SNM may be possessed, under the licensee's agreement state license, at other locations.

The corporation conducts its business principally at San Diego, California. The corporation is not owned, controlled or dominated by an alien, a foreign corporation, or foreign government within the meaning of the Atomic Energy Act of 1954, as amended, and of NRC's regulations.

The principal officers of the corporation and certain other executives of the licensee are as follows:

CORPORATION OFFICERS

GENERAL ATOMICS

Name	Citizenship	Title	Address
J. Neal Blue	USA	Chairman & Chief Executive Officer	10955 John Jay Hopkins Dr. San Diego, CA 92138
Linden S. Blue	USA	Vice Chairman	10955 John Jay Hopkins Dr. San Diego, CA 92138
John E. Jones	USA	Sr. Vice Pres. & Director	10955 John Jay Hopkins Dr. San Diego, CA 92138
Max D. Kemp	USA	Sr. Vice Pres. Finance	10955 John Jay Hopkins Dr. San Diego, CA 92138
James Edwards	USA	Vice Pres. & General Council & Secretary	10955 John Jay Hopkins Dr. San Diego, CA 92138
R. N. Rademacher	USA	Vice Pres. Human Resources	10955 John Jay Hopkins Dr. San Diego, CA 92138

1.1 DESCRIPTION OF LICENSED ACTIVITIES

The licensee at its San Diego site has been engaged for over 30 years in both government and privately-sponsored research and development operations involving use of special nuclear material (SNM).

Activities cover the conduct of both pure and applied research and development and fabrication of fuel materials in the nuclear energy and related fields. These activities are performed in various facilities described in Section 2.7, Part I. Details of present operations are covered in Section 3, Part I.

The main activity involving SNM pertains to the modular High-Temperature Gas-Cooled Reactor (MHTGR) system. Activities at GA involve the application of research, investigations of high-temperature materials, design and fabrication of reactor system components, and the development and fabrication of enriched (up to fully enriched) nuclear fuel elements. In the production of MHTGR type fuel elements, pyrolytic carbon coated uranium, thorium, and uranium-thorium dicarbide or oxide particles are prepared, made into compacts, and assembled and sealed into specially designed graphite blocks or bodies.

The TRIGA research reactor systems involve the design, development, fabrication, and installation of research reactors and their fuel elements.

Other activities using SNM include direct conversion research and development (thermoelectric and thermionic), irradiation services of varying types involving physics research, activation analysis, and other research and development efforts.

A small amount of SNM is contained in various sources, such as Pu-Be sources, and employed throughout the site for research and development purposes. Specific EA-1 building laboratories and the Hot Cell are authorized to perform work with unencapsulated Pu bearing samples. In other areas, Pu may also be stored in fireproof safes, vaults or vault-type rooms.

Specific uses of SNM are subject to review and approval prior to commencement of operations. Section 3, Part II, describes these uses.

1.2 ORGANIZATION

1.2.1 General Atomics (GA)

Figures I 1.2-1 and I 1.2-2 show the basic company structure and the relationship of those units possessing or controlling SNM.

1.2.2 Operating Organizations

The organizations that carry out most of the activities under this license are the Reactor, Defense and Enterprises divisions. These organizations are shown in Figure I 1.2-1. Part I Section 3, "Present Operations", discusses work being performed by the licensee at the present time. The following sections briefly define some of the organizational units performing that work.

1.2.2.1 Reactor Division

Power Reactor Programs of the Reactor Division has the responsibility to develop the technology necessary to specify the fuel, core configuration, core composition, reflector, burnable poison, control poison and shielding materials, graphite, and control and poison materials for use in the MHTGR and other power reactor concepts.

Nuclear Fuel Fabrication is responsible for fabrication of HTGR type fuel and for the management of fuel fabrication facilities.

1.2.2.2 Enterprises Division

The TRIGA organization of the Enterprises Division develops and manufactures components for the TRIGA research reactors manufactured and sold by GA. The TRIGA reactor fuels are marketed internationally through this division as part of its responsibility for developing, fabrication, and marketing of the TRIGA line of research reactors.

This organization is also responsible for fabrication of fuel for TRIGA reactors and for management of the respective fuel fabrication facilities.

The TRIGA organization maintains and operates two TRIGA reactors. These reactors are used for a wide variety of research and testing activities and irradiation services.

1.2.2.3 Defense Division

Various organizational units within the Defense Division are responsible for research and development activities on fuel and materials of all types. Associated laboratories are used in a variety of research activities generally directed toward development of MHTGR and TRIGA reactor technology. Hot cell activity normally encompasses evaluation of irradiated test specimens. A staff of nuclear physicists, engineers and metallurgists perform reactor analyses and evaluations of MHTGR fuel cycle technology.

1.2.3 Compliance Functions

All functions responsible for assuring compliance with applicable license requirements and controlling the radiological and nuclear safety and safeguards of licensed material are part of the Human Resources organization of General Atomics. Namely, these functions are: Nuclear Safety, Licensing, Safety and Nuclear Compliance, Nuclear Material Accountability, Statistics & Measurement Control, Security, and Health Physics.

The compliance functions are described below and are headed by managers or supervisors which are synonymous titles for signifying the responsible person. Their relationship within the GA organization is shown on Fig. I 1.2-2.

1.2.3.1 Licensing, Safety and Nuclear Compliance (LSNC)

This function administers licenses and reviews and approves all Work Authorizations (WA) involving SNM for compliance to applicable regulation and license conditions. This function provides interpretation of licenses and regulations and determines the need for licensing actions. It coordinates the final preparation and processing of applications, amendments, and correspondence with federal and state licensing agencies. This function disseminates license requirements to operating organizations and maintains or oversees maintenance of master license records to permit independent review by NRC or GA audit functions. All related correspondence is issued over the signature of the Manager, Licensing, Safety and Nuclear Compliance. In addition, this function supervises and is responsible for the overall planning, coordination, and administration of the special nuclear material measurement control and accounting, nuclear safety, health physics, and industrial safety functions.

1.2.3.1.1 Health Physics

Health Physics assures compliance with radiological safety standards and provides various services such as personnel external and internal monitoring, dose rate measurement, radioactive material detection and assay, air and water sampling, external radiation and contamination surveys, effluent monitoring, and other related activities. Health Physics operates a fully equipped laboratory. The functions of Health Physics in review and approval of new work (and changes thereto) are presented in Section 3, Part II. The staff of Health Physics is organized into the following four groups:

1. Health Physics Technicians - The Health Physics Technicians perform surveys of work areas, special surveys for control of operations involving radiation exposures to personnel. Individual Health Physics Technicians are assigned to specific work areas to conduct Health Physics activities, to inspect operations and to advise personnel concerning radiation safety.

2. Health Physics Laboratory - The laboratory performs measurements on the samples obtained from various facilities, environmental samples, and the bioassay program.

3. Records and Reports - Records and Reports is responsible for management of records for personnel external and internal monitoring, the bioassay, in-vivo total body and lung counting programs, the meteorological program, records storage program, Work Authorization coordination, radiation safety training records, and other special projects.

4. Health Physics Management - The Manager, Health Physics, manages the Health Physics program at GA. This includes, but is not limited to, the review and approval of work involving the use of SNM, auditing and inspecting facilities authorized to use SNM, conducting radiation safety training classes, writing Health Physics procedures and reports.

1.2.3.1.2 Nuclear Safety

Nuclear Safety provides routine review and approval of proposed activities in which significant neutron multiplication is a possibility. Detailed functions of this group are presented in Section 3, Part II.

Nuclear Safety reviews activities involving special nuclear material to assure the nuclear safety of such activities. Nuclear Safety reviews and/or develops company policy, criteria and procedure affecting the safe handling and storage of SNM.

1.2.3.1.3 Nuclear Materials Accountability (NMA)

This function assures compliance with SNM custody and control rules, regulations and practices. This function implements the program for accountability, custody and control of special nuclear material. NMA maintains a manual of SNM accounting control procedures. NMA assures compliance with safeguards material control and accountability regulations and license conditions. NMA maintains complete, detailed records of SNM on hand by project and location of material. NMA has physical custody of all of the SNM in the storage areas under its control.

1.2.3.1.4 Security

Security provides security measures to prevent the unauthorized access to special nuclear material and provides appropriate industrial security. The security function includes the following: (1) maintenance of a Security Office and a force of watchmen, (2) physical protection of controlled areas and protected areas, as required, (3) provision for monitoring the fire and intrusion alarms and related communication systems, (4) implementation of security inspection procedures, and (5) assuring adequacy of physical protection of special nuclear material.

1.2.4 Advisory and Audit Functions

1.2.4.1 Criticality and Radiation Committee

The Criticality and Radiation Safety Committee (CRSC) provides advice, reviews and audits for activities involving radioactive materials and radiation-producing machines. In addition, CRSC reviews the policies and criteria governing these activities as they relate to radiological safety and nuclear safety, and will also review specified operations before implementation as may be covered by the criteria. The committee typically consists of members qualified in nuclear physics, health physics, chemistry, engineering, and metallurgy. The Office of the President appoints the members and selects the Chairman. Sub-committees are appointed by the CRSC Chairman as necessary. The Chairman or his designee maintains the official files of the Committee's actions and meetings. CRSC reports to the Office of the President, and is fully independent of the various operating groups. The committee's audits are conducted at least once each year and each such audit includes the activities of LSNC. Reports of CRSC activities are prepared for top management.

1.2.5 Administrative Procedures

The administrative procedures used by the licensee to assure radiological and nuclear safety, are presented in Section 3, Part II of the SNM-696 renewal application. The basis for this assurance is a consistent pattern of organizational responsibilities and a set of manuals and procedures used as day-to-day guides.

1.3 PERSONNEL AND TRAINING

1.3.1 Personnel

As of September 1989, the staff of the licensee comprised approximately 1235 people, of whom about 155 have doctorate degrees, approximately 212 have master degrees, and about 318 hold bachelor degrees. The personnel at the San Diego site are experienced in the technical and scientific fields necessary to support a broad range of nuclear research, development, design, and production operations.

When activities involving radioactive material or radiation-producing machines are contemplated, close scrutiny is made of the responsible individual(s) who will be directing such efforts.

Resumes of some of the management personnel in the area of nuclear operations and control are given below.

Dr. Keith E. Asmussen, Manager, Licensing, Safety and Nuclear Compliance

Ph.D., Nuclear Engineering, Iowa State University of Science and Technology, 1969

Graduate Study in Nuclear Engineering (1 year) University of Arizona, 1967

M.S., Nuclear Engineering, Iowa State University, 1966

B.S., Engineering Operations (Industrial Engineering), Iowa State University, 1965

Registered Professional Engineer, Nuclear Engineering, California

Member, San Diego Section American Nuclear Society

Dr. Asmussen joined General Atomics' (GA) Nuclear Analysis and Reactor Physics Department as a Senior Reactor Physicist in 1969. His initial responsibilities involved nuclear fuel management analyses and reactor physics calculations. In 1972 he was temporarily assigned to the Fuel Performance Branch where he was responsible for developing the reactor core thermal safety limit and other fuel related technical specifications for a large High Temperature Gas-cooled Reactor (HTGR).

In 1973, and again in 1976, he served as a site physicist at the Fort St. Vrain (FSV) HTGR. His responsibilities involved planning, coordinating and participating in the initial fuel loading, subcritical testing and monitoring, zero power physics testing and rise-to-power testing. Beginning in 1974, he spent 18 months working in the HTGR physics group of Hochtemperatur Reaktor Bau (HRB) located in Mannheim, West Germany. At HRB he acted as GA liaison and consultant regarding HTGR core and fuel design. In 1976, he returned to GA's San Diego offices and became a section leader engaged in Lead Plant HTGR core physics design and nuclear analysis. Late in 1977, he was given the special assignment of coordinator of all testing (in-pile and out-of-pile) related to resolving the FSV core temperature fluctuation problem.

In 1979, he became Manager, Fort St. Vrain Fuel Engineering where he was given the additional responsibility for directing all the technical analyses required to design, manufacture and license FSV reload segment fuel. Other responsibilities included fuel accountability, core reactivity monitoring and monitoring the performance of the core and fuel. He played a key role in developing revised Technical Specifications for the FSV reactor and obtaining NRC release for unrestricted full power operation. He worked intimately with Public Service Company of Colorado licensing personnel on a variety of issues involving personnel interaction with NRC staff. In 1983, he became Coordinator, Fort St. Vrain Core Activities. In this capacity his technical responsibilities remained unchanged but he assumed responsibility as project manager of these and related tasks.

From 1979 to 1985, Dr. Asmussen served on GA's Fuel Material Review Board which reviews and dispositions nonconformance reports, waivers, etc., related to the FSV Fuel Specifications.

In 1985, he became Manager of Licensing and Nuclear Material Control. His areas of responsibility were broadened in 1986 when he became Manager, Licensing, Safety and Nuclear Compliance. In this capacity, he is responsible for administering GA's licenses, liaison with regulatory agencies and reviewing and approving all work involving radioactive material for compliance with applicable regulations and license conditions. In addition, he is responsible for the overall planning, coordination, and administration of GA's special nuclear material control, nuclear safety, health physics, and industrial safety.

Laura R. Quintana, Manager, Health Physics

B.S., Biology, Chemistry, New Mexico Highlands University, 1976

M.S., Applied Nuclear Science (Health Physics), Georgia Institute of Technology, 1979

Manager, Health Physics (8/82 - present). Assures compliance with 10 CFR Parts 19 and 20 as well as state and U.S. Nuclear Regulatory Commission license-imposed radiological safety requirements. Provides review and approval of radiological safety of activities involving special nuclear materials or other radioactive materials, monitors activities involving special nuclear or radioactive materials, personnel monitoring, dose rate measurement, radioactive material detection and assay, air and water sampling and environmental monitoring.

Provides radiological safety support in decontamination/ decommissioning of facilities, including low-level radioactive waste disposal. This involves the identification of radionuclides, quantities and classifications as well as radiation and contamination measurements.

Assistant Radiation Safety Officer and subsequently Radiation Safety Officer at The Salk Institute, La Jolla, CA (2/80 - 5/82). Responsible for the radiation safety program and the radioactive material licensing of two affiliated companies, La Jolla Biological Associates and the Salk Institute Biotechnology Industrial Associates, Inc..

Mr. Vladislav Malakhof, Manager, Nuclear Safety

B.S., Mechanical Engineering, University of Missouri, 1962
M.S., Nuclear Engineering, University of California, 1964
Registered Professional Engineer (Nuclear), California

Mr. Malakhof joined General Atomics (GA) in 1963 and has worked since then in the field of reactor physics and criticality safety evaluations.

His primary area of experience is in the core physics analysis of High Temperature Gas-cooled Reactors (HTGRs). The activities in this area include: (a) spectrum calculations and preparation of microscope cross-sections; (b) fuel zoning and depletion calculations; (c) design of control rod, reserve shutdown system and lumped burnable poison; (d) reactor kinetics and accident analysis; (e) design of external neutron sources; (f) the fuel accountability for the Fort St. Vrain core; (g) the correlation of measured and calculated results, (h) the design of reload segments for the Fort St. Vrain core; and (i) the writing of safety analysis reports. He also was involved in the correlation of measured and calculated results for the Peach Bottom and Fort St. Vrain HTGRs. For the latter reactor, he participated in the initial loading and zero-power testing. Since 1976 he has been a member of the Material Review Board at GA's Fuel Fabrication Facility, which brings him into close contact with fuel manufacturing problems and their solutions, and familiarizes him with procedures and processes involved in fuel production. As the project manager of Fuel Test Element Post Irradiation Examination, he became familiar with the criticality and radiological safety in the Hot Cell.

His second area of experience is in criticality safety analysis. The major activities in this area include: (a) the safety analysis of HTGR fuel particles, rods or elements during manufacturing; (b) the safety analysis of fresh and spent fuel shipping casks; and (c) the safety analysis of fuel transfer machine and storage wells. He is the coauthor (with Dr. Baxter) of the Nuclear Criticality Safety Guide for specific application to HTGR fuel.

He was a member of GA's Criticality and Radiation Safety Committee (CRSC) from 1977 to 1986, where his duties were to carry out the secondary independent review of criticality safety at GA. As a committee member, he conducted reviews and audits not only of fuel fabrication areas but also other SNM containing areas. In 1986 he resigned from CRSC to become the Manager of Nuclear Safety at GA, and he continues to act in this capacity.

Chester L. Wisham, Manager, Nuclear Material Accountability

A.A. (Accounting), Mesa College, 1983

Manager, Nuclear Material Accountability (NMA) (1985 to date). Responsibilities include developing, revising, implementing, and enforcing nuclear materials control, safeguards, and accounting procedures. Manage the overall system of nuclear material control, including shipping, receiving, storage, and audits. Knowledgeable in the preparation for shipment of low-level waste, DOT regulations and disposal site requirements. Maintain liaison regarding nuclear material safeguards and control with other licensees, regulatory agencies, and all departments within the company.

Instrumental in the development of a computerized accountability system used by GA to implement the Nuclear Regulatory Commission's 10 CFR 70.57 and 70.58 and the related requirements of 10 CFR 70.51. Maintain a highly reliable and accurate system for the accountability of Special Nuclear Material (SNM).

Nuclear Materials Accountant (1963). Responsible for the maintenance and management of the SNM accountability system. Responsibilities included training nuclear material custodians, scheduling inventories, collecting and reviewing data for entry into the GA SNM material accounting system and accomplishing or supervising nuclear material control and safeguards reporting activities to assure compliance with the various regulatory agencies.

Nuclear Materials Assistant (1961). Maintained the company's accountability records and coordinated SNM control activities within the material balance areas.

Nuclear Material Processor (1960). Involved in the company's early activities involving low-level radioactive waste disposal.

Rodney N. Rademacher, Vice President, Human Resources

B.A. Industrial Psychology, San Diego State University, 1962.

Graduate Studies, San Diego State University.

Graduate Studies, University of Colorado, Colorado Springs.

Mr. Rademacher has been employed by the company since early 1974 in various management capacities prior to assignment to his present position in March 1988. Before this assignment he was Director of Human Resources where he performed in essentially the same capacity. He is responsible for designing, developing and directing company Human Resource programs, policies and procedures so as to effectively support the company's overall business objective. He functions as chief advisor on the personnel implications of company problems, business procedures and other management actions. The Security Force Department was added to his responsibilities in August 1985 and the Licensing and Nuclear Compliance Department in March of 1986. As such, he has a very broad understanding of the company's people, programs and business needs and requirements. He is intimately familiar with his organization's operations, requirements and applicable NRC and other government requirements. Because of his strong Human Resources and Safety orientation, he has developed an influential, positive working relationship with most GA managers and employees.

Before coming to GA, Mr. Rademacher was Director of Employee Relations for Getz Brothers & Company, Inc., 1973-74; Manager of Corporate Employment and EEO for Colorado Interstate Corporation, 1968-1973; Personnel Generalist for SDG&E, 1957-1968; and the U.S. Marine Corps Reserves, 1955-1956.

Dr. William L. Whittemore, Chairman, Criticality & Radiation Safety Committee

A. B. (Physics) Colby College, 1945.
A. M. (Physics) Harvard University, 1946.
Ph.D. (Physics) Harvard University, 1948.

Dr. Whittemore, who joined the company in 1957, is Physicist-in-Charge and Manager of the TRIGA Reactors Facility, with responsibility for the operation of the facility to provide irradiation services for customers, but also the conduct of R&D efforts including the development of advanced TRIGA concepts. He is also Manager of the TRIGA training program, which he has conducted for some 150 United States and foreign reactor operators. From 1957 and 1968, he headed a group engaged in neutron scattering measurements, using the Electron Linear Accelerator (LINAC), as well as reactor neutron sources. More recently, he has also been in charge of a group working to develop neutron radiography.

From 1948 to 1957, Dr. Whittemore was on the staff of the Department of Physics at Brookhaven National Laboratory, working primarily in the fields of cosmic-ray and high-energy particle physics. During 1951-52, he was also visiting professor at Harvard University.

Dr. Whittemore has published extensively. His work in the high-energy field has resulted in about 20 publications. In the fields of neutron in- elastic scattering and TRIGA development research, he has published, singly and jointly, more than 40 papers. He is coinventor of a system to utilize reactor neutrons with much higher efficiency to study thermal neutron in-elastic scattering. He has recently published a number of papers on his work in the field of neutron radiography, including its applications to medical problems.

Robert A. Rucker, Manager, Statistics and Measurement Control

B.S., Nuclear Engineering, University of Michigan, 1970

M.S., Nuclear Engineering, University of Michigan, 1971

Registered Professional Engineer, Nuclear, California, 1977

Registered Professional Engineer, Mechanical, California, 1983

Member of American Nuclear Society

Mr. Rucker has seventeen years experience in the fields of nuclear core and shielding design, measurement control for fuel fabrication, and nuclear criticality safety.

He has been Manager of Statistics and Measurement Control since 1984. His responsibilities include producing and maintaining procedures, measurement equipment, and statistics data to assure proper control of special nuclear material in compliance with NRC regulations; calculating measurement error components for bimonthly inventories, annual contractor audits related to measurement control, performing analysis of scale and balance errors, computer code write-ups, and inventory control system review in response to NRC concerns.

He has served as deputy nuclear safety engineer since 1987. He attended the Nuclear Criticality Safety Shout Course, June 1-5, 1987, sponsored by the University of New Mexico. This course included an extensive discussion of KENO, and examples of its use. He has been involved in nuclear safety inspections, and has given nuclear safety lectures at Radiological Safety training courses. He was also responsible for criticality calculations, using transport techniques, for the first use of boronation in the fuel fabrication process at GA.

Also he is currently responsible for shielding analysis for design of the OCRWM spent fuel shipping cask using Monte Carlo (MCNP), transport, and point-kernel techniques for the calculation of neutron and gamma dose rates; and nuclear core design for military and space applications.

Previously he was responsible for nuclear analysis and cost/performance optimization of the commercial size HTGR core including fuel management, control rod patterns, and detailed power distributions. He supplied data for safety analysis for Fort St. Vrain reload fuel, and served as on-site core physicist at Fort St. Vrain. He has performed core design and analysis on several TRIOGA reactors. He was also responsible for the nuclear analysis and design of the core and blankets of a demonstration size fast breeder reactor. Additionally he designed and analyzed fuel irradiation and critical experiments for verification of computer codes and modeling methods.

1.3.2 Training

1.3.2.1 Radiological Safety

A training course in radiological safety is required for all GA employees who expect to handle special nuclear material. This course is also required for all supervisory personnel who have subordinates engaged in these activities. The Radiological Safety Course covers measurement units, biological effects, limiting exposure to external radiation, prevention of internal exposure, use of protective clothing and monitoring devices, use of survey instruments, radiation safety rules and policies (including ALARA), concept of criticality, emergency procedures, use of survey instruments, and governmental regulations. The course is presented by lectures and demonstrations including the use of selected audiovisual aids. In addition to the course, which requires a final examination, periodic instruction is given to employees by Health Physics personnel whenever rules change or a particular radiation safety problem arises.

1.3.2.2 Fuel Production Training

In addition to completion of the radiological training course (Section 1.3.2.1), operating personnel in fuel production activities are given supplemental training. The employee is indoctrinated in the radiological and criticality hazards and special material controls associated with the use of uranium and thorium. Administrative procedures are reviewed and alarm systems are demonstrated. After working under close supervision for a few months, the employee is required to attend a nuclear safety review course covering safety criteria, the significance of control devices and records, and the like. After satisfactory demonstration of awareness, competence, and reliability, an employee may take on greater responsibility.

1.3.2.3 Evacuation

Evacuation drills are conducted semiannually to familiarize employees with evacuation procedures. Corrective action, if necessary, is taken.

1.3.2.4 Emergency Services Training

Emergency Services Technicians participate routinely in training classes or drills. Training sessions emphasize familiarity with the names, arrangements, and special features of buildings and the location and use of fire fighting equipment. First aid training and films emphasize the use of resuscitators and self-contained breathing apparatus. Classes of fires, extinguisher use, general fire fighting techniques, and rescue and salvage operations are reviewed in training supplemented by films. Periodic wet drills and hot drills are held with actual practice in use of equipment.

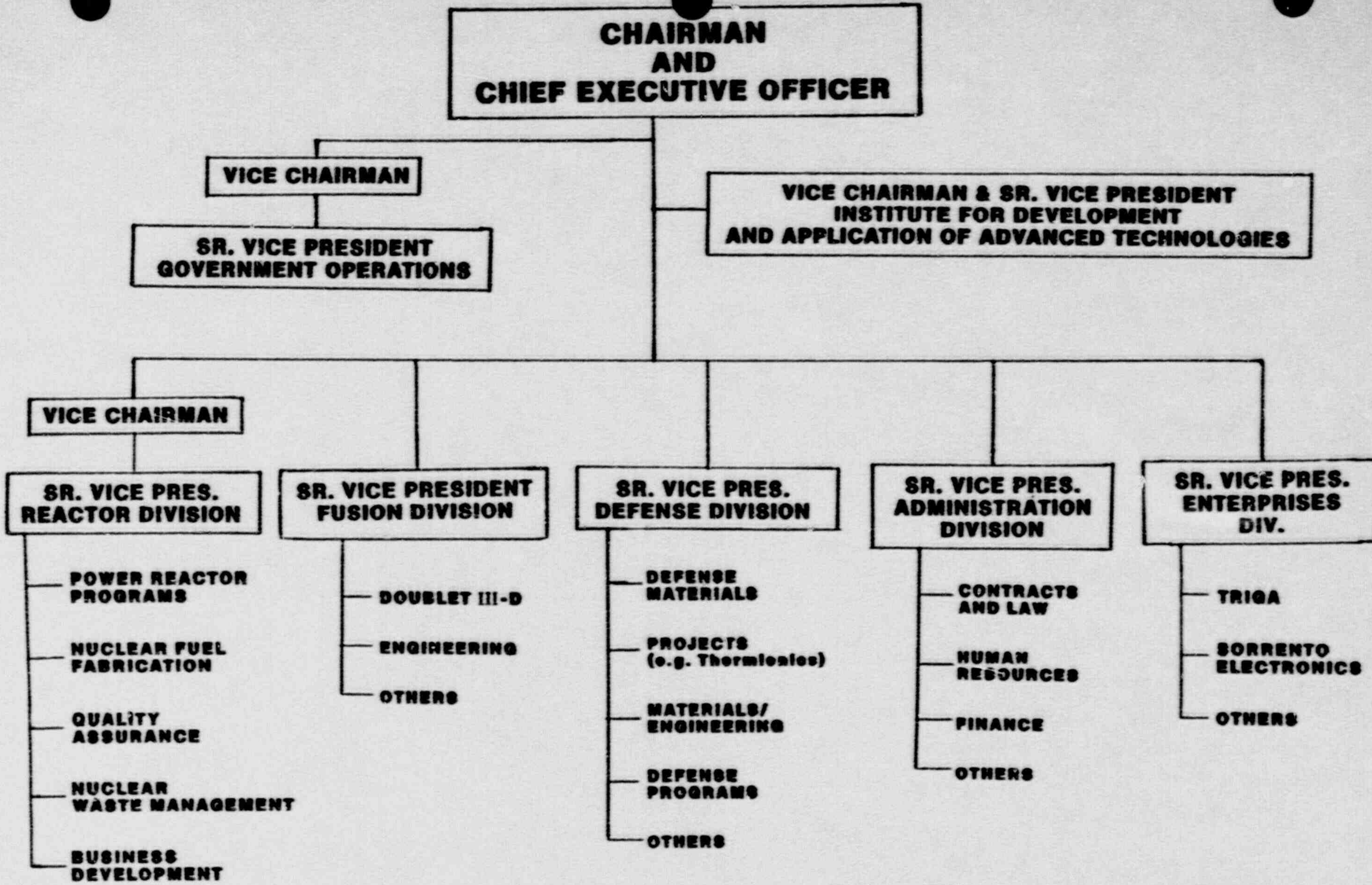

FIG. I 1.2 - 1 GENERAL ATOMICS ORGANIZATION CHART

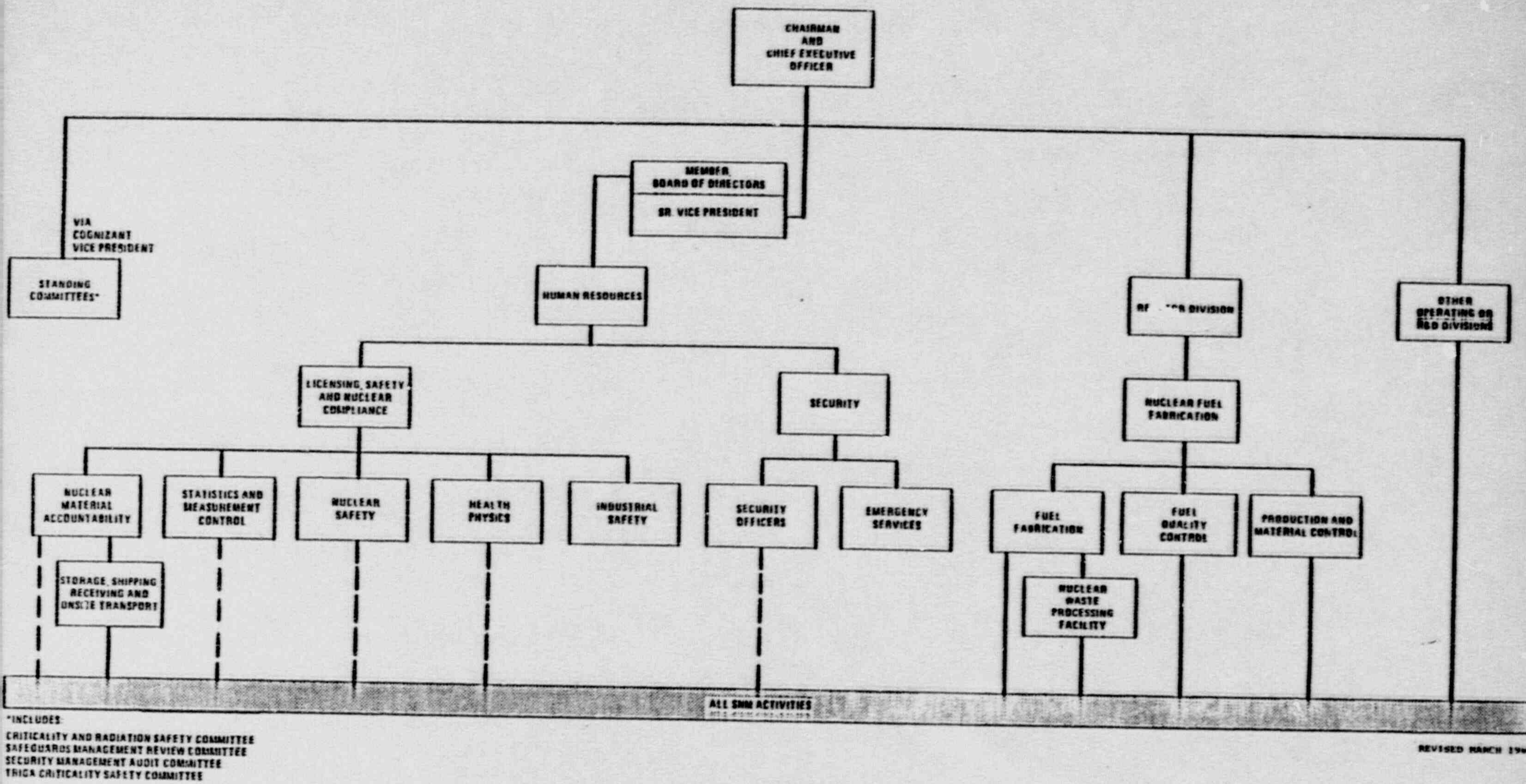

Fig. I 1.2-2. Radioactive Materials Management Organization Chart

2. SITE DESCRIPTION[1]

2.1 LOCATION AND SIZE

General Atomic's facilities in San Diego are located on two sites; these are the Main Site and the Sorrento Valley Site. The Main Site is located at 10955 John Jay Hopkins Drive, approximately 13 miles north of downtown San Diego. This site occupies approximately 60 acres.

The Sorrento Valley Site is located just north (about 0.1 mile) of the Main Site. The Sorrento Valley Site has two entrances, one at 11220 Flintkote Avenue and the other at 3483 Dunhill Street. This site also occupies about 60 acres.

A scale map of the area surrounding GA's sites is given in Figs. I 2.1-1 and -2. The heavily developed areas are shown in Fig. I 2.1-1. Fig. I 2.1-3 shows the details of the overall site building layout.

HTGR fuel production facilities as well as related process development activities/facilities are located on the Sorrento Valley Site at 11220 Flintkote. TRIGA fuel production facilities are located on the Main Site at 10955 John Jay Hopkins Drive.

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[1]Details of various facilities may be found in topical documents submitted under separate covers, such as GA's "Radiological Contingency Plan" dated June 1988, "Fixed Site and Transportation Plan for the Protection of Special Nuclear Material of Moderate and Low Strategic Significance" dated May 1989, and "Fundamental Nuclear Material Control Plan (FNMC) as revised.

2.2 TOPOGRAPHY

The main site is on Torrey Pines Mesa about 1 mile east of the ocean at an elevation of 300 ft above sea level. The site extends into the adjacent Sorrento Valley at an elevation of between 50 and 75 ft above sea level. The mesa runs in a northerly direction paralleling the coast and rising to a height of 400 ft above sea level between the site and the ocean.

Sorrento Valley runs in a northwest direction from the east side of the main site to the ocean, intersecting the ocean at the northern end of the mesa. Sorrento Valley is about 5000 ft wide at its mouth and narrows to 1000 ft at its southern end. The valley intersects Los Penasquitos Canyon east of the main site.

2.3 METEOROLOGY

2.3.1 General Influences

The weather and climatology of Southern California are dominated by the semipermanent Pacific high-pressure system which is a feature of the planetary circulation and which oscillates back and forth during the year as the seasons change. In the summer when the Pacific high-pressure system is at its most northerly position, it blocks traveling storm and high- and low-pressure systems, resulting in almost no rain from frontal activity during the summer season. The withdrawal of the Pacific high-pressure system to its most southerly position in the winter season allows storm systems to travel further south, resulting in winter rains in Southern California.

The Pacific high-pressure system further influences atmospheric circulation by forming a temperature inversion that restricts the mixing layer for pollutants and by causing low-average wind speeds in this restricted mixing layer. The lower altitude limit of the inversion, called the inversion base, is the upper limit beyond which cloud rise is retarded. Representative temperature profiles over a period of 5 months covering summer, fall, and winter show that inversions having bases between 250 and 5000 ft altitude occurred 76% of the time. Inversion bases occurring between 1000 and 2000 ft are most common in the summer, lowering to 250 to 1000 ft in the fall and increasing to 1500 to 2500 ft or higher in the winter.

2.3.2 Winds

The prevailing winds are usually westerly, although easterly winds are almost as common during the winter months. During the day, the westerly winds developing from the Pacific high-pressure system are reinforced by the land-sea breeze, resulting in stronger average wind velocities (6.5 to 9 mph) than from the easterly land breeze (1 to 7.2 mph). The land breeze is present at night during the cold season but seldom during the warmer months. This wind is shallow, usually a few hundred feet, while the sea breeze is often 1000 ft or more. Such air flow is effectively channeled by topographical features. Wind velocity, as a function of month and direction, is shown by the wind rose for San Diego in Fig. I 2.3-1. Strong winds are infrequent, with the strongest being 51 mph from the southeast in 1944.

The micrometeorology conditions at the site are determined by the terrain roughness, local topography, wind regimes (land and sea breezes), and solar heating. The dilution of airborne contamination due to normal operating releases will be determined by the small scale turbulence in the local area in combination with the wind and mode of release (ground level or elevated). A two-tower meteorological system is used to determine the micrometeorological conditions at the site. The data from these two towers goes to recorders and computers which calculate the standard deviations of the horizontal and vertical wind variations.

2.3.3 Precipitation

The average annual rainfall in the City of San Diego is 9.78 in., but relatively wide variations in the monthly and seasonal totals take place. This is illustrated by the fact that 75% of the annual precipitation occurs from November through March. The monthly averages for the period from 1939 through 1978 are given in Table I 2.3-1. The maximum annual precipitation during the last 60 years was 24.93 in. in 1941. The maximum precipitation in any 24-hour period within a month is shown on Table I 2.3-2.

TABLE I 2.3-1

AVERAGE PRECIPITATION FROM 1939 THROUGH 1978

Period	Average Precipitation (in.)
January	1.85
February	1.89
March	1.50
April	0.70
May	0.28
June	0.05
July	0.04
August	0.09
September	0.13
October	0.42
November	0.96
December	1.87

TABLE 2.3-2

MAXIMUM PRECIPITATION IN 24 HOURS FROM 1941 TO 1979

Month	Precipitation (in.)
January (1943)	2.65
February (1971)	2.61
March (1952)	2.40
April (1965)	1.40
May (1977)	1.50
June (1972)	0.28
July (1968)	0.10
August (1977)	2.13
September (1963)	0.90
October (1941)	1.20
November (1944)	2.44
December (1945)	3.07

2.3.4 Tornado

Tornadoes on the Pacific Coast are of a low frequency and are not severe. Small tornadoes and water spouts have been reported. In the one degree square containing San Diego and its vicinity, only five tornadoes were reported between 1916 and 1971. Typical damage consisted of removing the roof from a house.

2.4 GEOLOGY AND HYDROLOGY

The geology of the site is that of the coastal plains. The rocks which crop out in this area are part of a prism of sedimentary rocks of Cretaceous and Tertiary age which thin eastward and are seldom found more than 10 miles inland. They lie upon crystalline rocks which make up the Peninsular Range in central and eastern San Diego County. In the site area, the sedimentary rocks are up to 1000 ft thick. They consist of extremely well-cemented sandstones and shales of Cretaceous age below (not exposed in the site area) and firmly indurated siltstones, shales, and sandstones of Eocene age above. The sand blanket varies in thickness, with some of the region covered by marine terrace deposits of up to 30 ft in depth. The geology of the southwestern part of San Diego County is shown in Figs. I 2.4-1 and I 2.4-2.

The site lies in the Los Penasquitos drainage basin. Little water flows into Sorrento Valley except during occasional heavy rains, and it is carried off by the Los Penasquitos Creek which drains to the northwest into the Pacific Ocean.

2.5 SEISMOLOGY

The San Diego region is susceptible to earthquakes; however, since 1800 only two earthquakes have occurred with an intensity as high as VIII on the modified Mercalli Scale, one in 1800 and the other in 1894. An earthquake of intensity VIII on the modified Mercalli Scale corresponds to an acceleration of about 0.25 g with a period of 0.1 to 0.3 repeated several times. Since 1934, the epicenters of three small shocks have been located within 5 miles of the site but not in the immediate vicinity.

No mappable faults exist within the property limits. The fault nearest the property is the Rose Canyon fault (shown in Fig. I 2.4-1), which is 5 miles distance at its closest approach. Geological evidence indicates that there has been no surface displacement on the fault since early Pleistocene times, before deposition of the terrace deposits which cover much of Torrey Pines Mesa; epicenters have been located along the fault trace, however. The second nearest fault on land is the Elsinore Fault which lies 40 miles from the site.

All buildings which contain special nuclear material are designed to meet the seismic criteria specified in the Uniform Building Code (UBC) in effect at the time the buildings were constructed. The seismic parameter "C" (later designated "ZKC") used by the analyst were in accordance with the UBC in effect at the time and were dependent upon the particular type of structural component being analyzed. The magnitude of these parameters are still consistent with and meet the requirements of the UBC 1973 Edition. A summary of the buildings and seismic parameters used is given in Table I 2.5-1.

2.6 POPULATION AND LAND USE

The present population within a 1-mile radius of the main site is primarily of an industrial and university campus makeup, with an estimated

TABLE I 2.5-1

SEISMIC DESIGN

Building	Name on Plans	Construction Date	Seismic Parameter "C" (or "ZKC")	Effective Uniform Building Code (UBC)
SV-A	Metallurgic Develop. Bldg.	July 1961	0.133	UBC 1955 Ed.
SV-B	Light Mfg. Bldg.	Aug. 1963	0.133	UBC 1961 Ed.
L-Bldg. A	Science Bldg. A	Sept. 1957	0.133	UBC 1955 Ed.
B	Science Bldg. B	Aug. 1957	0.133	UBC 1955 Ed.
C	Science Bldg. C	Aug. 1959	0.133	UBC 1958 Ed.
Hot Cell	Torrey Pines Hot Cell	Mar. 1959	0.133, 0.200 & 1.00	UBC 1958 Ed.
ECF	Marine Gas-Cooled Reactor Critical Facility	Oct. 1961	0.133	UBC 1961 Ed.
EA-1	Experimental Area Bldg.	Sept. 1964	0.067 and 0.133	UBC 1964 Ed.
E-Bldg.	Experimental Bldg.	Feb. 1957	0.133	UBC 1955 Ed.
	Second Addition	April 1964	0.133 and 0.200	UBC 1964 Ed.
Butler	Various Vault Storage	1961 - 1963	0.067	UBC 1961 Ed.
TFF	TRIGA Fuel Fab Bldg	1975	0.133	UBC 1970 Ed.

daytime total of approximately 16,000 people (about 1300 are GA employees). The immediate vicinity surrounding the Flintkote Avenue Facilities is zoned for industrial activity. Interstate Highway 5 is located about 1/2 mile to the east of the Sorrento Valley Fuel Manufacturing Facilities (Bldgs. SV-A and SV-B). The location of nearby industrial and community facilities are shown in Fig. I 2.6-1.

The majority of the present population to the north is in a series of small towns extending to Oceanside, 25 miles north with a population of 101,000. Escondido, 18 miles northeast of the site, has a population of 91,500. To the south is the metropolitan area of San Diego. The distance and population of surrounding communities is given in Table I 2.6-1.

TABLE I 2.6-1

DISTANCE/POPULATION OF SURROUNDING COMMUNITIES

Community	Distance and Direction (air miles)	Population[a]
Del Mar	5 miles north	5,100
Los Penasquitos	8 miles northeast	33,000
Mira Mesa	6 miles east	49,800
University City	4 miles south	38,600
La Jolla	5 miles southwest	30,000
Clairemont	6 miles south	87,700
North City West	5 miles north	25,600

[a]Population data based as 1987.

No significant fresh water recreation areas exist within the local hydrological area, nor is there significant agricultural activity. Los Penasquitos Creek flows into an area called Sorrento Slough which is part of Torrey Pines State Park. The upper portion of the slough is near the licensee's site, (about one-half mile away). The slough is a game refuge and an area of tidal mud flats. All plants and animals in the area are protected and essentially no human use is made of this area.

Because of terrain and zoning, most future residential development will occur beyond a 2-mile radius from the site. Significant residential development is presently underway in the Mira Mesa area 5 miles east and in University City 4 miles south of the main site. Estimates of future growth indicate the area with a 5-mile radius could have a population of 190,000 by 1993.

2.7 FACILITIES DESCRIPTION

The following is a description of the various facilities at the San Diego site which may routinely handle SNM. Fig. I 2.1-3 is a plan view of the site. The square footage quoted for the various buildings is the total floor space enclosed within the walls.

2.7.1 Sorrento Valley Site Facilities

2.7.1.1 Fuel Manufacturing Building: SV-A (Bldg. No. 37) (106,380 ft^2)

Located at 11220 Flintkote Avenue on the Sorrento Valley Site, the Fuel Manufacturing Building contains offices, shops, and an area used for fuel and other fabrication activities. The building is 460 ft long and 120 ft wide with about two-thirds of the building of high bay construction. The east section of the building is divided into two floors for offices, a protective clothing change room, a laboratory and store rooms. Nonrelated activities carried out in the facility include a machine shop, a sheet metal shop, and an assembly area for mechanical parts. Approximately one-half of the building area is devoted to fuel fabrication activities. The fuel fabrication area is bounded by two outside walls, a masonry wall and a structural steel wall, which separate it from other non-fuel operation areas and activities. Access to the fuel fabrication area is restricted to limit access to authorized personnel, to control SNM, and to prevent the spread of contamination. A separate ventilation system is maintained for facilities and areas involved in SNM processing.

2.7.1.2 Fuel Production Process Development Building: SV-B (Bldg. No. 39) (15,200 ft^2)

Process development, pilot scale operations, and specialized fabrication work related to fuel production are conducted in a building adjacent to and north of the SV-A Building. Grinding, machining, and polishing operations of other non-SNM is also conducted in this building. A portion of the building is devoted to offices and other activities.

2.7.1.3 Nuclear Waste Processing Facility: (NWPF) (Bldg. No. 41) (14,364 ft^2)

The Nuclear Waste Processing Facility (NWPF) is located on the Sorrento Valley Site just south of SV-A (Building 37). The facility consists of a main processing and compacting area (Building 41), various storage areas, and a high level storage facility. East of the building, at a grade level 15 feet lower than Building 41, is a service and storage yard used for processing and packaging low-level waste. Access to the facility is limited to authorized personnel. Northwest of Building 41 is a 7,000 ft^2 fenced area containing a concrete high level storage facility. Access to this area is also limited to authorized personnel.

2.7.1.4 Storage and Evaluation Area, Sorrento Valley: (Building 41) (780 ft^2)

This facility is located in the southwest corner of Building 41 which also houses offices, research and development laboratories, and the Nuclear Waste Processing Facility. The building is a permanent structure, constructed on a 4-inch thick reinforced concrete slab. The exterior walls are constructed of 22-gauge metal siding over metal studs, and the roof is constructed of 26-gauge metal decking. The two interior walls that separate the area from the remainder of the building extend from the floor to the ceiling and are constructed of 22-gauge metal siding. Entrance into the area is through metal doors and a roll-up door for receiving and shipping material. The doors are secured with non-mastered, high security, 6-pin core locks manufactured by "Best." The roll-up door is secured by a "Best" padlock from the inside. The area is mainly used for SNM storage, preparation of shipments and evaluation of receipts. All doors are equipped with balanced magnetic switches and motion detecting equipment which alarms into the SCS and are set in the secure mode during off-hours or when the facility is otherwise unoccupied.

2.7.2 Main Site Facilities

2.7.2.1 Laboratory Building: (Bldg. No. 2) (119,370 ft^2)

The Laboratory Building contains laboratories, offices, shops, and low-level caves for work with low-level activity. Most of the research activities in metallurgy, chemistry, and experimental physics are conducted in this building. One set of laboratories is used for the fabrication, inspection and testing of thermionic devices.

2.7.2.2 Hot Cell Facility: (Bldg. No. 23) (6950 ft^2)

The Hot Cell Facility is equipped to perform a wide range of investigations of the physical, metallurgical, and chemical properties of irradiated specimens, including examinations of full-size power reactor fuel elements. The facility includes a high-level cell with three operating stations capable of handling activity levels of up to one million Ci of 1 MeV gamma, an adjacent low-level cell that can be used separately or in conjunction with the high-level cell, and a metallography cell equipped to provide complete metallurgical investigations including micro-, macro-, and stereo-photography. Supporting areas include a service gallery, physical test room, machine shop, manipulator repair, decontamination room, an X-ray room, change room, offices and fenced storage areas outside of the building.

2.7.2.3 TRIGA Reactors Building (Bldg. No. 21) (6730 ft^2)

Located north of the Laboratory Building, the TRIGA Reactors Building provides an area for diversified experimental and irradiation studies using the inherently-safe TRIGA Mark I, Mark F, and Mark III reactor facilities. Included within the building are associated reactor control consoles, a low-level counting room, a small shop, a neutron beam tube room, x-ray room and administrative offices. Specific uses of SNM in this area generally are governed by the terms of Utilization Facility Licenses R-38 and R-67; however, SNM that is not within the reactor pools is under this license. Two fenced storage areas are located outside of the building.

2.7.2.4 Chemistry Laboratories (Bldg. Nos. 27 and 27-1) (5800 ft^2)

This building consists of radiochemistry and analytical chemistry laboratories and offices. The laboratory is used for general laboratory activities, including activities related to the TRIGA reactors and Hot Cell operations. About 1100 ft^2 of the total area is located in a nearby underground bunker which houses a high-level chemistry lab and associated storage.

2.7.2.5 TRIGA Fuel Fabrication Building (Bldg. No. 22) (7500 ft^2)

The TRIGA fuel fabrication building, approximately 60 ft x 125 ft, is constructed of reinforced concrete prefabricated panels of about 7-1/2 in. thick for the walls. The roof is prestressed concrete approximately 4 in. thick. The building contains storage vaults, a drum storage area, operations associated offices, lockers and restrooms, as well as the fuel fabrication areas. The building has on the north end a pad providing outside space for a bottled gas farm, liquid nitrogen storage tank, air-conditioning units, high-efficiency air filter plenums and blowers, etc., which require routine servicing by persons not needed in the fuel fabrication areas.

The building is divided by the vault, walls, and 3/8-inch thick steel plating. The southern portion of the building is used for non-TRIGA related activities, such as storage.

2.7.2.6 Low-Level Liquid Filtration Facility (Bldg. No. 25) (600 ft^2)

The low-level liquid filtration facility is located about 300 feet southwest of the TRIGA reactors facility. It is approximately 30 ft. x 20 ft. This building houses a system for filtering liquids containing low levels of radioactive contamination. After filtering, the liquid is sampled and analyzed. If the concentrations of contaminants are below applicable federal, state and local regulatory limits, the liquid is disposed of into the sanitary sewerage system. If the concentrations do not meet the criteria for disposal in the sanitary sewerage system, the liquids are solidified for shipment to an authorized disposal facility.

2.7.2.7 Experimental Critical Facility Buildings (Bldgs. 31) (13800 ft^2)

This facility is comprised of two buildings. The two buildings are a reactor building and an assembly building. They are presently used for experiments with radiation sources/ machines and the storage of source and limited SNM within suitable containers.

The two buildings are subjected to the appropriate controls to minimize the possibility of uncontrolled spread or release of radioactivity to other areas and prevent unauthorized exposure to radiation.

2.7.2.8 LINAC Complex (Bldg. No. 30)

The LINAC complex is a heavily shielded (earth and concrete) building which was originally designed, constructed and licensed (by the State of California) for conducting accelerator-oriented activities. Currently, a linear accelerator capable of operating at potentials up to 15 Mev is being installed in the main accelerator building of this complex. Other portions of the complex are being used for storage, other experiments/activities and/or for associated office space.

2.8 UTILITIES AND SERVICES

2.8.1 Utilities

Gas and Electricity

Commercial quantities of gas and electricity are supplied by San Diego Gas and Electric Company.

Emergency and Auxiliary Power

Emergency and auxiliary power generators are available to assure continued operation of critical equipment, lighting, security, fire and other safety alarms, and required surveillance.

An auxiliary 25 kW(e) power system located near the Administration Building automatically engaged in case of a power failure. This system supplies power to the main site, fire and security alarm systems.

In the event of a power failure in the SV-A building (Bldg. No. 37), a standby electric generator automatically becomes energized. It is capable of producing 75 kW(e) of rated electric power thereafter to designated components. The auxiliary power unit supplies emergency power to the criticality, fire and security alarms, as well as to certain equipment cooling systems. In addition, wet-cell battery or emergency generator powered emergency lights are located strategically throughout the facility to illuminate evacuation routes and equipment that may require surveillance during power outages.

Sewerage Systems

Sewer service is supplied by the City of San Diego Department of Utilities. Sewage released from the licensee's San Diego facilities is processed at the 100 million gallons per day Point Loma Sewage Treatment Plant.

Hold-up tanks are provided for sampling of effluent liquids before release to the sewerage system.

Water

Water is supplied by the City of San Diego Department of Utilities.

2.8.2 Fire and Police Protection

The Northern Division of the San Diego Police and Fire Department is located two miles southeast of the main site. Local authorities have been advised of operations involving SNM at the licensee's facilities. The San Diego Police Department and the San Diego Fire Department have agreed to provide assistance to GA in an emergency.

GA maintains a staff of Emergency Services TEchnicians who are specially trained to respond to emergency situations. They are on duty 24 hours a day for 7 days a week. Emergency Services manages and inspects all fire extinguishers, building fire protection systems, and emergency equipment on a routine basis. Emergency vehicles include a fire truck, a hazardous materials response truck, and an emergency response vehicle. Emergency Services participates in routine, periodic safety inspections.

2.8.3 Security

GA fully implements the security measures specified in its NRC-approved physical protection plan, "Fixed Site and Transportation Plan for the Protection of Special Nuclear Material of Moderate and Low Strategic Significance." The Security organization consists of senior and experienced management personnel with a force of over 20 security officers (watchmen). The principal purpose of the security organization is to protect GA facilities against industrial or radiological sabotage and the theft or diversion of special nuclear material therefrom. The Security Department maintains a security supervisor on GA's general site at all times. The security supervisor has overall shift responsibility for alarm station operations. The Security Control Station is manned by a member of the Security Department who directs alarm responses.

The watchmen are trained and qualified in consideration of the requirements of 10 CFR 73.67.

A minimum of two qualified individuals (e.g. alarm station operator and one watchman) are on duty at all times to assess and respond to an alarm caused by unauthorized penetrations or activities.

Visual checks of controlled access area environs are conducted at a frequency of four hours or less.

A Security Control Station (SCS) is located adjacent to the lobby in the Administration Building (Bldg. 1). It contains the alarm and communications systems. The SCS is continually manned by a member of Security and is operated as a controlled access area through the use of two locked doors. One door provides access from the adjacent security office and the other provides access from the lobby. Windows equipped with one-way reflective film provide surveillance capability of the lobby.

A base station radio system and backup system, providing two channels, are maintained in the SCS. Each guard station contains either a remote controlled desk unit or a two-way portable. Security vehicles are equipped with two-channel mobile radios, and walking patrols are equipped with two-channel handie-talkie portable units.

Base station radio communications equipment is connected to auxiliary power sources and will remain operable in the event of loss of primary power.

Intrusion detection and alarm systems are installed, tested and inspected in accordance with statements in GA's physical protection plan.

FIG. 1 2.1
MAP OF SUR

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-1
ROUNDING AREA

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Aperture Card

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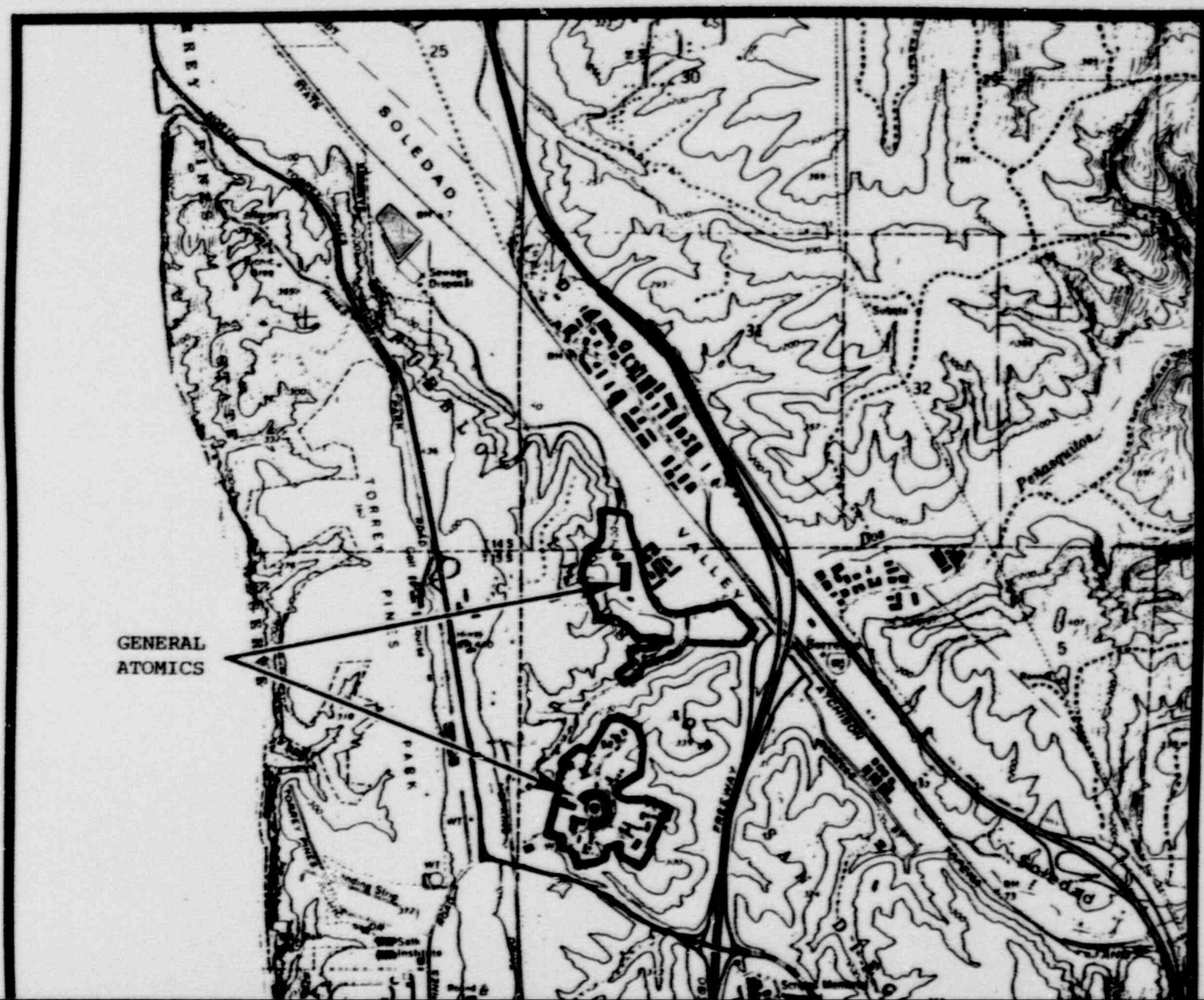
GENERAL
ATOMICS
SOLEDAD
VALLEY
TORREY
PINES
PARK
Sewage
Disposal
FREEWAY
Penasquitos
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SI
APERTURE
CARD

Also Available On
Aperture Card

FIG. 1 2.1-2
MAP OF SITE & SURROUNDING AREA

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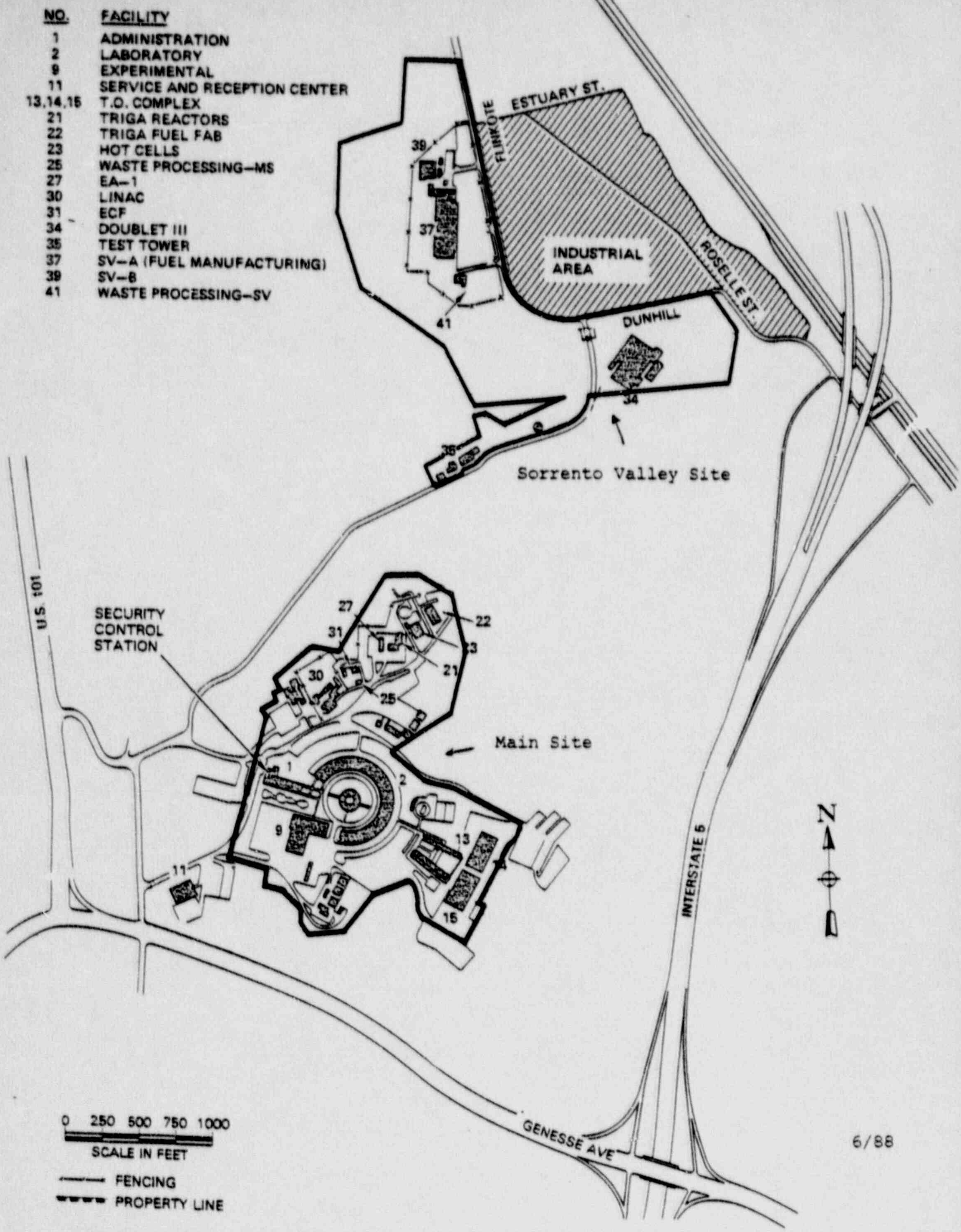

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Fig. I 2.1-3 Plan View of Sites

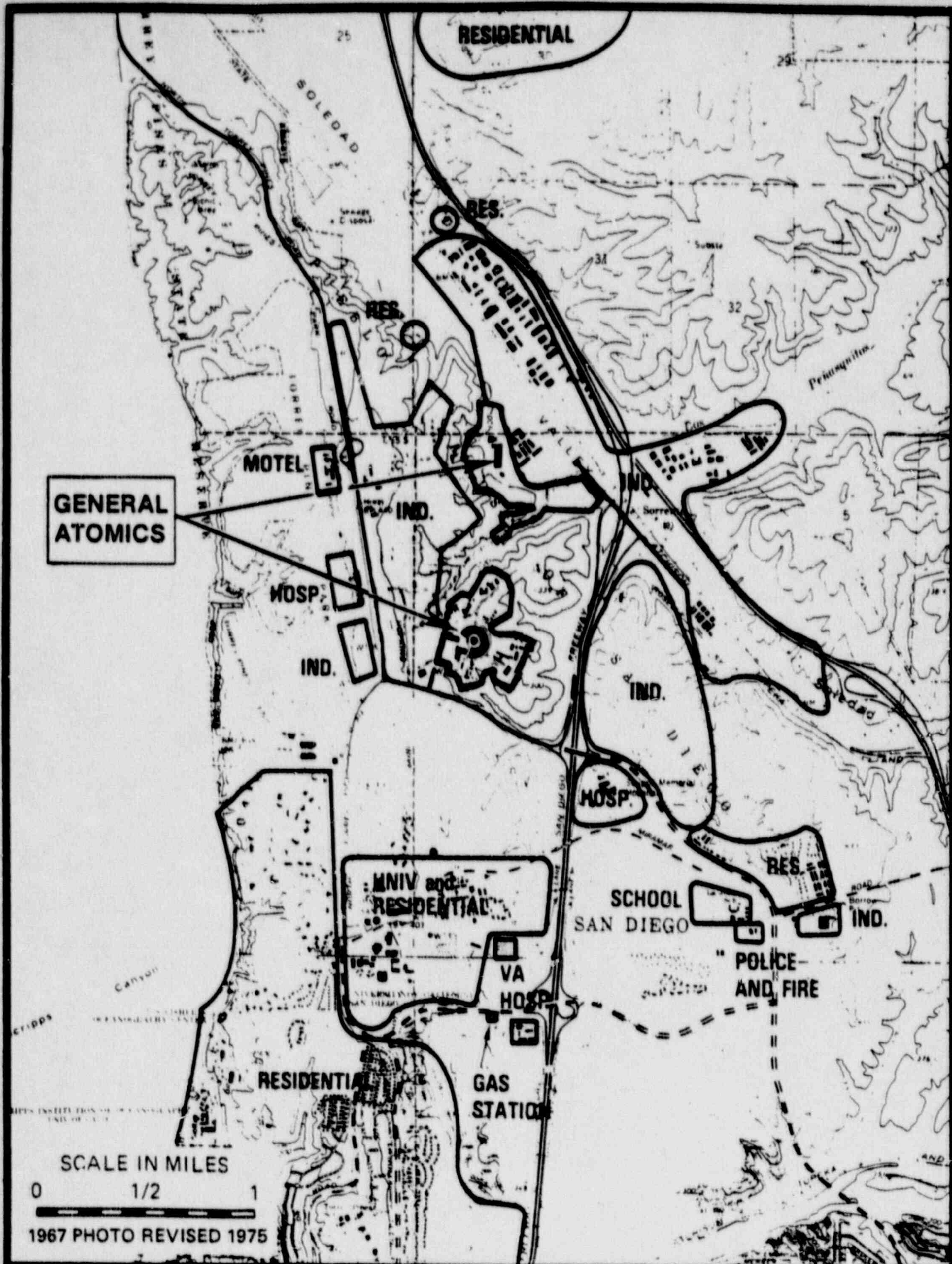

Fig. I 2.6-1 Map Showing Nearby Industrial Complexes

3. PRESENT OPERATIONS

The operations described in this section include the receiving, transfer, use, storage, shipping, fabrication, research and development, and other related activities that involve special nuclear material (SNM).

Nuclear and radiological safety aspects are discussed under the operation descriptions as applicable.

Materials safeguards for these operations are in compliance with the criteria established under Section 5, Part II, Specifications, of this renewal application.

The physical protection of SNM operations are in accordance with the criteria set forth in GA's NRC-approved plan entitled, "Fixed Site and Transportation Plan for the Protection of Special Nuclear Material of Moderate and Low Strategic Significance." The criteria are employed in the use, storage, and transit of SNM subject to this license.

3.1 FUEL PRODUCTION (HTGR)

Due to the recent decision to decontaminate and decommission GA's Fuel Fabrication Facility, this section is currently under revision.

3.2 RECEIVING SPECIAL NUCLEAR MATERIAL (TO BE REVISED)

Upon receipt of a package containing SNM, receiving personnel immediately notify Health Physics and NMA. Health Physics personnel survey the external surface of the package for radiation and contamination levels. NMA then takes charge of the package and transports it to an evaluation area where the SNM is unpackaged, evaluated and prepared for storage. Verification of all SNM receipts is the responsibility of NMA. If upon receipt at receiving any radioactive contamination or package damage exists special attention is warranted. Such package unloading and unpackaging is done under the guidance of Health Physics.

Shipping containers remain sealed until they are unloaded. The package contents are verified against data furnished by the supplier concerning the SNM content, chemical composition, and package gross, tare, and net weights, as appropriate. The procedures and methods applied to the opening for sampling and contents verification are described in detail in the licensee's Fundamental Nuclear Material Control Plan.

Temporary storage of incoming and outgoing SNM is permitted in suitable, locked areas, provided that the material is stored in primary shipping containers approved pursuant to 10 CFR Part 71, "Packaging of Radioactive Material for Transport," storage is in an array no more reactive than permitted in 10 CFR Part 71, taking into account other SNM in the storage area, and the requirements of the Physical Protection Plan are met.

The evaluation room is a work room provided with work benches and weighing equipment. A laboratory fume hood is available for material handling and is connected to the ventilation system which contains a high-efficiency particulate air filter.

3.2.1 Nuclear Safety

The nuclear safety of this operation is ensured by adherence to shipping container and storage criteria until the containers are opened one at a time; the contents are removed to the evaluation hood or to storage. Hood safety is based on the mass and/or geometry limits of the individual SNM package, since the conetents of only one package at a time are permitted within the evaluation hood. Storage nuclear safety is discussed in Section 3.3.

3.2.2 Radiological Safety

Radiological safety is based upon conducting operations in an approved enclosure after the materials are removed from their shipping containers. Shipping containers are checked for outside surface contamination prior to opening.

3.2.3 Criticality Alarms

The requirements of 10 CFR 70.24 for criticality alarms monitoring the temporary storage of SNM in sealed shipping containers loaded on their vehicles pursuant to 10 CFR Part 71 are exempted. The nuclear safety of the shipping containers during transportation has been demonstrated in the application for NRC approval. The conditions prevailing during temporary storage are entirely analogous to those prevailing during transport by common carrier when no criticality alarms are required.

3.3 STORAGE **(TO BE REVISED)**

SNM is stored in vault-type rooms and protected areas specifically designated for this use only. Most of the storage is under the direct control of trained and authorized NMA personnel, and access is restricted to authorized personnel. Storage areas are constructed and equipped to meet NRC regulations.

In addition to the storage locations discussed in 3.1.3.4 and 3.7.4, the other storage locations approved at the present time and listed in the order of discussion herein are:

ECF Storage Facility
By-Products Storage Building in the Waste Yard
Hot Cell Storage Yard
Irradiated TRIGA Element Storage at the Waste Yard
NMM Central Storage Yard

3.3.1 RESERVED

3.3.2 ECF Storage Facility

The ECF Storage Facility is located in two buildings that formerly housed an experimental reactor. The operating license for this reactor has been terminated. This facility is no longer utilized; it is retained here to preserve documentation of the special storage array that was used.

The facility is comprised of two buildings. The buildings, shown in Fig. I 3.3-1 and I 3.3-2, respectively, are a reactor building and an assembly building. The facility layout, including the protected area, is shown in Fig. I 3.3-3.

The reactor building consists of a 2 ft thick concrete shielded cell and an entry foyer. The shielded exposure cell is 27 ft wide x 42 ft long x 23 ft high. The foyer is 27 ft long x 12 ft wide. The roof is a series of 24 in. reinforced concrete beams. Access to the cell is through two 1/2 in. thick steel bulkhead doors, or through a large shield plug in one wall. One of the bulkhead doors is an emergency exit only with no access from the outside. Cell access via the other door or the shield plug must be gained through the foyer. Access to the foyer is via a large metal roll-up door or a metal clad personnel door. These accesses are locked. The building floor plan is shown in Fig. I 3.3-1.

The assembly building consists of a metal building 20 ft wide x 26.5 ft long x 8 ft high. The building has a concrete slab floor. The building floor plan is shown in Fig. I 3.3-2.

For purposes of SNM storage the facility is considered to be three separate storage areas; the assembly building, the reactor cell and the reactor building foyer. Each of these is nuclearly isolated from the other. The assembly building is isolated by distance and the intervening shield wall isolates the reactor cell and the foyer.

The reactor cell has been designed to house fast and intermediate neutron spectrum critical assemblies. For this reason it does not have a means of water supply. The location of the structure is near the edge of a small canyon and any runoff water drains freely away from the building.

3.3.2.1 Storage Criteria

Several types of authorized SNM storage are utilized as discussed below. Each ECF storage are may be used for only one type of storage at a time. Due to the nuclear isolation, a different type of storage may be used in different areas except that Type 3 storage, HTGR fuel materials in 55-gallon barrels is restricted to use in the two reactor building areas due to the necessity to restrict the use of water.

Type 1. FSV-3 Shipping Container

HTGR fuel elements loaded in FSV-3 shipping containers may be stored in plane arrays and stacked no more than three high.

Type 2. Barrels - General

Special nuclear material may be stored in 55-gallon or larger capacity metal barrels. Each barrel will be limited to 350 g U-235. Barrels may be placed in a side-by-side arrangement forming single plane arrays.

Type 3. Barrels - HTGR Fuel Materials

HTGR type fuel materials may be stored in 55-gallon or larger metal barrels double stacked in a plane array subject to the limitations given below.

a. Each barrel is limited to 350 g U-235 in HTGR process/product type materials.

b. All fuel materials shall also contain thorium at Th/U-235 ratio of 3.3552 or greater.

c. Only fuel materials such as particles, rods and certain process scrap may be stored. Specifically bulk waste, such as wipes and paper, may not be so stored.

d. The total array shall be limited to 23 by 14 by 2 units or smaller.

e. The container shall be steel barrels, 55 gallon or larger.

f. Each unit in the array shall be allocated a space equivalent to a cuboid 22.345 in. square by 32.695 in.

high or larger.

g. The storage area shall be within a building. The space utilized shall be free of a piped water supply and shall be posted that introduction of water is forbidden.

3.3.2.2 Nuclear Safety Analysis

The nuclear safety of the loaded FSV-3 shipping containers in storage (Type 1) is assured by limitation of the plane array to not more than three layers. A detailed analysis of this array, described in Ref. 3.3-1, assumed the FSV-3 containers to be loaded with 1.5 kg or fully enriched uranium and 11.3 kg of thorium per element/container. The containers were taken to be in closest packing array geometry. Both diffusion and transport calculations using broad group cross sections were made. The analyses indicate a k_{eff} of 0.731 for an infinite planar array of the containers stacked 3 high, and a k_{eff} of 0.877 for a flooded array that is infinite in all three directions.

The nuclear safety of the Type 2, barrels-general, storage array is based upon standard limit Type F, Section 5.5, Part I, and is justified nuclearly safe therein.

The nuclear safety of the Barrel - HTGR Fuel Materials (Type 3) has been determined by a series of calculations as outlined below. Because of the restriction to HTGR materials, credit can be taken for neutron absorption by Th-232. The nominal Th-232/U-235 ratio is taken as that of the lowest ratio particles that are produced, 3.3552. The bulk of the materials requiring storage are fuel rods, composed of a mixture of fissile and fertile particles, with Th/U ratios up to 20. In addition, the barrels contain carbon and possibly some water -- at least in the region where the uranium is localized (the "fuel" region). The densities of the materials in the fuel region have been tabulated in Table I 3.3-1 along with the densities of the metal container and the water reflector. Optimum moderation (H/U-235 = 100, 500) by hydrogen has been assumed.

TABLE I 3.3-1
MATERIAL COMPOSITION

	Isotope	Atom Density, Ratio or Mass
A.	Fuel Region	
	H^1	H/U-235 = 100, 500
	O^{16}	H/O = 2
	C^{12}	C/U-235 = 335
	Th-232	Th/U-235 = 3.3552
	U-234 (0.8%)	3 grams
	U-235 (93.2%)	350 grams
	U-238 (6.0%)	22.5 grams
B.	Metal Container	
	Fe^{56}	8.48×10^{-2} atoms/barn-cm
C.	Water Reflector	
	H^1	6.70×10^{-2} atoms/barn-cm
	O^{16}	3.35×10^{-2} atoms/barn-cm

The dimensions of a single barrel are given in Table I 3.3-2. Since the outside diameter of a barrel is at least 56.7563 cm and the lateral dimensions of the storage room are 27 ft x 42 ft, the maximum planar array is 22.56 x 14.50 barrels. Thus, consideration of a 23 x 14 x 2 array will yield results which are conservative when applied to two-layered arrays which can actually be stored in the building, when structural interferences which restrict the space utilization are considered. Further, conservatism is provided by the fact that the top reflector is 17 ft away rather than being close coupled as assumed in the model.

TABLE I 3.3-2

BARREL GEOMETRY

A. Inner Dimensions

Diameter	56.515 cm
Height	82.8675

B. Metal Thickness

Sides	0.12065 cm
Ends	0.088392 cm

Description of the Model

The 23 x 14 x 2 array has been modeled as a cubical array with the barrels in close contact in all three directions. Water reflection of the array was modeled by including a layer greater than 20 cm thick tightly surrounding all 6 sides. In addition, consideration was given to full density water between the barrels. Fig. I 3.3-4 shows a partial schematic of the array geometry.

The model for the individual barrels is shown in Fig. I 3.3-5. Three coaxial cylinders were defined which corresponded to the fuel, inner barrel and metal container regions. The height and diameter of the inner cylinder (the fuel) were allowed to vary, subject to the obvious constraint that they could not exceed the inner dimensions of the barrel. Credit was taken for the effect of gravity in that the fuel region was required to be in contact with the bottom of the barrel. The space between the fuel region and metal container was assumed to be a vacuum ("void").

Analysis

The effective neutron multiplications for the arrays that were studied were calculated with the KENO computer code (Ref.

3.3-2). Cross-sections used in the calculations were generated using the MICROX spectrum code (Ref. 3.3-3). Specifically, 18-group[1] modified P1 transport cross-sections were generated for cylindrical fuel regions whose material densities were defined by the criteria in Table I 3.3-1 and by fixed total volumes for the fuel region. These total volumes are listed in Table I 3.3-3. The maximum and intermediate volumes in this table are those for the whole barrel and for a cylinder with the same diameter but a height of 1 ft. The minimum volumes were determined such that the water in the fuel mixture was at maximum density (at the given H/U-235 ratio).

TABLE I 3.3-3

TOTAL VOLUMES OF FUEL REGIONS

H/U-235 Ratio	Minimum	Intermediate	Maximum
100	1.35 liters	76.5 liters	207.9 liters
500	6.71 liters	76.5 liters	207.9 liters

Using the appropriate MICROX cross-sections, the following k_{eff} calculations were made:

a. Arrays with full water moderation between the barrels; H/U-235 ratios of 100 and 500; all three fuel region volumes (the diameter of the fuel region in this case was equal to the inner diameter of the barrel).

b. Arrays with no water moderation between the barrels; H/U-235 = 500; all three fuel region volumes (diameter of fuel region equal to inner barrel diameter).

c. Arrays with no water moderation between the barrels;

[1]The energies of the 18 groups are given in Section 5, Table I 5.3.2.

H/U-235 = 500; fuel region volume of 6.71 liters; in this case the diameter of the fuel region was allowed to be less than the inner barrel diameter.

In addition to these, calculations were made for a homogenous water reflected slab whose dimensions were the same as the 23 x 14 x 2 array and for a single bare cylinder with height equal to diameter at maximum water density. Both of these were at H/U-235 = 500. The latter calculation was for comparison with the results of a 1-dimensional transport calculation performed with the DTFX code (Ref. 3.3-4 and 3.3-5).

Results

The results of calculations A, B and C described in the preceding section are given in Tables I 3.3-4, I 3.3-5 and I 3.3-6 respectively. In these tables, is the statistical standard deviation of the results and reflects generation to generation variation in the calculated keff. For comparison with these, the KENO calculcation of the water reflected slab yielded a keff of 0.44 ± 0.1. The results of the single barrel calculations are listed in Table I 3.3-7. The agreement between the DTFX and KENO values for the bare sphere are very good.

TABLE I 3.3-4
K_{EFF} FOR ARRAY WITH FULL WATER MODERATION BETWEEN BARRELS

H/U-235	Volume of Fuel Region (Liters)	k_{eff}	
100	1.35	0.24	0.011
	76.5	0.25	0.017
	207.9	0.25	0.007
500	6.71	0.34	0.005
	207.9	0.28	0.008

TABLE I 3.3-5
K_{EFF} FOR ARRAY WITH NO WATER MODERATION BETWEEN BARRELS

H/U-235	Volume of Fuel Region (Liters)	k_{eff}	
500	6.71	0.43	0.007
	76.5	0.41	0.008
	207.9	0.36	0.008

TABLE I 3.3-6
REDUCED DIAMETER ARRAYS

H/U-235	Diameter (cm)	Height (cm)	k_{eff}	
500	56.515	2.675	0.43	0.007
	37.676	6.002	0.58	0.011
	24.703	14.00	0.80	0.016
	20.443	20.443	0.85	0.011
	16.74	30.48	0.80	0.010
	10.15	82.8675	0.56	0.011

TABLE I 3.3-7
K_{EFF} FOR SINGLE BARRELS

A. KENO Calculations for Water Reflected, Full diameter Geometries

H/U-235	Volume of Fuel Region (Liters)	k_{eff}
100	1.35	0.16
	207.9	0.11

B. KENO and DTFX Calculations for Bare, Reduced Diameter Geometries

H/U-235	Volume of Fuel Region (Liters)	k_{eff} (DTFX)	k_{eff} (KENO)
50	6.71	0.69	0.72 ± 0.0126

(Height = Diameter = 20.443 cm)

Conclusions

Several conclusions can be drawn from the results of Tables I. 3.3-4 through I 3.3-6.

From the first table, it is apparent that H/U-235 = 500 is the more reactive of the two moderation ratios. Thus, this value has been used in the other calculations. From the results in Tables I 3.3-4 and I 3.3-5, it is clear that full water moderation between the barrels actually lowers the reactivity of the array. This might have been expected in light of the optimum moderation in the fuel regions and the large volumes between the barrels. It is not safe to assume, however, that water between the barrels at less than full densities is less reactive than when no water is present. Another conclusion that can be drawn from the tables is that the array is much less reactive when the fuel region is smeared over a large volume than when it is at its minimum volume. This effect is due to the greatly reduced leakages and U-235 densities, and suggests that the interaction between the barrels is not the dominating factor. A good example for comparison with these smeared cases is the low keff of the homogenous water reflected slab (0.44). The densities for the slab were the same as those for the V = 207.9 liter cylinder.

The criticality safety of the array is established by the results in Table I 3.3-6. This data is plotted in Fig. I 3.3-6 and shows the strong peaking at 0.85 for the case in which the fuel regions have equal heights and diameters. From Table I 3.3-7, the keff of the single bare fuel region itself is 0.7, so the array is not much more reactive than the single container. It should be pointed out that under the assumption of no moderation between the barrels, moving the barrels farther apart will give a lower k_{eff} for the array.

3.3.2.3 Radiological Safety

Criticality alarms are provided for all three storage areas at the facility. Radiological safety is assured by only handling closed containers.

3.3.3 By-Products Building in the Waste Yard

This storage facility is a metal butler-type building with a concrete floor. It is approximately 20 ft by 20 ft. Although it is primarily for by-products, various types of SNM (principally irradiated materials) are also stored in this area.

This storage facility is secured by a changeable combination padlock and is within the chain link security fence which surrounds the Waste Yard. Gates in the fence are secured by locks keyed to the Gulf security system. The criticality alarm system is a part of the alarm system serving the Waste Yard.

Four types of storage are provided for SNM and are described as follows:

Lazy Susans

This storage comprises six cylindrical tubes approximately 24 in. in diameter which are located along the north wall of the storage area. These tubes extend 8 ft above and below ground level. When not in use, these tubes are stored in the down position. Mounted on each tube are three circular shelves approximately 24 in. in diameter and vertically spaced 17 in. apart. Containers of material are placed on these shelves for storage.

Barrel Storage

High-radiation level barrels may be stored in four below-ground-level cylindrical concrete line holes. These holes are 30 in. in diameter, extending 11 ft 4 in. below the floor and separated from each other by approximately 10 in. edge-to-edge. Each hole has a removable plug of solid concrete 30 in. thick.

Storage Shelves

Along the west wall of the building are two shelves, each 20 ft in length. One shelf is 10 in. deep and 15 in. wide and the other is 37 in. deep and 10 in. wide. Both shelves are constructed of concrete with 10-in.-thick concrete lips across their fronts for personnel shielding.

Floor Storage

Occasionally, materials are stored on the floor. However, this arrangement is used only for materials, such as sources, that can be stored in shipping containers that provide adequate personnel shielding.

3.3.3.1 Materials Storage

Storage in the lazy susans and on the storage shelves is in accordance with the criteria that govern storage in the NMM Vault-Type Storage Room at the Central Storage Facility. Each barrel storage position is limited to 350 g of U-235, 220 g of plutonium, or 250 g of U-233. The U-235 limit is the same as a Type A in Section 5.5, Part I for individual units and Type F for arrays involving only U-235. The plutonium and U-233 limits are based on the minima in the curves of Figs. I 5.4-5 and I 5.4-8. Interaction calculations are required when containers of Pu and/or U-233 are stored on the floor.

3.3.3.2 Radiological Safety

Only closed containers of materials can be handled in this room. The only hazard is gamma radiation from radioactive materials.

3.3.4 Hot Cell Storage Yard

This is a specially secured, posted, alarmed, and fenced area located immediately adjacent to the Hot Cell Facility and under the control of the facility staff. The area is used for storing irradiated material and SNM contained within either approved shipping containers or within other types of shielding and/or containers that are used solely within the confines of the main site.

3.3.4.1 Materials Storage

A maximum of 5 kg of SNM may be stored in this area.

Storage geometries are no more reactive than those approved for the shipping containers and/or arrays.

3.3.4.2 Radiological Safety

The materials stored are highly radioactive. Adequate shielding is used to reduce the radiation level at the inner fence to less than 100mRems/hr, and the fence is posted as a "High Radiation Area." An alarm on the gate leading into this area turns on a flashing warning light in the area and warns areas manned on a 24-hour basis (the Hot Cell Facility Office and the central security office). The Hot Cell Yard is a controlled area with physical barriers with radiation area posting. The level at this barrier is less than 2 mRems/hr, 100 mRems/7 days, and 500 mRems/yr.

3.3.5 Irradiated TRIGA Element Storage at the Waste Yard

This storage facility may contain irradiated uranium-zirconium fuel elements in two kinds of storage. The area is roughly rectangular, about 80 ft by 100 ft, and its nearest point is about 1000 ft east of the TRIGA Reactors Building. It is enclosed by an 8-ft-high chain link fence with a locked gate. The area is adjacent to the Waste Yard and is provided with a criticality alarm that is a part of the Waste Yard system.

3.3.5.1 Materials Storage

In the area, up to a maximum of 650 g of U-235 in the form of uranium-zirconium fuel elements may be stored in each of the containers employed; these are standard 55-gallon metal drums with axially centered 8-in. iron pipes (which may be lined with lead for radiation control) with the annuli filled with magnetite ore. Drum lids are a conventional type with gaskets and clamping bands. Under the lids and resting upon the pipe tops are lead shields approximately 16 in.2 and 2 in. thick. Drums are stored in a single plane array, isolated from all other stored U-235.

A detailed criticality analysis was performed on the drum storage using the GGC-5 spectrum code and the 1DFX discrete ordinates transport code described in Section 5, Part I, Nuclear Safety. Nine energy group cross sections were used; these cross sections were averaged over a 500/1 H/U-235 water-uranium spectrum. The model described in Table I 3.3-8 was utilized.

TABLE I 3.3-8

TRIGA DRUM STORAGE MODEL CYLINDRICAL GEOMETRY

Radius (cm)	0.0	10.16	10.98	28.57	28.73

Region	1	2	3	4
Material	Fuel, H_2O	Iron	Magnetite, H_2O	Iron
Number density (atoms/barn-cm)				
H	6.83x10-2	-	-	
O	1.35x10-2	-	2.42×10^{-2}	
Fe		8.41×10^{-2}	1.82×10^{-2}	8.41×10^{-2}
U-235	7.26×10^{-4}	-	-	-
U-238	5.05x10-5			

Height (cm): H = 38.50, H = 43.56 (height plus reflector savings)

Boundary conditions:

Left: o/ = 0 (symmetry)

Right: = 0 (to model infinite plane array of drums)

keff = 0.83

This model represents 17 fresh TRIGA fuel elements containing a total of 650 g of U-235. The central pipe is fully flooded and homogenized, which results in an H/U-235 ratio of 430, very close to optimum. Fully enriched uranium was assumed, although the standard TRIGA element contains 20% enriched fuel, and the TRIGA-FLIP fuel is 70% enriched with a heavy load of erbium poison. The magnetite ore shielding material was assumed to be dry which results in maximum interaction with the surrounding drums.

This conservative model was found to be significantly subcritical with a k_{eff} of 0.83. Further calculations were performed to study the effect of enrichment changes and changes in the magnetite water content, the effect of stacking the drums vertically, and the effect of packing all the drums with the maximum number of rods they will hold (21 rods, 830 g U-235).

The results of these calculations are shown in Table I 3.3-9.

TABLE I 3.3-9

TRIGA DRUM STORAGE k_{eff} VALUES

Case	U-235 (g/drum)	Enrichment %	Description	k_{eff}
1	650	93.5	Infinite plane array, dry magnetite	0.83
2	650	20.0	Infinite plane array, dry magnetite	0.78
3	650	93.5	Single drum, dry magnetite	0.78
4	650	93.5	Infinite array, wet magnetite	0.80
5	650	93.5	Infinite array, dry magnetite stacked 2 high	0.89

6	650	93.5	Infinite array, dry magnetite stacked infinitely high	0.91
7	830	93.5	Infinite array, dry magnetite drum packed full	0.95

Optimum moderation in central pipe used for all cases.

The conclusions drawn from this study show that the drum storage facility exhibits no criticality hazard. The maximum possible multiplication under normal operations, using a conservative model, is subcritical with a k_{eff} of 0.83. Even if the drums were accidentally stacked vertically or if they were accidentally loaded to maximum capacity, no criticality hazard would exist.

3.3.5.2 Radiological Safety

Radiological safety of this storage yard is based upon the double containment of the irradiated fuel (intact fuel element jackets and capped pipe sections), the shielded containers or storage positions, and the 8-ft fence and locked gate. The radiation at the point of closest approach is less than 100 mRems/hr, and the fence is posted as a "High Radiation Area."

3.3.6 NMM Central Storage Yard

The NMM Central Storage Yard is an area, about 70 ft. square, enclosed by an 8-ft-high chain link fence with a locked gate. It is located to the north of the building housing the TRIGA Fabrication Facility and the NMM Central Storage Facility. A criticality alarm system is provided per Part II, Section 4.2.1.4, Criticality Alarm System.

SNM may be stored in a plane array of 55-gallon barrels or larger capacity containers. Each container will be limited to a maximum of 350 g of U-235. The individual containers are nuclearly safe on the basis that they are the same as standard limit Type A and the array of containers is safe on the basis of standard limit Type F, Section 5.5.

REFERENCES

3.3-1 "Nuclear Safety Summary of Fuel Rod Production," Amendment to SNM-696, AEC Docket No. 70-734, October 9, 1970.

3.3-2 G. E., Whitesides, N. F., Cross, "KENO - A multigroup Monte Carlo Criticality Program," Union Carbide Corporation - Nuclear Division, Report Number CTC-5, September 10, 1969.

3.3-3 P., Walti, P., Koch, "MICROX - A Two-Region Flux Spectrum Code for the Efficient Calculation of Group Cross-Sections," Gulf-GA-A10827, Gulf General Atomic, 1972.

3.3-4 K. D. Lathrop, "DTF-IV, a FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering," Los Alamos Scientific Laboratory, Report Number LA-3373, July 5, 1965.

3.3-5 D. Mathews, "DTFX Code Input Instructions," November 2, 1973.

3.3-6 H. C. Paxton, et al., "Critical Dimensions of Systems Containing U-235, Pu-239, and U-233," USAEC Report TID-7028. Los Alamos Scientific Laboratory and Oak Ridge National Laboratory, June 1964.

3.4 LABORATORY OPERATIONS

The laboratory operations include a wide spectrum of small-scale physical, metallurgical, chemical, and engineering investigations utilizing SNM, experiments by skilled scientific personnel within defined locations, usually a laboratory room. Work in this class is typically conducted in the Laboratory Building, the Chemistry Laboratories, the Hot Cell and various other GA laboratories.

These operations have typically included but are not limited to the following efforts using SNM:

1. Detailed metallurgical tests of unirradiated samples containing SNM.

2. Metallurgical examination and chemical analysis of up to 1 Ci of irradiated material containing SNM.

3. Investigation of U-235 hexafluoride -- uranium oxide conversion using less than 500 g of U-235 in enriched uranium on a laboratory scale.

4. Laboratory scale process development for making compacts, particles, and fuel rods containing U-235 and U-233.

5. Development of process control and quality control techniques.

6. Laboratory fabrication and assembly of special reactor test fuel elements.

7. Radiochemical research.

8. Routine chemical analysis.

The safety of these operations is assured by adherence to formal review and approval procedures (see Part II). Every new or changed operation involving SNM must be defined, undergo review and approval, and have a Material Balance Area (MBA) established. These procedures ensure that the operations have been properly planned; that adequate equipment in the form of hoods, fire protection, waste collection, etc., is provided; that personnel have adequate training and experience; and that planned operations are in full compliance with all applicable licenses.

Special nuclear materials in these operations are generally controlled by mass limits. The MBA log book for the operation provides the means of enforcing and auditing adherence to these limits. The possession limit under each MBA is the mass limit authorized; in addition, a throughput limit is often established, depending on the nature of the operations. When a throughput limit is reached, a special review and inspection is made and, generally, the laboratory and its associated waste lines and duct work must be surveyed to ensure that there is no significant holdup within the space; the MBA book is then zeroed out for throughput, and operations may be resumed. Periodic audit ensures that the MBA books are properly maintained, that limits are not exceeded, and that operations are safely conducted.

In terms of SNM criticality safety, laboratory operations are divided into four classes, all based on mass limits. Progressive degrees of control become applicable as the allowable mass in a given laboratory increases. In terms of U-235, the basic level of control is 350 g or less. Operations below this level are quite safe, and a minimum number of controls are necessary. The next level is 500 g or less, which requires controls to prevent exceeding the mass limit. A level of over

500 g but less than 740 g adds the requirement for nuclear isolation (no SNM in adjacent laboratories, or other means of isolation). The first two classes of laboratory operations based on mass limits are listed under the exemption from criticality monitors.

The last class of laboratory operation is one in which highly limited laboratory-scale processes may be carried out at several defined stations. Each station is limited to 350 g of U-235, must have acceptable integrity, and must retain the SNM under accident conditions. In this case, the MBA covers the entire laboratory and may possess over 740 g; however, a log must be maintained on each station to permit auditing and to ensure that the individual 350-g limit is not exceeded. The documentation required to obtain authorization to perform the work must contain physical descriptions of each station, including processes to be performed and means of containment. Also, an acceptable analysis of the nuclear interaction of the various stations must be included. The operating organization must also assign an individual who assures nuclear safety, conducts routine inspections, and advises his management of the nuclear safety control status. The throughput limits in this case apply to the laboratory as a whole, and SNM measurements with statistical control are required.

The criteria for radiological safety with any radioactive material are contained in the Radiological Safety Guide. These criteria must be met in obtaining a Work Authorization. Section 4 of the Specification Volume incorporates the criteria.

3.4.1 Nuclear Safety

Laboratory Operation Class One

The mass limits of class one are 350 g U-235, 250 g of

U-233, 220 g of Pu-239 (encapsulated), or 220 g of combined SNM within a space defined by walls. These limits are based on Fig. I 5.4-1 and Table II 5.4-1, Part II which demonstrate nuclear safety under all conditions of moderation, reflection, and double batching. The physical limits provided by the walls of the space provide adequate isolation.

<u>Laboratory Operation Class Two</u>

The mass limits of class two are 500 g of U-235, 300 g of U-233, 250 g of Pu-239 (encapsulated), or 250 g of combined SNM within a space defined by walls. The laboratory is prevented from exceeding its limits by the controlling of SNM issuance to the MBA. The laboratory must be a controlled access area as defined in 10 CFR 73. These limits are justified by the following analysis of the interaction with similar material in adjacent laboratories.

Interaction between laboratories involving the general limit of 500 g U-235, 300 g U-233, 250 g Pu-239, or 250 g combined SNM is controlled by spacing: no more than two stations may be considered as not isolated by 12 ft or 9 ft including two 5.5-in. concrete block walls. When considering the two stations that can be separated by less than the above distance, such as adjacent laboratories separated by only the intervening wall, the calculations below demonstrate the safety of the two stations.

A detailed criticality analysis was performed to determine the effect of interaction between two laboratory batches of SNM through a laboratory wall. The laboratory batches each consisted of 500 g of 93.5% enriched U-235, 300 g of pure U-233, or 250 g of pure Pu-239. The situation studied was the simultaneous placement of two optimally moderated, fully reflected batches of SNM directly against opposite sides of a 4-in. gypsum board laboratory wall.

The GGC-5 zero-dimension spectrum code, described in Section 5, Part I, was used to average nine energy group cross sections over spectra corresponding to the most reactive degree of water moderation. This most reactive degree of moderation corresponds to the critical mass curve minimum. From Figs. 8, 27, and 34 of TID-7028,[2] the critical mass minima correspond to water moderation characterized by the hydrogen-to-SNM atom density ratios in Table I 3.4-1.

TABLE I 3.4-1
OPTIMUM MODERATION

SNM	U-235	U-233	U-239
H/U or H/Pu	500	430	885
Batch size (g)	500	300	250

The 1DFX discrete ordinates one-dimension transport theory code, also described in Section 5, Part I, was used to determine the multiplication of the system. The model used was developed as described below. The most reactive single unit is a sphere. The size and one-group diffusion theory geometric buckling for laboratory batches of optimally moderated SNM in the shape of a sphere were calculated. By maintaining constant geometric buckling, the size of equally reactive or nuclearly equivalent cubes of the same materials was calculated (see Table I 3.4-2).

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[2]Paxton, H. C., et al., "Critical Dimensions of Systems Containing U-35, Pu-239, and U-233," USAEC Report TID-7028, Los Alamos Scientific Laboratory and Oak Ridge National Laboratory, June 1964.

TABLE I 3.4-2
SPHERE-CUBE EQUIVALENTS

SNM	U-235	U-233	Pu-239
H/U or H/Pu	500	430	885
Batch size (g)	500	300	250
Sphere radius (cm)	13.19	10.61	12.58
Equivalent cube edge size (cm)	22.85	18.37	21.78
Equivalent cube fuel mass (g)	620	373	310

To verify the accuracy of this simple conversion the multiplications for the two U-235 systems described above were calculated using 1DFX. Nine energy groups were used with S4 quadrature and P1 scattering. The multiplication for 500 g of U-235 in a fully water reflected sphere at an H/U ratio of 500 was found to differ from that of the nuclearly equivalent, fully reflected 620 g cube by less than 0.4%. Thus, the two systems are indeed nuclearly equivalent.

These nuclearly equivalent systems were then used to determine interaction effects. A 1DFX model, shown in Fig. I 3.4-1, was used. Full water reflection on all sides not up against the wall was assumed. Optimal moderation was used: H/U-235 = 500, H/U-233 = 430, and H/Pu-239 = 885. The transverse dimensions were increased by twice the reflector savings for an infinite water reflector to account for reflection on all sides of the units.

Although the most reactive shape for a single unit, in rectangular geometry, is cubic, this is not necessarily true for two interacting units. If the shape is made more flat against the wall, neutron leakage is increased, reducing k_{eff}, but interaction between the two units is increased, which acts to raise k_{eff}. To determine the most reactive shape, a series of 1DFX calculations was run with different shapes for a 620-g batch of U-235 against each side of the laboratory wall. The results of these calculations, shown in Fig. I 3.4-2, reveal that the most reactive shape corresponds to an aspect ratio of 0.86; that is, the unit thickness is 0.86 times the two dimensions up against the wall.

The models used for the final calculations are shown in some detail in Table I 3.4-3. Using these models, 1DFX was used to calculate the system multiplication for two laboratory batches on opposite sides of a 4-in.-thick laboratory wall. The multiplications for these most reactive situations are all safely subcritical (see Table I 3.4-4).

Laboratory Operation Class Three

The mass limits of class three are 740 g of U-235, 530 g of U-233, 460 g of Pu-239 (encapsulated), or 460 g of combined SNM within a nuclearly isolated space. The physical nature of the SNM must be such that it is readily identifiable and well contained. This, together with control of SNM issuance to the MBA, makes exceeding mass limits incredible. These mass limits are justified on the basis that they are 90% of the minimum critical mass assuming optimum moderation and reflection as shown in Part II, Section 5.4. Full nuclear isolation from other SNM must be provided.

TABLE I 3.4-3
LABORATORY BATCH INTERACTION
1DFX MODEL
U-235 - SLAB GEOMETRY

Distance (cm)	0.0	5.08	27.93[a]	37.93[b]

Region	1	2	3
Material	Wallboard and air	Fuel and Water	Water
Number density (atoms/barn-cm)			
H	8.04×10^{-3}	6.665×10^{-2}[c]	6.70×10^{-2}
O	1.207×10^{-2}	3.333×10^{-2}[c]	3.335×10^{-2}
Ca	2.011×10^{-3}	---	---
S	2.011×10^{-3}	---	---
U-235	---	1.333×10^{-4}[c]	---
U-238	---	9.264x10	

Boundary condition	$\phi = 0$ (symmetry	$\phi = 0$ (vacuum)
Transverse dimensions - cm -including reflector savings	28.31[d]	

Other SNM:		U-233	Pu-239
Distance (cm)	(a)	21.70	24.78
	(b)	31.7	34.8
Fuel region density (c)	H	6.682×10^{-2}	6.69×10^{-2}
	O	3.341×10^{-2}	3.346×10^{-2}
	U-233 or Pu-239	1.551×10^{-4}	7.560×10^{-5}
Transverse distance (cm) (d)		24.78	28.37

TABLE I 3.4-4
k_{eff} VALUES
Most Reactive Configuration

SNM	U-235	U-233	Pu-239
Batch size (g)	500	300	250
k_{eff}	0.920	0.874	0.867

Isolation by separation is provided by not permitting SNM to enter laboratories adjacent to a class three laboratory that share a common wall unless that wall meets the 12 in.-of-concrete criteria.

Laboratory Operation Class Four

The mass limits of class four are 350 g of U-235 per defined and documented station and 5 kg in MBA possession. U-233 and plutonium are not permissible under this rule. The safety of the individual station is justified under standard limit Type A, Section 5.5, Part I, which demonstrates the safety of the individual 350-g stations under the combined conditions of optimum moderation, reflection, and double batching.

Calculations of the interaction between the various 350-g stations must be made and documented and undergo review and approval as specified in Part II. The keff for each 350-g station shall be taken as 0.62 and the maximum allowable solid angle shall be 2.80 steradians.

3.4.2 Radiological Safety

Radiological safety of laboratory operations is based upon the utilization of control procedures and equipment meeting the specification in Section 4.1, Part II. No operation may be undertaken until the radiological hazards have been defined, the proper provisions for control have been made, and the proposed operations have been reviewed and approved.

3.4.3 Criticality Alarms

Criticality warning alarms will be maintained in those material balance areas as required by 10 CFR 70.24.

3.5 HOT CELL FACILITY

The Hot Cell Facility is located within a controlled area. Complete personnel access control is maintained during working hours. During off-shift hours, the facility is locked and checked at least every 4 hours by the security patrol.

The Hot Cell Building has approximately 7000 ft^2 of floor space consisting of office space, three Hot Cells, an operating gallery, and hot and cold auxiliary areas. Figures I 3.5-1 and I 3.5-2 show the plan view of the facility and details of the cells and shielding.

The high-level cell, which is the largest of the cells and which has the most shielding, is 8 ft wide, 18 ft long, and 15 ft high. The cell walls range from 42-in.-thick high-density concrete on the front and end to 60-in.-thick conventional concrete on the rear. A two-section steel door separates this cell from the adjacent low-level cell; the lower section is 21 in. thick and 11 ft high, and the upper section is 12 in. thick and 3-1/2 ft high. There are three operating stations, two on the front wall and one on the end wall, each with a viewing window and two master-slave manipulators. The low-level cell is 10 ft long, 8-1/2 ft wide, and 15 ft high. The walls of this cell are formed by the high-level cell door, a 17-in.-thick solid steel door to the service area, a 36-in. front wall, and a 32-in. back wall of high-density concrete. The front wall has a viewing window with manipulators and various shielded access holes. There are also shielded transfer tubes connecting the low-level cell to the other two cells.

The metallography cell measures 9 ft long, 5 ft wide, and 11-1/2 ft high. The walls are made of high density concrete and range in thickness from 34 to 36 inches. Personnel access to the cell is through a 15-in.-thick solid steel sliding door to the service area. The front wall of the cell has one operating station equipped with a viewing window, manipulators, and access holes. On the corner of the cell is an operating station equipped with a stereo-microscope and remote operated specimen stage for viewing small specimens. The side wall of the cell contains a metallograph mounted in such a manner that the stage can be retracted into the cell when the instrument is in use. When not in use the instrument is retracted into the cell wall, and a lead-filled shielding door located inside the cell is closed to protect the optical and electronic components.

The operating areas of each cell are those areas in which active work is performed on irradiated material and on samples removed from that material. These areas are neutronically isolated from the locations used solely for storage of SNM-bearing materials as described below.

There are special storage wells in the cells, one in the low-level cell floor and three in the high-level cell floor. The wells are 12.25 in. inside diameter and 6 ft 1 in. deep with 18-5/8-in.-thick gasketed plugs. The wells are located 2 ft from the back wall of the cell and are located on 5 ft 6 in. centers. These wells may be used to store radioactive and special nuclear materials.

In addition to the small storage wells above there are two storage wells for HTGR fuel elements, one well in each cell. The well in the low-level cell is 16 ft. 4 in. deep and 2 ft 8 in. in diameter with a 2 ft 2 in. thick high density concrete plug. The center of this well is 3 ft from the back wall of the low-level cell and 33-1/4 in. from the center of the small dry well. The 10.55 in. of conventional concrete between these two wells does not provide nuclear isolation. This well will accept a FSV shipping cask. The well in the high-level cell is 11 ft 8 in. deep and 23-1/4 in. in diameter with a 20 in. thick conventional concrete plug. This well is centered between two of the small storage wells. There is 14.7 in. of conventional concrete between the fuel element well and each of the small storage wells providing nuclear isolation for these wells. This well provides storage for up to three irradiated HTGR fuel elements.

The Service Gallery, Fig. I 3.5-1, contains an array of eight storage wells for irradiated materials. The wells are recessed 6 in. below the service gallery floor. The wells are 14 ft 8 in. deep by 13.38 in. diameter. An eight inch thick lead shot filled plug caps each well. The wells are separated by a minimum of 13.52 in. of high density concrete. These wells are used to store Hot Cell specimens for future study. The radiation at the surface will be less than 100 mr per hour.

Auxiliary hot areas within the facility include the hot change room, the hot machine shop, the equipment decontamination room, storage areas for supplies, equipment, and casks, the service gallery and loading dock, and the service corridor.

The operating gallery is a normally clean area encompassing the operating faces of the cells. Work performed in this area includes remote hot cell operations, photography, and other normally clean operations.

More detailed descriptions of the facility and its operation are contained in "Safety Study for the General Atomic Hot Cell Facility."[3]

3.5.1 Process Description

The operations performed in the Hot Cell Facility can best be described as examination of by-product and fissionable materials. The largest and most highly shielded cell, the high-level cell, is used for such operations as visual examinations, photography, puncturing of specimens for gas analysis, decanning or decladding capsules or fuel elements, cutting of small samples for metallographic examinations, dissolution of small specimens, and general preparation of samples for further testing in the low-level or metallographic cell.

The low-level cell is used primarily as an interlock cell or buffer area for introducing radioactive materials into the adjacent cells and for the remote transfer of equipment into the high-level cell. Operations such as density measurements, hardness, and tensile tests on radioactively low-level specimens are performed in this area, although any of the operations performed in the high-level cell may be performed in this cell providing the shielding is adequate for the activities involved.

In the metallography cell, specimens which have been cut and transferred from the high-level cell are mounted, prepared for examination, and remotely examined and photographed.

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[3]"Safety Study for the General Atomic Hot Cell Facility," USAEC Report GA-1953, General Dynamics, Gulf General Atomic Division, January 24, 1961.

3.5.2 Nuclear Safety

There are three modes of operation for the low-level cell and the high-level cell. The cell's operating limits are defined by the operation. These modes are as follows:

1. Miscellaneous SNM operations.

2. FSV fuel element destructive operations.

3. FSV fuel element transfer and inspection.

The operating limits for these three operations are shown in Table I 3.5-1. The operations are mutually exclusive requiring each operation to be completed and all SNM placed in storage before another type of operation begins. The normal input to the miscellaneous operations consists of material which has been irradiated in reactors and is well identified. With this identification of materials, double batching is not credible. The nuclear safety limits are 90% of the optimum geometry minimum masses given in Part II, Section 5.4, item 2c, under conditions of optimum moderation and reflection.

The nuclear safety limits for operations with FSV fuel elements is based on the detailed analysis of fuel elements in proposed storage arrays (Ref. 3.5-1). The results of the analyses are summarized in Table I 3.5-2. The calculations show the storage of fuel elements in isolated columns, rows, and a plane array of the specified separation to be nuclearly safe. Destructive operations on FSV fuel elements require assigned locations for the fuel elements and removed rods with an approved interaction calculation.

For the metallography cell (including the metallograph)

Table I 3.5-1 shows the nuclear safety limits. These limits are based on Fig. I 5.4-1, and similar data from TID-7028 (Ref. 3.5-2) with the 2.3 safety factor applied, which demonstrate the safety of the stated limits under conditions of optimum moderation, reflection, and double batching combined. The more conservative assumption of double batching is made in these locations, because the materials generally consist of samples removed from larger fuel assemblies and both the identity and SNM content can be subject to uncertainty.

TABLE I 3.5-1

HOT CELL SNM INVENTORY LIMITS

Location	Miscellaneous[1] U^{233}	U^{235}	Pu^{239}	In FSV Fuel Elements[2] gm U^{235} in Elements (or equiv.)
Total facility	530	740	460	8400 in 6
Met Cell	250	350	220	-
Low Level Cell[3]	530	740	460	2800 in 2
High Level Cell[3]	530	740	460	2800 in 2
Any small dry well*[4]	250	350	220	-
Any large dry well*[5]	-	-	-	3300 in 3
Low & High Level Cell[6]	-	-	-	8400 in 6

[1]Includes all SNM not otherwise described. It may be in any physical form.

Except for a maximum of 5 g, all Pu is in a "bred-but-unseparated" form. Where more than one fissile isotope is present, inventory limit shall be determined by the equation.

$$\frac{m\ (U^{235})}{740} + \frac{m\ (U^{233})}{530} + \frac{m\ (Pu^{239})}{460} \leq 1 ,$$

where m is the isotopic mass in grams based on the original unirradiated content of the materials.

[2]Includes all SNM in the form of FSV fuel elements with 1.4 kg U-235 and 11.3 kg Th-232 per element (pre-irradiation values). "In the form of" means either in intact fuel elements or fuel rods in an equivalent (less reactive) geometry.

[3]Location shall contain either miscellaneous or FSV Fuel Element SNM, but not both. Fuel elements shall be in fixtures maintaining a minimum surface to surface distance of 12 in. The products of fuel element destructive operations shall be in an assigned location.

[4]A small dry well is one less than 14" in diameter. All material will be stored in closed five-gallon containers. Small dry wells are located in: service gallery, low level cell, high level cell.

*The locations of all dry wells are shown in Fig. 3.5-2.

TABLE I 3.5-1 (continued)
HOT CELL SNM ININVENTORY LIMIT

[5]A large diameter dry well is one with a diameter of more than 14". There are such dry wells in both the low and high level cells. FSV elements will be stored in closed containers.

[6]This condition applies only during transfer of fuel elements. During the time when more than two fuel elements are in the cells, all elements but one will be stored in a fixture which insures a minimum center to center distance of 20 in. between the elements. The remaining element will be in transit.

TABLE I 3.5-2
NUCLEAR SAFETY ANALYSIS OF FSV FUEL ELEMENTS

Description			k^{eff}
		One fuel Element*	0.67
1.1 kg U-235	1 ft water	Two fuel Elements, side by side	0.86
9.4 kg Th-232	Reflector	Infinite row of side by side elements	0.95
		Two fuel Elements stacked end to end	0.71
		Infinite Column of fuel elements end to end	0.74
1.4 kg U-235	Bare	One fuel Element	0.38
11.3 kg Th-232	25% of Normal Density water between blocks	Infinite Array with 20 in. center-to-center spacing, maximum reactivity	0.88

The models assume a volume of water equal to the volume of the coolant holes homogenized with the element.

*Values from Ref. 3.5-1.

When in-cell storage is open for addition or removal of samples the cell limit will not be exceeded and operations will be restricted to the one involving the storage access.

When in-cell storage for fuel elements is open for transfer or exchange of fuel elements, or equivalents, all miscellaneous SNM produced by destructive operations will be in the small storage wells.

The use of the initial loading SNM inventory is conservative because reactor fuel materials tend to lose reactivity with exposure.

The mass limits on the small dry wells shown in Table 3.5-1 provide nuclear safety. The limits are based on limiting each well to a factor of 2.3 below the minimum critical mass as given in the specifications Section 5.4, item 2c.

Inventory logs are maintained for each controlled accumulation of SNM. These records show sample identity and SNM content as well as the total SNM in each controlled area. A member of the Hot Cell technical staff is assigned responsibility for facility internal inspection and day-to-day enforcement of SNM control and logging procedures.

The concrete thickness between the storage wells in the low level cell, while substantial, is not adequate to provide nuclear isolation. An interaction calculation was made in which the small well was modeled as a maximum stack of 5 gallon containers and the cask well was modeled as three FSV fuel elements at the uppermost part of the cell. This maximizes the interactions between the two units. The small well sees 1.1151 and the large well sees 0.5974 steradians. Both are acceptable values.

3.5.3 Radiological Safety

The continued safety of the operation is assured by adherence to approved procedures for handling radioactive materials and for maintaining the facility and through the formal qualification of all workers.

The high-level cell is designed to contain and shield 1 x 10^6 Ci of 1 MeV gamma radiation. The low-level and the metallography cells are each designed to 1 x 10^5 and 1 x 10^4 Ci respectively. These levels are the maximum operating limits of the various cells.

Access control within the building is assisted by the building design. The building is arranged so that the machine shop, decontamination room, service corridor, and service gallery can be operated as a contamination control zone permitting maintenance, etc., without complete decontamination. The back door to the building is closed to traffic, and access to this zone, except for transfer of casks and hot waste, is through the change room. Hot and cold change facilities are provided in the change room. The operating gallery is normally clean, and access to this area is from the lobby and service corridor. The gallery can be converted into a contamination zone by securing the door to the lobby and opening the door to the service corridor.

The roof area above the building directly over the cells is chained off and marked as a high-radiation area. Signs and markings are used extensively throughout the building to identify hazardous areas.

The ventilation system is designed so that the air flow pattern is always from a clean area to a contaminated area and from ceiling to floor and is equipped with dampers and an interlock system to assure proper flow direction. Exhaust air from radioactively dirty areas passes through pre-filters and high-efficiency air filters before being exhausted to the atmosphere. An "elephant trunk" system services the operating gallery, decontamination room, machine shop, X-ray room, and service corridor. This system is equipped with a cyclone separator to separate chips, dirt, and dust particles from the air before it is admitted to the main exhaust filtering system. Stack gas samples are continuously passed through monitoring equipment which has an audio and visual alarm in the facility. Table I 3.5-3 summarizes the containment and ventilation for the Hot Cell process areas.

The facility is equipped with several area radiation monitoring systems, a continuous air monitor, air flow sensing elements on the ventilation system, and hot-drain tank liquid-level sensors which are connected to audio-visual indicating panels in the operating gallery and office area to alert personnel of unsafe or changing conditions. These systems also alert the plant security force during nonworking hours.

The filter cassette, cyclone separator, fume scrubber, ventilation fans, and exhaust stack are located in a controlled access area at the north end of the building. The liquid waste tank trailers are located in another controlled access area to the north of the building. Entry into both of these areas is monitored on the audio-visual panels mentioned above.

Portable survey instruments are used throughout the area, and personnel are sometimes equipped with personal radiation detectors which give an audible indication in the presence of gamma radiation. Personnel are also required to wear film/TLD badges and pocket dosimeters when working at the facility. Hand and foot monitors are located at entries to the facility contamination control zones.

The monitors are equipped with audio and visual indicators and have an alarm set point. Protective clothing is required in all areas of the Hot Cell with the exception of the office, lobby, operating gallery, and change room. In addition to all other safeguards, cells are entered with a second person on standby at the operating gallery side of the low-level cell window. Television and audio communications are maintained at all times when personnel are in a cell or in the service gallery area.

The handling of effluent waste from the Hot Cell Facility is conducted under the Waste Management Program at the main site. Sources of waste include all the solid radioactive waste at the Hot Cell which results from scrap generated during the normal Post Irradiation Examinations performed on test elements, capsules, thermionic cells, and similar devices. Liquid waste is made up entirely of water that has been used to decontaminate equipment to acceptable levels for performance of maintenance or is the result of washing areas within the facility to keep them at levels consistent with personnel entry. Gaseous waste consists of small amounts of fission gases that may be released from samples within the different test devices and particulate matter that may become entrained in the cell ventilation air flow.

The only waste stream from the Hot Cell Facility that is released to an unrestricted area is the air (gas) flow used to maintain the different cells at proper negative pressure conditions. This air passes through three filtering systems. Prefilters, primarily designed to remove relatively large particulate matter, are located in back of each cell with a second prefilter at the main filtering station. The air is then passed through high-efficiency air filters that have an efficiency of 99.97% for particles of 0.3 micron size. It is then released to the atmosphere from a 26-ft exhaust stack.

Liquid waste is collected in 500-gallon-size portable tanks located in a restricted area. Upon filling, the liquid is transferred to the Nuclear Waste Processing Facility (NWPF).

TABLE I 3.5-4

IDENTITY AND CATEGORIES OF HOT CELL WASTE

Type of Waste	Physical Form	Chemical Form	Disposition
Solid	Metals, graphite plastics, paper, wipes, wood	$U\text{-}ThO_2$ Mixed fission products	Low-level to NWPF(a) High-level to commercial waste disposal[b]
Liquid	Decontamination water	Mixed contaminants including fission products	Transferred to NWPF
Gas	Hot Cell ventilation	Particulate and small quantities of iodine and krypton	Filtered and released to atmosphere

[a]Solid dry wastes are removed to a commercial land burial facility in metal drums or wooden boxes. Some waste materials may be compacted in drums prior to shipment.

[b]Solid high-level wastes are put into sealed metal containers and shipped inside approved shielded casks to a commercial burial site.

3.5.4 Criticality Alarms

Criticality alarm detectors are located in the operating gallery. These are shown in Fig. I 3.5-1 as Remote Area Monitoring Systems. Criticality alarms cannot be located within the cells because of the very high variable radiation levels that exist there. Exemption is therefore required from the 120 ft air equivalent location requirement in 10 CFR 70.24. The combination of shielding, criticality detectors in the gallery, continuous air monitors and audible alarm systems provides protection equivalent to that required by 10 CFR 70.24.

REFERENCES

3.5-1 "Nuclear Safety Summary of Fuel Rod Production," Amendment to SNM-696, AEC Docket No. 70-734, October 9, 1970.

3.5-2 Paxton, H. C., et al., "Critical Dimensions of Systems Containing U-235, Pu-239, and U-233," USAEC Report TID-7028, Los Alamos Scientific Laboratory and Oak Ridge National Laboratory, June 1964.

3.6 THERMOELECTRIC GENERATORS

3.6.1 General

Thermoelectric generators containing encapsulated plutonium may be assembled in a nuclearly isolated laboratory complex. The units typically range in size from a few mw(e) to the order of 0.5 watts. The activity consists of assembling the principal components of the generator into an enclosure, performing the subsequent tests, and interim storage with eventual shipment to the customer.

Double or triple encapsulated sources of plutonium are obtained from qualified suppliers such as Los Alamos Laboratory, McDonald Douglas, Monsanto, etc. Each source will be serialized. No operations are performed on the source which could cause significant chemical or physical damage to the sources. The maximum amount of plutonium in any single source will not exceed 200 grams.

Each source used in the thermoelectric operation shall have its encapsulation designed to prevent release of the plutonium during normal use and foreseeable accidents. Each encapsulation design shall have undergone the minimum temperature, pressure and crush tests stated below. Complete records of design and test data will be maintained.

Capsule Tests

Fuel capsules with simulated void volumes were exposed to the following environment: The temperature of each capsule was raised to the test temperature and held for the duration of the test. Test temperature for the tests was 850°C. The capsules were tested up to a maximum internal pressure of 800 Atms. without failure.

Crush Test

To test the ability of the Hastelloy C capsules to withstand mechanical damage without bursting, sample capsules were crushed between steel jaws. Forces up to 4000 lbs. were applied without rupturing the capsules.

Plutonium capsules will be assembled with other generator components involving vapor degreasing, mechanical and adhesive attachment of components, in-process electrical testing, and final battery structural assembly by TIG welding.

1. Capsules are inspected on receipt.

2. Inventory control is done by storing capsules in fireproof vault or safe until used in production assembly.

3. Capsule is mechanically attached to generator components.

4. Generator structure is sealed by TIG welding.

5. Complete generator is leak checked to verify weld integrity.

6. Generator is acceptance tested to obtain electrical performance.

3.6.2 Nuclear Safety

The fuel material may be a composition of Pu and non-fissionable elements on materials. The SNM of any source will be limited to 200 gm of Pu (all isotopes summed). Subject to the 200 gm limit, the plutonium may be combined with non-fissionable elements or materials.

The storage and handling of the encapsulated units will be in a criticality safe geometry which have considered optimum moderation, flooding, etc.

3.6.3 Radiological Safety

The primary safety objectives when handling the fuel capsules will be to: assure the integrity of the encapsulated fuels, assure early detection of any contamination, and maintain accountability of all sources. To meet these objectives the following general procedures are followed.

1. Receipt of Capsules

a. A Health Physics technician will be present.

b. A wipe will be made of the entire outside surface of the shipping container. If the alpha activity is 200 dpm/100 cm^2 or less, the Health Physics technician will release the delivery vehicle. If alpha contamination is greater than 200 dpm/100 cm^2, notifications per DOT regulations will be made. A survey of the delivery vehicle will be made and the vehicle decontaminated if necessary, prior to release.

c. If there is no detectable activity on the packing material, the inside shipping container will be opened and the inside of the lid will be wiped.

d. If the wipe of the inside of the lid over the capsules indicated alpha activity of 200 dpm/100 cm^2 or less, the capsules will be removed one at a time, and a wipe will be made over the entire surface of each capsule. If the alpha activity on the wipe is less than 0.005 microcuries, the capsule will be considered not to be leaking.

2. Assembling Generators

a. A Health Physics technician will be present, as required.

b. The capsule will be mechanically attached to the generator components.

c. Final assembly of generator.

d. Functional test of generator.

3. General Handling Procedures Capsules and Generators

Fuel capsules will be stored in shipping containers or in a fireproof safe. The capsules will be removed from the safe as necessary for production use.

All generator assembly and testing will be planned, conducted and monitored to preclude any effect on the integrity of the capsules. In-process wipes will be taken and checked for activity.

Assembled generators will not be removed from the assembly area until wipes are taken and checked for activity. The results of all wipes will be routinely logged and maintained for at least five years and for such longer time as the NRC regulations may require.

4. Routine Leak Tests

As a minimum, each plutonium capsule shall be tested for leakage and/or contamination at intervals not to exceed six months. In the absence of a certificate from a transferor indicating that a test has been made within six months prior to the transfer, the sealed source shall not be put into use until tested by licensee.

The test shall be capable of detecting the presence of 0.005 microcuries of removable alpha contamination. The test sample shall be taken from the plutonium source or from appropriate accessible surface of the device in which the sealed source is permanently or semi-permanently mounted or stored. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Commission.

If the test reveals the presence of 0.005 microcuries or more of removable alpha contamination, the licensee shall immediately withdraw the sealed source from use and shall cause it to be decontaminated or to be returned to the manufacturer. Within five days of a test which reveals 0.005 microcuries or more of removable alpha contamination, a report will be made to the NRC describing the equipment involved, the test results and the corrective action taken. A copy of such a report shall be sent to the Director of the nearest NRC Regional Compliance Office, listed in Appendix D of Title 10, Code of Federal Regulations, Part 20.

The thermoelectric generators will be transferred in accordance with procedures utilized to account for and control special nuclear materials, assure proper packing for transport and prevent the spread of radioactive contamination.

3.7 TRIGA FUEL FABRICATION **(TO BE REVISED)**

3.7.1 Facility Description

Uranium zirconium hydride fuel elements for TRIGA research reactors are fabricated in the TRIGA Fuel Fabrication Facility portion of the TRIGA Fuel Lab Building. This building is located within the main site, adjacent to and east of the Hot Cell as shown in Fig. I 2.1-2. The building is divided into two separate facilities consisting of the NMM Central Storage Facility and the TRIGA Fuel Fabrication Facility. The TRIGA Fuel Fabrication Facility is subdivided into two basic process storage areas. These are the TRIGA fuel process area and the TRIGA vault-type storage room. The NMM Central Storage Facility is split into two SNM storage areas; the drum storage area and the NMM vault-type storage room. The two vault-type rooms are located within a single storage area with an internal divider used to define the two separate material access areas. Separate doors are used to control entry to these areas. The two main facilities in the building have separate access control exercised through use of separate entry doors in the building lobby. These two doors are where the material access area entry and exit controls are maintained according to the 10 CFR 73 Category II facility requirements set forth in the applicable General Atomic Security Plan and the Materials and Plant Protection (safeguards) Amendment to the NRC materials license.

The NMM Central Storage Facility is further described in Section 3.3.1 section. The remainder of this section is addressed only to the TRIGA Fuel Fabrication Facility.

The building is designed with a covered outside equipment pad area which will contain the HEPA Filter & Blower System, gas bottle farm, liquid nitrogen supply dewar, etc., thereby eliminating unnecessary access to the process area by the supply and service persons. See Fig. I 3.7-2 for general building layout.

The TRIGA fuel process area is divided into separate zones which are used to define process station boundaries, equipment locations, logical grouping of process activities and assist in material handling. The zones are:

1. Metal preparation
2. Furnace area
3. Hydride area
4. Machine shop area
5. Assembly and inspection area
6. Office and locker room

Each of the zones and the contained equipment are described in more detail in the description of the Process Steps and Stations (Section 3.7.5).

The storage vault-type room area consists of 1-ft-thick walls of 140 lb/ft^3 concrete. A movable partition is provided to permit adjustment of the material access area boundaries since the storage area is shared between two facilities. The SNM is stored in planar arrays along one side of each concrete wall. The arrays are constructed of metal and meet the criteria for SNM storage given in Section 3.7.4.1.

The ventilation system for the building consists of several independent blower systems. One system conditions the air of the office spaces and is a closed system. One system provides exhaust for the storage areas. Two systems provide air exhausts for the TRIGA fuel processing area; one servicing elephant trunks and special containments while the other provides general room air exhaust. Each area of the building is assured proper air flow and negative pressure differential by the system of exhaust blowers. All the building exhausts are equipped with high-efficiency particulate air filters and continuously operated air sampling equipment. Air inlets are fitted with barometric dampers to assure proper air balance and prohibit the escape of radioactivity in the event of ventilation system shut-off or failure.

The construction of the building is primarily of concrete; either prestressed or reinforced. The walls are nominally 7-in.-thick, reinforced concrete. The exterior doors are of heavy gauge metal meeting the requirements of 10 CFR 73. The roof is of prestressed concrete beams over which a concrete slab is poured and is sloped sufficiently to eliminate the possibility of water pooling.

3.7.2. Nuclear Safety

The nuclear safety analysis of the TRIGA Fuel Fabrication uses the same methods, procedures, and assumptions that are described and verified in Section 5, Part I, of the application for renewal of materials license SNM-696. The criterion used for the safety evaluation of the units considered in this building was to perform a simple, conservative analysis with the introduction of refinements only when indicated necessary by the initial calculations. Cross sections for use in this analysis were obtained from the GAM and GATHER codes (Ref. 3.7-1) with resonance calculations performed where necessary (Ref. 3.7-2). The nine broad energy group structure defined in Section 5.3, Part I, was used for the criticality calculations. The ability of this nine-group structure to handle the variations in flux spectrum from unflooded to fully flooded assemblies is also described in Section 5.3, Part I. Cross sections were averaged over a spectrum appropriate to the problem under consideration. Conservative assumptions used in the analysis include:

1. Use of homogeneous uranium-water mixtures for all situations where fuel water mixing was possible.

2. Interaction calculations based on optimum possible fuel-water mixing with no reflection.

3. Neglecting all absorber material present in a station except uranium, water, and zirconium.

4. Use of 93.5% enriched uranium for criticality calculations although the facility is currently limited to processing uranium or less than 20.0% enrichment.

5. Use of the most reactive geometries (i.e., spheres) unless other shapes, such as fuel rods, are fixed.

Other specific nuclear safety considerations are discussed in the individual zone or station descriptions.

3.7.3 Radiological Safety

All building operations that may generate airborne radioactivity (i.e., hydriding, machining, etc.) are conducted within closed equipment, hoods, glove boxes or are exhausted via elephant trunks. Air ducts from each of the above utilize high-efficiency particulate air filters to treat the effluent air. The filters have an operating efficiency of 99.95% for 0.3 micron particles and are of fire-resistant type and are equipped with differential pressure indicators. Each of the elephant trunks are designed for a flow of 150 ft/ min. at 4 in. from the orifice plane.

Categorization of TRIGA fuel processing wastes as to solid, liquid, or gas is presented in Table I 3.7-1. The table identifies each source, waste category, its physical and/or chemical form and gives the treatment or disposition of the wastes, except for the treated waste streams which are released to unrestricted areas. These streams are the ventilation systems and the water from the fume scrubber in the process area.

TABLE I 3.7-1

DESCRIPTION OF WASTE STREAMS

Source	Waste Category	Form	Disposition
Pickling Tank	Liquid	Spent HNO3 + HF with dissolved U	Waste Yard[a]
Pickling Tank Ventilation	Air and gas with entrained liquids	Air with oxides of nitrogen and dissolved uranium	Released to atmosphere via fume scrubber
Pickling Tank Ventilation	Liquid	Water from fume scrubber	Released to sanitary sewer
Ventilation, melting and casting, parting, finish machining	Gases with entrained solids	Air with entrained uranium dust	Released via high-efficiency air filter
Centerless grinder	Liquid	Water with uranium	Waste Yard[c]
Vacuum system	Liquid	Oil with uranium	Waste Yard[d]
Mop water	Liquid	Water with uranium	Waste Yard[c]
Wash water	Liquid	Water with uranium	Waste Yard[c]
Trash barrels	Solid	Paper and rags with uranium	Waste Yard[b]

[a]Mixed with neutralizing agents, absorbent, and solidifying materials prior to shipment to commercial land burial.
[b]Shipped to commercial land burial facility in metal drums or wooden boxes.
[c]Evaporated in solar evaporation ponds. After evaporation, resultant pond sludge is treated as in (d).
[d]Mixed with absorbent and solidifying materials prior to shipment to commercial land burial.

The exhaust ventilation systems are provided with prefilters and high-efficiency particulate air filters to reduce the quantity of particulates and the resulting concentration of radioactivity released to the environment. The ventilation system serving the pickling station discharges through a fume scrubber employ-ing water scrubbing to remove acid fumes.

The scrubber water having unmeasurable levels of radioactivity is blown down without in-line monitoring to the building drainage system and is subsequently discharged to the plant sewer system. The plant sewer system discharge is sampled routinely and verifies the levels as acceptably low.

Equipment to control other liquid waste consists of various containers to temporarily store the liquid wastes until transfer to the Waste Processing Facility for treatment and disposition. For such liquids handled in batches, no in-line monitoring is necessary. The fume scrubber blowdown is sampled, and having been shown to have very low activity, is directed to the building drainage system, and is subsequently discharged to the sanitary sewer without in-line monitoring. The sewer system discharge waste is sampled routinely and verifies the levels as acceptably low.

Sampling equipment for airborne radioactivity exists at the outlets of the ventilation system and at the exhaust from the fume scrubber. Samples are collected daily and the concentration of long-lived alpha and beta radioactivity is determined. Alert levels for the exhaust effluent are based on actual operating levels and are evaluated by the "ALARA" requirements of 10 CFR 20. The alert levels are reevaluated periodically.

All solid waste is transferred to the Waste Yard where it is packaged for removal to a land burial site by a commercial waste disposal company.

All building operations are monitored by criticality alarms installed per 10 CFR Part 70, Paragraph 70.24, which sound locally and at the secondary central security control station.

3.7.4 Storage

Within the facility, SNM is stored in various temporary arrays inside the process area and in the TRIGA vault-type room. Limits, criteria and contained materials applicable to the vault-type room are described in Section 3.7.4.1 below. The description of the individual temporary storage arrays and their limits located within the process area zones are discussed in Section 3.7.4.2, however, their interaction with other SNM locations is discussed and summarized in Section 3.7.5.

3.7.4.1 TRIGA Vault-Type Room

Storage within the facility of in-process materials generated in the manufacture of enriched U-Zr fuel elements, other than temporary storage as described in Section 3.7.4.2, is limited to the TRIGA vault-type room.

The storage area is designed for storage of a variety of material including chopped sheets (1/4-in. squares), castings (1/2 and 1-1/2 in. in diameter), broken buttons, meats (1-1/2 in. in diameter), and fuel pins 1/2 in. in diameter. This room may be used for storing research and development material, as well as material generated by the normal U-Zr fuel process.

The storage arrangement in the vault constitutes a plane array along one wall of each vault aisle. Special steel racks have been designed for each of the various types of materials to be stored. The racks are securely attached to both the floor and the ceiling of the room, and are designed to prevent the material from being dislodged and to prevent water from being retained in significant volume in any compartment.

The material stored in this vault typically consists of uranium metal, U-Zr alloy, or hydrided U-Zr alloy containing uranium enriched up to 20.0% in U-235. U-Zr fuel elements bear an inscribed identification number and the alloy material has an identification number engraved on it immediately after being parted into fuel meat lengths. Such external markings plus the special design of the storage racks, which by their dimensions are designed to accommodate only one specific type of material, ensure that each kind of material is placed in the correct location within the storage area.

Storage is maintained under one of the following criteria:

1. SNM metal, alloys, or compounds are stored in closed containers, or as processed shapes, in a plane array containing a maximum of 3.6 kg U-235 with a maximum volume of 1 gallon per unit or container, with 16-in. center-to-center spacing horizontally and 18 in. center-to- center spacing vertically and 8-in. surface spacing between units or containers. Safety of this arrangement is based on standard limit Type G in Section 5.5, Part I. The safety of the individual unit is based upon standard limit Type B in Section 5.5, Part I.

2. SNM metal, alloys, or compounds are stored in isolated plane arrays of 160 g U-235 per ft^2 provided that the maximum allowable subcritical unit is limited to 250 g of U-235 and the local regional average satisfies the 160 g criteria. This is standard limitType E in Section 5.5, Part I.

3. Material may be stored in a flat plane configuration, against the storage wall, as long as the thickness of the plane is not greater than 1.5 in. and the uranium concentration of any individual liter of volume is not greater than 0.4 kg of U-235. From Fig. I 5.4-4, Section 5, Part I, the safe thickness for an infinite slab is 1.5 in. for uranium concentration up to 0.4 kg U-235/liter of slab with full reflection assumed.

The 12-in.-thick concrete walls provide neutronic isolation from other storage locations and SNM processing areas.

3.7.4.2 <u>In-Process Storage</u>

Means are provided in the facility process area for the ready, yet safe storage of in-process materials such as castings, recycle scrap, and meats. This storage is in the form of steel storage racks secured to walls and as carts which offer safe portability of materials.

3.7.4.2.1 <u>Storage Racks</u>

Two storage racks are located in the Furnace Area and one in the Assembly Area. The storage criteria used in these three racks are the same as criteria 1 used in the vault-type room. For purposes of interaction calculations the racks are assumed to be loaded according to criteria 1, 3.6 Kg of U-235 in 1 gallon containers. The k_{eff} for this container is 0.600, as shown for standard limit type B-4 in Section 5.5, Part I. Carts may not be located closer than 5 feet from the front of the storage racks; this restricted area is marked on the floor.

3.7.4.2.2 <u>Scrap Storage</u>

A storage rack in the machine shop contains scrap material such as chips and turnings in 5-gallon drums. The drums are loaded to a maximum of 350 g of U-235 each and are individually safe as justified for standard limit type A, Section 5.5, Part I. The drums are 12 in. in diameter and 14 in. high. They are positioned on two shelves that are 36 in. long and separated vertically by 26 in. The containers are positioned two to a shelf with 1 12-in. surface-to-surface spacing in the horizontal and vertical directions. The k_{eff} for a single type A unit for purposes of interaction is 0.62 and the maximum allowable solid angle interaction is 2.8 steradians. The solid angle intercepted at one of the four containers by the other three containers in the rack is only 0.946 steradians; hence, the rack of four containers is safe and an adequate margin remains for interaction with other equipment in the locale. Carts may not be parked closer than 2 feet from the front of the storage racks; this restricted area is marked on the floor.

3.7.4.2.3 Element Carts

Cart top storage is used throughout the TRIGA fuel process area. The interaction calculations assume that a number of typical positions are occupied. A separate interaction study has been performed which assumed carts closely coupled to and virtually surrounding many of the process stations. This study demonstrated that restrictions on cart locations are not required other than those stated in Sections 3.7.4.2.1, 3.7.4.2.2, and 3.7.4.2.5.

The basic configuration for cart top in-process storage is a plane array of fuel castings, machined meats or assembled elements. The fuel pieces are stored end-to-end in parallel 1-1/2 in. diameter cylindrical geometry. The cylinder spacing used with fuel enriched up to 93.5% U-235 is 6 in. on center. The 20% enriched meats are stored in a similar array except on 3-in. centers. Different enrichments of SNM are not in use simultaneously, and the cart top positions are appropriately blocked when higher enrichments are used.

Criticality calculations for the nuclear safety analysis were based on a 1.7/1 H/Zr content in the fuel meat; the current upper limit for fuel production is 1.65/1. Fully enriched uranium was also assumed, and criticality for safety and interaction purposes was based on infinite rather than finite fuel cylinders.

Atom densities for the fuel meat, based on 1.7/1 H/Zr and 93.5% enriched uranium, are given in Table I 3.7-2.

TABLE I 3.7-2

TRIGA FUEL MEAT ATOM DENSITIES AFTER HYDRIDING[a]

Hydrogen	0.06017 atoms/barn-cm
Zirconium	0.03539 atoms/barn-cm
U-235	0.001215 atoms/barn-cm ($0.475\ g/cm^3$)
U-238	0.000084 atoms/barn-cm
H/U-235	50

[a] 93.5% enriched uranium and 1.7 H/U-Zr ratio (1.65 is upper limit for actual meats) are assumed.

An infinite array of infinitely long 1.5-in.-diameter cylinders of fully enriched UZrH1.7 on 6-in. centers has a calculated k_{eff} of 0.603 when fully water flooded. The 20% enriched $UZrH_{1.7}$ fuel on 3-in. centers has a calculated k_{eff} of 0.849 when modeled as a 1.5-in.-thick infinite slab with full water flooding; the slab was assumed to be a uniform fuel-water mixture of rods plus gaps. Thus, the nuclear safety of the individual meats and those stored on cart tops is guaranteed under all accident conditions.

For the interaction calculations the multiplication factor of bare, infinitely long cylinders of fully enriched $UZrH_{1.7}$ was calculated. For a 1.5-in.-diameter cylinder, keff was 0.05. All criticality results are summarized in Table I 3.7-3.

TABLE I 3.7-3

CRITICALITY ANALYSIS SUMMARY

	k_{eff}
Infinite array of infinitely long 1.5-in.-diameter fully enriched $UZrH_{1.7}$ cylinders, fully flooded on 6-in. centers	0.603
Infinite slab of 20% enriched $UZrH_{1.7}$ plus water, 1.5 in. thick, with full water reflection representing the 1.5-in.-diameter rods on 3-in. centers	0.849
Infinitely long, 1.5-in.-diameter fully enriched $UZrH_{1.7}$ cylinder, bare	0.050

In considering interaction solid angles, two cases are considered for the cart: a central meat, which interacts only with similar meats on each side, and an edge meat, which also interacts with the hydride furnace. The cart storage arrangement for the fully enriched meat was used since this forms the most reactive case.

3.7.4.2.4 Container Carts

Cart tops are also used for transport of containers of bulk materials such as uranium metal and weighed out charges for induction casting. The basic units transported are 1 gallon containers each holding up to 3.6 Kg of U-235. Physical holders are provided to restrain the containers on the cart top to a 12-in. surface-to-surface geometry. Safety of this arrangement is based on standard limit type G in Section 5.5, Part I. The safety of the individual unit is based on standard limit type B in Section 5.5, Part I.

Interaction calculations are performed by considering an individual container on the cart as interacting with the other containers and with adjacent equipment.

3.7.4.2.5 <u>Casting Carts</u>

Castings resulting from the melting and casting process step are handled two at a time on a cart which has fixtures to retain the unseparated castings or molds which have not been separated from the castings. The fixtures maintain a 12-in. surface-to-surface separation between the two units.

The nuclear safety of individual mold-casting units is discussed in the description of the melting and casting process, Section 3.7.5.3. A KENO (Ref. 3.7-4) calculation has been performed to justify the nuclear safety of the individual units on the cart and to establish a reactivity value for interaction purposes.

The calculations were made on a 5 in. x 5 in. x 17.5 in. system which is the basic mold criteria. A homogeneous mixture of 1.6 Kg of U-235 in 93.2% enriched uranium and water was assumed. The maximum moderator ratio within these constraints is 117. Calculations were made using both KENO, a monte carlo code and DTFX, a one dimensional transport code. The cross sections were obtained through a MICROX calculation for 18 broad groups. Both methods yielded a flooded, unreflected keff of 0.57. Similar calculations were made at lower moderator ratios which confirmed the fully flooded case is the most reactive.

Interaction calculations are performed by considering the individual container as interacting with the other container on the cart and with adjacent equipment. The cart position study described in section 3.7.4.2.3 indicates that the allowable solid angle of interaction seen by casting carts will not be exceeded if no more than 6 carts are nested at one location.

3.7.5 Processing Steps and Stations

A flow diagram of the TRIGA fuel fabrication process is given in Fig. I 3.7-3. For convenience, the steps in the fabrication process are also listed in Table I 3.7-4. For each step the following information is given:

1. Process
2. Equipment
3. Zone
4. Maximum special nuclear material per operations (U-235 mass limit)
5. Method of transport

SNM storage in these areas is according to the criteria set forth in Section 3.7.4. Comingling of material containing uranium of different enrichments in the different areas is prevented by appropriate procedural and administrative controls.

U-235 processing step and stations are controlled to their individual limits. The material to be processed, metallic uranium or U-Zr alloy, contains uranium enriched in U-235 up to 93.5% within a minimum of 87 wt % zirconium or uranium enriched in U-235 up to 20% within a minimum of 55 wt % zirconium. While not described in the discussion of each operation, the SNM hold-up at each station is determined by a weight difference closure between input and output materials. This is an accurate method because the majority of the operations are mechanical in nature and are performed on metallic materials. The closure is performed frequently such as for each cart load of material processed through a lathe. The materials are taken to one of the weighing stations (discussed in the rest of this section) and weighed. A material balance book is maintained for each applicable station to record this material closure.

TABLE I 3.7-4

TRIGA FUEL ELEMENT FABRICATION

Operation	Station No.	Description
		a. Processes b. Equipment c. Zone location d. Maximum SNM per operation e. Method of transport
Uranium Preparation	1, 3, 24	a. Rolling, annealing, chopping b. Rolling mill, vacuum furnace, shear, balance c. Metal preparation d. 10 Kg U-235 in process e. 4-wheeled cart with appropriate stainless steel pans and containers
Melt Preparation	5	a. Weighing materials and loading furnace crucibles b. Balance, containers and crucibles c. Furnace Area d. 3.6 Kg U-235 in process e. 4-wheeled cart with appropriate storage containers
Melting and Casting	6	a. Induction melting and casting b. Vacuum induction furnace, crucible mold c. Furnace Area d. 1.6 Kg U-235 in process e. 4-wheeled cart with mold and casting fixtures
Casting Extraction	7	a. Remove casting from mold and separate b. Work bench and hand tools c. Furnace Area d. 1.6 Kg U-235 in process e. 4-wheeled cart with mold and casting fixtures

TABLE I 3.7-4 (continued)
TRIGA FUEL ELEMENT FABRICATION

Operation	Station No.	Description
Parting of Castings and Ingots	8	a. Cutting castings from hot top b. Abrasive cut off saw c. Machine shop Area d. 1.6 Kg U-235 in process e. 4-wheeled cart with mold and casting fixtures
Parting Castings	9 - 10	a. Part castings to length and diameter for hydriding b. Lathe, drill press c. Machine shop d. 1 Kg U-235 in process e. 4-wheeled cart with meat cart top
Hydriding	11, 30	a. Form $UZrH_x$ by holding meats at elevated temperature in H_2 atmosphere b. Hydriding furnace c. Hydride Area d. 3 Kg U-235 e. 4-wheeled cart with meat cart top
Centerless Grind	12	a. Finish meat to proper diameter b. Centerless grinder c. Machine shop d. 1 Kg U-235 in process e. 4-wheeled cart with meat top
Special	13 - 14	a. Machine detail in meats for special purposes b. Surface grinder, mill c. Assembly Area d. 1 Kg U-235 in process e. 4-wheeled cart with meat top

TABLE I 3.7-4 (continued)
TRIGA FUEL ELEMENT FABRICATION

Operation	Station No.	Description
Assembly and Quality Control	15 - 02	a. Clad acceptable meats in aluminum, stainless steel, Hastelloy, or Incoloy cans; clean and/or coat clad elements b. Welding lathe, helium leak detection, inspection c. Assembly Area d. 3 Kg U-235 e. 4-wheeled cart with meat cart top
Chip Washing	21	a. Remove foreign surface contaminants prior to reprocessing b. Water c. Machine shop Area d. 350 g U-235 e. Hand carry container
Pickling	23	a. Treat scrap alloy or hydrided alloy in acid solution to remove surface oxide b. Acid solution, acid resistant dissolving pan, acid resistant storage container c. Fines burning area d. 350 g U-235 e. 4-wheeled cart
Weighing	24	a. Precision weighing at all stages of process b. Balance c. Hydride area d. 3.6 Kg U-235 e. 4-wheeled cart with appropriate top

Table I 3.7-4 (continued)
TRIGA FUEL ELEMENT FABRICATION

Operation	Station No.	Description
D-2	any	a. Nonstandard process steps b. As required by process c. Any area, with approved solid angle calculation d. 350 g U-235 e. 4-wheeled cart with appropriate top
Fines Burning	2, 33, 24	a. Control burn scrap fines b. Burn furnace c. Twin shell blender d. Balance

All scrap and waste materials removed from the facility are evaluated for SNM content by gamma counting or by sampling and laboratory analysis. Gamma survey methods are used to evaluate the effectiveness of equipment cleanout and to assure that unknown SNM hold-ups do not exist. The hold-up in each piece of equipment is limited to 350 g U-235 as determined by in and out weight differences.

Station limits set forth in the detailed discussion on the stations apply to the material that is actually in process in or on the particular piece of equipment and do not reflect the material that may be present on a nearby cart awaiting processing. In each case the nuclear safety of the combined stations and carts is assured through evaluation and documentation of interaction solid angles.

Cart-top carriers designed for safe transport of material are used with a standard four-wheeled cart. The carts are used exclusively for transport of U-Zr material throughout the building. Openings in the cart tops are blocked off to permit only the limit for the type of material in process. The nuclear safety of the carts is described in Section 3.7.4.2.

In summary, the station limits, transfer cart limits, and storage limits are maintained taking into account that the uranium content and U-235 enrichment may vary with the fuel element requirements. During the production of elements of a specific enrichment level of U-235 in a given zone, all other special nuclear material is excluded from that zone.

Interaction calculations have been performed on all equipment and the associated fuel transport carts and all resultant values are well below the limiting criteria. As noted in Section 3.7.4.2.3, a separate extensive interaction study has shown that the only restrictions required on cart locations are the restricted space in front of storage racks, see Sections 3.7.4.2.1 and 3.7.4.2.2, and the restriction on casting cart nesting given in Section 3.7.4.2.5.

3.7.5.1 Uranium Preparation; Stations 1, 3, 24
(Mass Limit - 10 Kg U-235)

Uranium stock material is brought to the metal preparation zone in its storage or shipping container and is limited to one container at a time. Container loadings and shapes vary. Containers up to 3.6 Kg U-235 in 1 gallon may be stored within the facility. Larger loadings of U-235 in varying containers may be received from sources outside the company. These will be stored in the NMM storage facilities and be issued at the time of use herein. The material is then weighed and placed in containers in batches ready for placing in the casting furnace. These containers are then returned to the TRIGA Vault-Type Room. All locations where operations are conducted on the uranium metal are exhausted by local elephant trunks through a high-efficiency air filter system. Any container listed for U-235 in Standard Limit-Type B, Section 5.5, Part I, may be required. The analysis for the limit B indicates that the 3.6 Kg U-235 in 1 gallon container is the most reactive, having a k_{eff} of 0.600 when fully flooded but unreflected and 0.95 fully flooded and reflected.

Uranium stock material (irregular shaped pieces of broken ingot) is reduced to chips (about 1/8-in. cubes). The uranium size reduction is accomplished by cold rolling the stock pieces into a sheet about 1/8-in. thick. These pieces are placed in stainless steel pans 10 in. x 8 in. x 2 in. deep (2.62 liters volume). The sheets are chopped into small pieces using a shear mounted in a hood. The chopped uranium is placed in containers with a volume of 1 gallon or less. Each can contain a maximum of 3.6 Kg U-235.

This step consists of three separate stations where fissile material is under process, excluding the carts used to transport the uranium. These stations are (1) the rolling mill station, (2) the chopping machine, and (3) a weighing table. These stations are indicated in Fig. I 3.7-2. The batch processing is performed in series; therefore, fissile material will not be in all of these stations at the same time. However, for interaction purposes, it was conservatively assumed that full permissible fissile loads were present at each area.

The feed stock and the rolled sheets at Station 7, rolling mill, are handled in 10 by 8 by 2 in. stainless steel pans. The station is limited to a total of 4 kg., which is processed, piece by piece from the input feed stock to the output, rolled stock, pan. While the station is well enclosed, it does not qualify as a water free station and each pan is therefore assumed to contain 4 kg U-235 in a metal-water mixture with an effective density of 1.526 kg. U-235 per liter. Figure 9 of TID-7028 (Ref. 3.7-5) shows that a reflected 2.62 liter volume is subcritical for all loadings below about 8 kg./liter. The pan is therefore safe even if it is double batched.

KENOIV analysis was made to establish the fully moderated bare and reflected 12 in. water reactivities of a pan. MICROX cross sections were used employing the 18 group structure shown in Table I 5.3-2, and the following atom densities:

Pan	U-235	3.909-03	atoms/b-cm
	U-238	2.683-04	
	H	6.110-02	
	O	3.055-02	
Reflector	H	6.686-02	
	O	3.343-02	

The bare k_{eff} is 0.299 +_ .0036 (115 of 120 generations) and the 12 inch water reflected k_{eff} is 0.764 +_ .0065 (79 of 84 generations). The validation of KENO IV indicates a possible non-conservative bias of .0141 at the hydrogen ratio of 15.63, which applies to this case; therefore any k_{eff} for which the 2 upper bound is less than (.95 - .0141=) .9359 is acceptable and the upper bound for the reflected pan is only 0.777.

The sheets a[illegible] t[illegible] to Station 3 and chopped into small pieces wh[illegible] are [illegible] into a 1 gallon c[illegible]iner. No more than [illegible] U-23[illegible] are placed in any one container. These cont[illegible] [illegible]ighed into suitable charges at the weighing [illegible] the subsequent melting process. The [illegible] gallon con[illegible] with up to 3.6 Kg of U-2[illegible] is [illegible] on [illegible]ard Limit Type [illegible] Section 5.5, Part I, as are the [illegible] value [illegible] 0.95 when [illegible] and reflected and 0.600 when flooded bu[illegible] unreflected.

3.7.5.2 <u>Melt Preparation, Station 5</u> (Mass Limit 3.6 Kg U-235)

The uranium, zirconium and other additives such as erbium to be used in the element fabrication are received from storage or other feed material preparation steps in containers limited to a volume of 1 gallon and 3.6 Kg U-235. The proper amount of uranium and zirconium are weighed and charged into the induction furnace crucible having a 5 in. diameter and a volume of 3.2 liters. Other additives may be included in the crucible or placed in a small addition hopper. The crucible is placed into the furnace. The weigning is accomplished at the weighing Station 5 within the furnace area.

The nuclear safety of this station is based on Standard Limit Type B i[illegible] Part I. The k_{eff} is 0.95 when flooded and ref[illegible] [illegible]600 when flooded but unreflected. A spacing of at [illegible] surface-to-surface is maintained between the feed container and the crucible.

3.7.5.3 Melting and Casting, Station 6 (Mass Limit 1.6 Kg U-235)

Two types of fuel rods are manufactured by the casting process. One is standard TRIGA fuel and the second is small fuel pins. The former requires casting rods slightly less than 1.5 in. in diameter and the second requires casting rods about 0.51 in. in diameter.

Melting and casting of the UZr alloy is accomplished using a vacuum induction furnace located in the furnace area at Station 6. The furnace exterior surfaces and induction coils are water cooled. The water cooling system is a limited volume, closed system. An elevated emergency cooling tank located outside the building may be manually coupled to the furnace cooling system. The furnace components are shown in Fig. I 3.7-5. The process melts the contents of the crucible, mixes them by induction, and pours the result into a cold or heated mold in the lower portion of the vacuum furnace. In an alternate mode of operation the mold is placed within the induction coil to permit remelting of the alloy within the mold and/or its cavity top. An inert gas blanket is added prior to pouring the melt. The hot molds are permitted to cool radiatively and conductively by adding an inert gas. The warm molds are removed from the furnace and allowed to air cool.

The initial step in the casting process is to melt pre-measured quantities of materials to form the desired alloy. This is cast to form an ingot approximately 3.25 in. dia and 12 in. long. The ingot is then parted into 3 segments, each about 4 inches long.

The rods are cast by placing a segment of the ingot in the top cavity of a rod mold. The segment is remelted, and the cavity channels the melted fuel into the fuel meat cavities in the lower part of the mold. Typical molds are:

Mold Type I	4 ea	1.5 in. dia. x 10.75 in. long
Mold Type II	25 ea	0.52 in. dia. x 6.5 in. long

Nuclear Safety Basis

The nuclear analysis submitted here is directed toward fabrication of any diameter rods limited only by the allowable quantity of U-235 within a geometrical constraint.

The material required for casting rods, described above, is about 12.7 Kg of alloy limited to 1.6 Kg of U-235. In the 5-in. diameter crucible, the alloy is in a single ingot contained in graphite. The alloy is poured into a mold. Alloy dimensions within the mold are constrained to a 5 in. x 5 in. x 17.5 in. parallelepiped or, alternatively, to dimensions having a less reactive, larger geometrical buckling.

Nuclear safety is assured under normal conditions by limiting the allowable amount of U-235 to a safe mass. Under normal conditions, the safety limit can be based on a dry mass limit of 10 Kg U-235. As Fig. 8 of TID-7028[1] (Ref. 3.7-5) shows, this mass limit is safe with allowance for accidental double batching for incidental amounts of moisture up to an atomic ratio of H/U = 2.

In the accidental event of a water leak, it would normally be immediately detectable because of a loss of vacuum, and automatic power shut-off. In the unlikely event of significant

[1]Since the quantity of graphite is approximately 7,300 g which is equivalent to a C/U-235 atomic ratio of 90, the actual critical mass is much larger as Fig. 14 of LA-3221-MS (Ref. 3.7-7) shows.

quantities of water being introduced into the furnace, safety is assured by safe geometrical dimensions for the alloy material within the molds. All alloy is constrained within equivalent to dimensions 5 in. x 5 in. x 17.5 in. Since the geometrical buckling for that water reflected parallelpiped is 0.0355 cm^{-2}, then the equivalent safe cylinder diameter is 5.5 in. Applying a geometrical safety factor of 93% for the cylindrical diameter results in an equivalent critical diameter of 5.75 in., which, according to Fig. 1.A.3 of AHSB Handbook (Ref. 3.7-6), is a safe cylinder size for concentrations up to .4 Kg U-235/liter. Using Fig. 1.A.1 of the AHSB Handbook, give a critical mass of 2.4 Kg of U-235 which is 50% higher than the allowable 1.6 Kg U-235. The graphite mold designs will constrain the alloy within the dimensions 5 in. x 5 in. x 17.5 in. or less. Since the nuclear safety analysis given in this paragraph is quite general, then any alloy configuration in the graphite mold with a geometrical buckling greater than 0.0355 cm^{-2} is acceptable. Since the 5 in. diameter crucible has been analyzed according to a similar argument (maximum U-235 density in the alloy -- .75 g/cc., and a 5-in. cylinder is safe up to densities greater than 1 g/cc according to Fig. 1.A.3 of Ref 3.7-6), then it too is safe.

The credible, but highly unlikely, event that the graphite mold should tip, thus spilling alloy was investigated. All molds have lengths greater than the mold well diameter (15 in.) so that it is impossible for a mold to tip horizontally more than a given angle. For the maximum tip angle (25° from the horizontal), the maximum spill for the 1-1/2 in. diameter mold is 335 g of alloy per single rod mold assuming the highly unlikely condition of the alloy remain-ing molten. For the case of a single 4-rod mold (the worst possibility) , the maximum possible spill is 1440 g of alloy or 168 g U-235. This corresponds to less than half the safe mass under the optimum moderation conditions.

To summarize then, the furnace has been found to be safe under the following accident conditions:

a. A water leak

b. Spill of metal out of the mold

In the operation of the casting furnace, a single charge of SNM is used and it resides either in the crucible or the mold. For interaction purposes the mold represents the most reactive case and it is considered as the interacting unit. The calculations described in Section 3.7.4.2.5 are used to define a keff of 0.57 for use in interaction calculations.

3.7.5.4 Casting Extraction, Station 7 (Mass Limit 1.6 Kg U-235)

Upon reaching proper cool-down temperature the UZr alloy castings are removed from the molds by destroying the mold. The casting is separated from the mold on the furnace area work bench (Station 7). Only one loaded casting mold is permitted at this station. The ingots are prepared for machining by separating the individual ingots from each other. This requires cutting or breaking the castings from the hot top if the physical cross-section is small enough. If this is not the case, the castings are placed on the casting placed on the casting transfer cart and taken to Station 8. The hot top (the material in the mold top channels) residue alloy is returned to scrap storage or melt preparation.

The nuclear safety of this station has the same basis as the melting and casting process, Section 3.7.5.3. The reactivity analysis in Section 3.7.4.2.5 indicates a k_{eff} of 0.57 when the intact casting with hot top is flooded and unreflected, the value for use in interaction calculations.

3.7.5.5 Parting of Castings and Ingots, Station 8

(Mass Limit - 1.6 Kg U-235)

Castings that cannot be broken apart at Station 7 are taken to the cutoff saw, Station 8, for removal of the hot top. This unit is a liquid-cooled abrasive saw. The fuel is present in the shape of the casting. Only one casting can be cut apart at one time although two may be present on the transfer cart.

The nuclear safety of this station has the same basis as the melting and casting process, Section 3.5.9.3. The reactivity analysis in Section 3.7.4.2.5 indicates a k_{eff} of 0.57 when the intact casting with hot top is flooded and unreflected, the value for use in interaction calculations.

The waste from this operation is contaminated with the abrasive and cannot be directly reused in the manufacture process. This waste accumulates in the coolant sump. The SNM amount is limited to 350 gm U-235 maximum and is established by measurement of weight loss between input and output process materials. The material is collected, evaluated for SNM content, oxidized at Station 2, and stored awaiting the accumulation of sufficient material to warrant shipment off site for recovery of the contained SNM.

3.7.5.6 Machining, Enriched U-ZrH Elements, Stations 9A, 9B, 9C and 10
(Mass Limit - 1 Kg U-235)

The meats are machined and drilled in the Machine Shop. The resulting turnings and chips are collected and stored in the containers under the same conditions as described in Section 3.7.4.2.2 and recycled. After machining, the meats are inspected for surface cracks. Material transport to and from the machine shop is accomplished on four-wheeled carts with appropriate cart-top carriers.

The machining is conducted on a single casting ingot or parted meat at each lathe at Stations 9A, 9B, and 9C. In normal practice Stations 9A and 9B are used for machining 1.5-in. diameter material and Station 9C is used for .5-in.-diameter, therefore all stations do not normally operate simultaneously. The 1.5-in. diameter meats have a central hole drilled at the drill press, Station 10. For purposes of interaction calculations, all stations are assumed to be in operation and contain SNM simultaneously.

The nuclear safety of each station is based upon the use of a single piece of 1.5-in. diameter material at each station. Fig. I 5.4-3 in Section 5.5, Part I, demonstrates that a single cylinder of material less than 3 in. in diameter cannot be made critical under any condition of water moderation and/or reflection. The k_{eff} for a single cylinder of $UZrH_{1.7}$ material without reflection is 0.050. This is demonstrated in Section 3.7.4.2.3.

Scrap, in the form of chips and turnings initially collects in the bed of the machine tool being used. The material is promptly removed to 5 gallon metal storage containers with the SNM amount per container limited to 350 gm U-235; this is established through gross weight and the nature of the alloy in process. Due to the spring like nature of this scrap a 5 gallon container cannot hold the limiting amount of SNM except with the high enrichment (70% and greater) alloys, which are no longer in normal production.

3.7.5.7 Hydriding Furnace, Station 11
(Mass Limit - 3.0 Kg U-235)

The furnace is a 6-in. i.d. by 11-ft long Inconel tube that has 9 ft. electrically heated with external elements. The overall length of the furnace is 13 ft. It is mounted horizontally with its axis 5 ft from the floor. The furnace can contain up to five racks of elements, each rack 1-1/3-ft long, or nine racks of pins 1/2 in. x 5.5 in.

Elements are transported to and from the furnace and the associated rack loading hood, Station 30, on an appropriate cart-top carrier.

The nuclear safety of the hydride furnace is based on an analysis which considers the furnace a 6.063 in. cylinder of varying length and studying the effects of varying the distribution of a given mass of U-235. The analysis considered the reflected cylinder to be of varying height and a geometrical buckling calculation was made to determine the reactivity-equivalent sphere. The spherical critical concentration of U-235 in a homogeneous water mixture was then obtained from Fig. 9 of TID 7028 (Ref. 3.7.5). In each case, this is the concentration which would also make the cylinder critical.

The buckling calculations used the standard relationship:

$$\left(\frac{2.405}{r_c + {}_c}\right)^2 + \left(\frac{\pi}{h + 2{}_c}\right)^2 = \left(\frac{\pi}{r_s + {}_s}\right)^2$$

Where r_c = radius of cylinder

h = height of cylinder

r_s = radius of sphere

${}_c$ = effective extrapolation length of cylinder

${}_s$ = effective extrapolation length for sphere

The values of ${}_c$ and ${}_s$ were obtained from Fig. 3 of TID 7028.

The safety of mass controlled SNM loadings was determined by distributing a given amount of U-235 over the volume of the cylinder. The safety factor is the ratio of the critical concentration to the mass-load-limited concentration. The safety factor has a minimum in the range of 20 to 30 in. column height, and this minimum is used to set the maximum permissible loadings. The result of this calculation, shown in Fig. I 3.7-5, demonstrates the safety to the furnace under conditions of internal flooding with the additional assumptions that the contained fuel finely fragments and that the resultant metal-water mixture is confined to the most reactive configuration (a region about 25 in. long). Fig. I 3.7-5 shows that 3.0 kg of U-235 has a safety factor of 1.11 (90% of critical), a limit justified under mass control when double batch is not considered) under these highly unlikely conditions. The H/U-235 ratio at the minimum safety factor point is 90.

The foregoing has assumed that the $UZrH_{1.7}$ fuel was distributed in the most reactive form (finely divided) over the most reactive volumes. This is a highly conservative assumption because the fuel is in the form of rods held within fixtures which limit the spatial distribution. The fuel rods have a high degree of integrity which has been demonstrated by water quench from high temperatures without fracture of the rods.

The normal geometry of the fuel within the furnace is determined by a fixture which holds five rows of 1.5 in. fuel rods, or a larger number of 0.51 in. rods with an equivalent cross-sectional area. An analysis similar to the foregoing using the cross-sectional area-equivalent cylinder (3.13 in. diameter) indicates that the 3.0 kg U-235 loading has a safety factor of 10. Fig. 10 of TID-7028 indicates that a cylinder of this size cannot be made critical at U-235 densities less than 17.5 kg/ assuming 93.2% U-235 and 12 wt % U in the UZr fuel, hence the nonflooded system cannot be made critical.

Any disarrangement within the furnace of a maximum fuel charge containing 3.0 Kg of U-235 falls within and is less reactive than the flooded cylinder.

For interaction calculations, it was assumed that the five rows of fuel rods in the furnace racks were replaced by one, infinitely long $UZrH_{1.7}$ cylinder with a cross-sectional area equivalent to that of five rods. For this bare cylinder, k_{eff} was calculated to be 0.30. No additional water between the rows of fuel rods was assumed in this calculation since presence of this water would imply flooding of the complete rack including full reflection, thus shielding the fuel from interaction.

3.7.5.8 Centerless Grinding, Station 12
(Mass Limit - 1 Kg U-235)

Subsequent to hydriding, the meats are finish machined to final dimensions by use of the centerless grinder, Station 12. This is accomplished by feeding the material one piece at a time through the station.

The nuclear safety of this station is based on the same discussion as the other stations in the machine shop in Section

3.7.5.5.

The waste from this operation collects in the coolant liquid and is concentrated in a filter. The limit on waste within the station is 350 g. The accumulation is determined from differential weight measurements and is verified through gamma survey as discussed in Section 3.7.5. This waste is contaminated with the abrasive and cannot be directly reused in the manufacturing process. Treatment and disposal of this material is discussed in Section 3.7.5.18.

3.7.5.9 <u>Special Machining, Stations 13 and 14</u>
(Mass Limit - 1 Kg U-235)

A few of the meats require special machining to accommodate instrumentation such as thermocouples. This is done at a surface grinder, Station 13, and a milling machine, Station 14. The machining is done on a single piece of material at a time. The nuclear safety is based on the same considerations as set forth for the equipment at Stations 9 and 10, Section 3.7.5.6.

3.7.5.10 <u>Assembly, Enriched U-ZrH Elements, Stations 15-20</u>
(Mass Limit - 3.0 Kg U-235)

The accepted meats are inserted into aluminum, stainless steel, Hastelloy, or Incoloy tubes at Station 15 and sealed by welding at Station 16. They are then checked for leak tightness at Station 18 and 19. Finally, the elements are inspected dimensionally and visually at Station 20, and stored in the vault-type room as finished elements. Elements are processed singly during this work, other than at Station 18, and carts are used to hold the meats awaiting assembly and the assembled elements.

Station 17 is a Magnaform machine, an electro-magnetic swaging process, used to swage control rod followers to special fuel elements.

Special cluster-type fuel assemblies are sometimes made at Station 15 by assembling four finished fuel elements into a four rod square with outside dimensions of 3 in. by 3 in. These assemblies are inspected at Station 20, placed into shipping containers and removed from the facility.

Nuclear safety at Stations 16, 17, and 19 is based upon a single fuel element being in the station and the same considerations as set forth for Stations 9 and 10, Section 3.7.5.6, apply.

Nuclear safety at Stations 15 and 20 is based upon the four rod fuel assembly. The safety is demonstrated by Fig. 10 of TID-7028 (Ref. 3.7-5), which shows that the critical diameter of a 50/1 H/U-235 mixture, fully water reflected, infinitely long cylinder is 5 in. The diameter of the equivalent four-rod-cluster cylinder is 3 in.

For interaction purposes, the 3 in. x 3 in. x 15 in. four-rod cluster was replaced by a single cylinder of equivalent cross-sectional area and 15 in. long. Assuming only UZrH1.7 and 93.5% enriched uranium in this cylinder and neglecting the clad material as an absorber, the unreflected k_{eff} was calculated as 0.25. The atom densities used in this calculation and the H/U-235 ratio are given in Table I 3.7-2.

At Station 18 a chamber is used to apply Helium gas pressure to the outside of finished fuel elements as a part of the leak detector test. The chamber is a 6-in.-diameter cylinder. This size vessel has been demonstrated in Section 3.7.5.7 to be safe for loadings of hydrided fuel containing up to 3 Kg of U-235.

The interaction calculations assume the maximum content at each station.

3.7.5.11 Chip Washing, Station 21
(Mass Limit - 350 g U-235)

Chips generated during the machining process are degreased by a hot water rinse to remove foreign surface contaminants prior to reuse. The chips are held in a 5-gallon container, 12 in. in diameter and 14 in. high, and mass limited to 350 g U-235. Drying is accomplished by drawing air through the chip container to the exhaust system.

Nuclear safety for any degree of moderation and flooding is ensured by the 350-g limit, which is less than standard limit Type A in Section 5.5, Part I. Safety in the event of double batching is also assured.

3.7.5.12 Pickling, Station 23
(Mass Limit - 350 g U-235)

Occasionally material becomes oxidized on the surface or scrap is generated that cannot be recycled. This material can be treated by acid dissolution before reuse, storage or disposal. A unit containing no more than 350 g U-235 is brought to the hood located in the fines burning area. Portions of the scrap material are taken from the container and surface pickled in a nitric - hydrofluoric acid solution. The procedure is repeated until all of the scrap material from the container is processed, until the acid solution is depleted, or until an amount of material containing up to 350 g of U-235 has been processed. When any one of the above conditions is met, the solution containing the dissolved scrap is transferred into a special acid-resistant storage container. Dissolved material from more than one scrap unit may be accumulated in the solution storage container, but the mass limit of the solution storage container is 350 g of U-235.

Since the dissolver is mass limited to 350 g of U-235, its nuclear safety is based on standard limit Type A in Section 5.5, Part I. Criticality safety of the scrap dissolver storage containers is also assured by the 350 g U-235 mass limit.

3.7.5.13 Weighing, Station 24
(Mass Limit - 3.6 Kg U-235)

A weighing balance is located at Station 24 in the hydride area. This station is normally used to weigh single fuel meats, but it may also be used to weigh containers. Nuclear safety is justified on the same basis as Stations 4 and 5 in Sections 3.7.5.1 and 3.7.5.2.

3.7.5.14 D-2 Type Stations
(Mass Limit - 350 g U-235)

General operating stations called D-2 type are periodically required within the TRIGA Fuel Fabrication Facility to accommodate nonstandard operations that affect special fuel element fabrication. The nuclear safety of the D-2 type station is based upon the limit of 350 g of U-235 at each of the subject stations. This quantity is Standard Limit Type A in Section 5.5, Part I. The criteria for the stations are: they may be located in a fuel processing area provided that (1) the solid angle produced by the addition to the D-2 station does not exceed the allowable total solid angle of any interacting station, (2) the total solid angle seen by the D-2 station does not exceed 2.50 steradians which is based upon a keff of 0.650 for the 350 g U-235 mass limit, and (3) all of the D-2 type stations will be documented and shall be approved by the Fuels Quality Assurance Division.

3.7.5.15 Patterson-Kelly Twin Shell Blender, Station 26
(Mass limit 350 g U-235 or any mass of oxide ash from the controlled burning of UZr alloy containing less than 11 wt% U-235).

The V-blender is formed of two 5.5" i.d. type 304 stainless steel tubes joined to form a 90° elbow. The V-blender rotates about an axis forming an isoceles triangle with the axis of the two tubes. The volume contained in the V-blender is 6.035 liters.

For operation under the 350 g U-235 limit the nuclear safety of the V-blender is justified under Standard Limit Type A, Section 5.5, Part I.

For operation with oxide ash from the controlled burning of UZr alloy, the nuclear safety is based on analysis. The analysis considered the V-blender to be a sphere of equivalent volume filled with a homogeneous mixture of the oxides formed by stoichiometric oxidation of UZr alloy containing 11.2 wt % U-235 to ZrO_2 and UO_2. Calculations using the DTFX transport code with 18 broad group cross sections generated by the MICROX spectrum code were made for H/U-235 ratios from 500 to 25 and for bare and reflected spheres (Ref. 3.7-8, 3.7-9). Conservatism is built into the calculation by the assumption of spherical geometry, consideration of a reference maximum reactivity alloy, the use of crystalline densities for the oxides, and the assumption of homogeneous mixing of the oxide and contained water. The results of the calculation are shown in Fig. I 3.7-6. The maximum k_{eff} in the two cases is as follows:

Unreflected k_{eff} = 0.67 for H/U-235 = 200, 0.104 kg/ U-235

Reflected k_{eff} = 0.88 for H/U-235 = 150, 0.130 kg/ U-235

3.7.5.16 Hydride Boat Hood, Station 30
(Mass Limit - 3.0 Kg U-235)

A hood is located in the hydride area for use in loading and unloading the fixtures (boats) used in the hydride furnace. Each of these boats is up to 5.5 inches OD by 12 inches long. They are held in two parallel cylindrical rows, each up to 4 feet long, within the hood. A metal fixture is provided to assure a 12-inch, surface-to-surface separation of the two fueled cylinders. Fuel meats are moved to and from the station on standard move carts, and are handled singly between the cart and the boats in the hood.

The nuclear safety of the station is based upon the 3.0 Kg U-235 limit and the 5.5-inch outer diameter of the fixtures. Figures I 5.4-25 and I 5.4-29 show that this configuration and loading has a minimum safety factor of 2.3 when fully water-moderated and reflected. This occurs when the material is concentrated in a cylinder about 32 inches long. Any other distribution of the fuel within the cylinder has a greater safety factor. Hence the safety of the system is demonstrated.

The reactivity of the system is obtained from an analysis based on the fact that the area of the envelope of the hexagonal fueled area within the fixture (19.339 sq. in.) is less than the area of a 5-inch cylinder (19.635 sq. in.) and the neutron leakage of a hexagonal shape is larger than that of a cylindrical shape. For this reason the bare and reflected reactivities for 5-inch cylinders 0.58 and 0.95 may be assumed for each of the two locations in the hood.

3.7.5.17 Waste Barrel Storage Area, Station 31
(Mass Limit - 235 per barrel)

Marked areas may be established for the holding of scrap and waste barrels prior to removal from the facility. Each area will be designated for a fixed maximum number of 55-gallon barrels. Each barrel may contain up to 225 gms of U-235. The barrels are to be upright, in a single stacked plane array.

The highest area density is realized in a triangular close packed array of barrels. A typical 55-gallon barrel is 22.5 inches in diameter and occupies 2.637 sq. ft. in such a close packed array. If the barrel contains the 225 gm limit of U-235, the equivalent SNM area density is 85.3 gms U-235 per sq. ft. The nuclear safety of this type of station is, therefore, based on Standard Limit Type E in Section 5.5, Part I. The maximum area density is less than 160 gms U-235 per sq. ft. and the maximum unit is less than 250 gms U-235. The applicable keff are therefore 0.71 reflected and 0.55 bare.

Interaction calculations shall be made on each waste barrel storage area that is established. These calculations shall be used to establish the minimum distance that SNM move carts may be spaced away from the array.

3.7.5.18 Fines Furnace, Station 2 (alt.)
(Mass Limit - 350 g U-235)

The fine UZr scrap resulting from various operations is burned to oxide at Station 2. This burning is carried out at regulated temperatures using a controlled flow of an N_2/O_2 gas mixture. The material to be burned is generally in the form of damp, bulk fines or as filters loaded with fines.

A 500 gal. tank connected to the end of the furnace tube is isolated from the tube by a rupture disc. In the unlikely case of an overpressure in the furnace tube, the rupture disc will break, releasing the pressure to the expansion tank. Both the tank and furnace tube have been designed and constructed to the intent of the applicable ASME pressure vessel code for a 200 psi working pressure. They have been approved by a pressure vessel inspector for the State of California. Normal furnace exhaust is through the by-pass line around the rupture disc and into the expansion tank. The expansion tank outlet is connected to the building exhaust duct overhead. A handhole in the tank permits periodic sampling of the internals for U. A drain on the bottom permits the removal of condensation.

A glove box mounted on the front end of the furnace tube assures containment of the fine particles during handling and furnace loading/unloading operations. The glove box is connected through a prefilter to the overhead exhaust duct. Four stainless steel fines burning trays about 5-1/4" - 5-1/2" wide by 18-1/2" - 18-3/4" wide by 1-1/2" high can be loaded from the glove box into the furnace tube on a rack specially designed to hold them. For burning filters, two trays which approximate cylinders 6-1/2" ID by 18"-18-1/4" long, cut vertically in half, can be loaded into the furnace tube.

The station limit, when operated in the fines burning mode, is 350 g U-235. The nuclear safety is justified as standard limit Type A in Section 5.5, Part I.

1

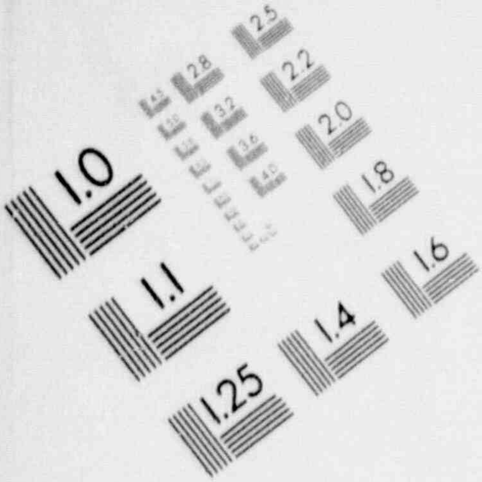
IMAGE EVALUATION TEST TARGET (MT-3)

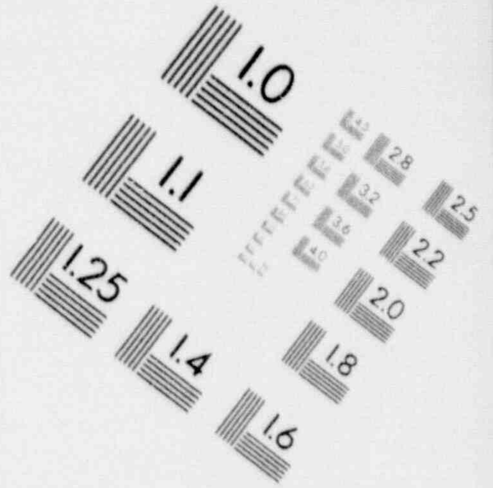
150mm

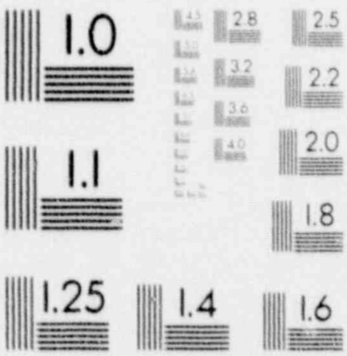
6"

1

IMAGE EVALUATION TEST TARGET (MT-3)







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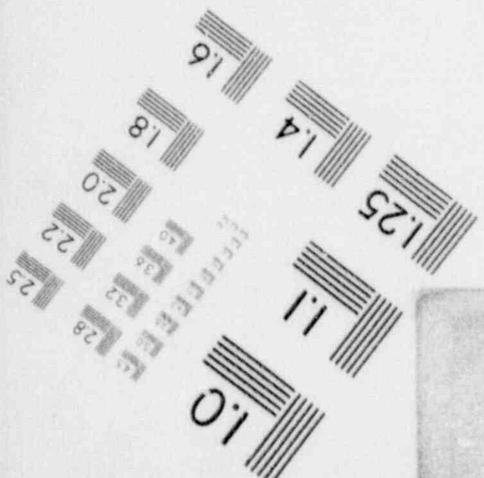

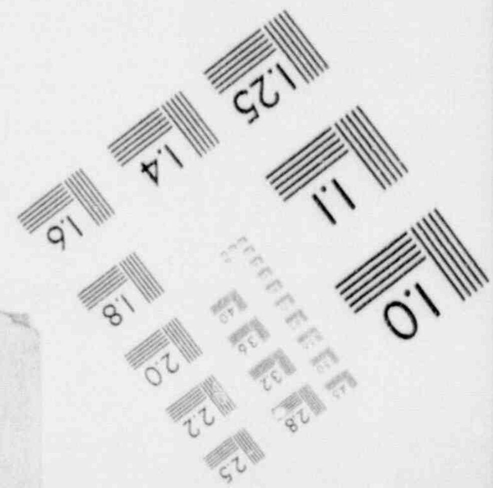

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0

150mm

6"

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3.8 RESERVED

3.9 RESERVED

3.10 RESERVED

3.11 WASTE DISPOSAL YARD **(TO BE REVISED)**

The Waste Yard is enclosed by an 8-ft-high chain link fence, including a barbed wire extension. The yard is occupied by and under the control of authorized personnel during working hours and is secured by a lock keyed to the security system at off-shift times. A security patrol checks the yard at least every 4 hours during nonworking hours.

3.11.1 Waste Yard Operations

The Waste Yard is an area set aside for collection. processing, and packaging for ultimate disposal of wastes and scrap generated in various facilities at the San Diego site. The Waste Yard (Fig. I 3.11-1) consists of service buildings, office, yard storage area, upper storage array and adjacent evaporation ponds. An incinerator for burning combustibles contaminated with SNM is located nearby and is a part of the Waste Yard operations; it is described separately in Section 3.12, Part I. The By-Products Storage Area is located within the Waste Yard but is not involved in waste processing operations. This is discussed in Section 3.3, Part I.

Radioactive waste is not normally buried on site. On-site waste processing consists of the following types of operations:

Solid Dry Waste - Shipped to commercial land burial facility in metal drums or wooden boxes. Some waste materials may be compacted in bales and placed in wooden boxes prior to shipment.

Water - Filtered or evaporated in solar evaporation ponds. The sludge resulting from filtering or evaporation is mixed as appropriate with absorbent and solidifying materials in metal drums, then shipped to commercial land burial.

Acid - Mixed with neutralizing agent, absorbent and solidifying materials in metal drums prior to shipment to commercial land burial.

Radioactive waste, generated at the Hot Cell Facility, is packaged at the Hot Cell for direct removal by a carrier to the commercial waste disposal company.

In summary, the main functions of the Waste Yard are to reduce the volume of liquids, convert liquid residue to solids and compaction prior to disposal by licensed radioactive waste disposal companies. These operations naturally divide into the processing of liquid waste and solid wastes. More detailed descriptions follow.

Liquid Wastes

The San Diego site operations which generate liquid wastes containing radioactivity have collection facilities which may range from collection bottles to barrels to plumbing systems and tanks. Those facilities where a possibility exists for significant amounts of U-235 to enter the collection system have critically safe geometry holding tanks. The liquids in the various collection vessels are sampled and analyzed by Quality Control or the Chemistry Department and checked by Health Physics Services before withdrawal for transport to the Waste Yard.

Transport of aqueous waste is accomplished in plastic containers, 55-gallon drums, or up to 500-gallon tank trailers. In any case, a maximum limit of 350 g of U-235 content is observed; experience has shown that the bulk of the aqueous waste is decontamination water and air scrubber water and that the limiting factor on transport is the bulk of water, not the SNM content. These wastes are transported to the Waste Yard for processing.

The evaporation ponds consist of four large concrete ponds each 20 ft by 60 ft and 2 ft deep with a total capacity of about 70,000 gallons. Two of these ponds are subdivided into three 20-ft by 20 ft ponds by means of 2 ft high separators. One of the ponds is subdivided into a 20 ft by 20 ft and a 20 ft by 40 ft by a single 2 ft high separator. The fourth pond is subdivided into three 20-ft by 20 ft by means of 1 ft high separators and, hence, when full, operates as a single large pond, but when the liquid level is low operates as three separate ponds. The basic SNM limit is 350 g of U-235 per pond, large or small. The level of the three small ponds is not allowed to rise to the point where the small ponds merge unless the total inventory in the three is less than 350 g of U-235, and normal practice is to hold the sum of the three below 350 g. The ponds are protected during inclement weather by a removable covering. The surfaces around the ponds are paved and walled to form a catch basin.

The SNM content of incoming aqueous wastes in the drums and/or trailers is established by sampling at the point of origin and by subsequent analysis. This SNM is added to the pond SNM inventory books when the waste is added to a particular pond.

The pH of the water in the ponds is periodically checked and neutralized by the addition of chemicals, if necessary. The solids and sludge settle, and the water evaporates until a damp sludge remains. This residue is shoveled out and mixed with absorbent and solidifying materials in metal drums, then shipped to commercial land burial. Evaporation to dryness is not allowed, since contaminated solids (dusts) might be blown outside of the pond.

The nonaqueous liquid wastes are also sampled and analyzed for SNM content. These materials are neutralized, if necessary, and mixed with absorbing and solidifying materials in metal drums prior to shipment to commercial land burial.

The solidification process is conducted near the area marked Acid Basin on Fig. I 3.11-1. The radioactive materials involved are wet and do not evolve dust so this operation may be safely conducted in the open. The process involves placing the barrel below a large power mixer and gradually adding the neutralizing materials and then the solidifying agent, typically cement. The mixed barrel is then set aside to solidify. After proper solidification takes place, the barrel is closed, secured, and placed with the other barrels awaiting shipment for burial.

Solid Wastes

Each San Diego site operation generating solid radioactive contaminated waste collects this material in designated receptacles. This waste is segregated into collection containers typically identified as compactable or compactable waste and as containing SNM or not containing SNM. The collection containers range from plastic bags in the laboratories to barrels and boxes at the fuel fabrication facilities. If known amounts of SNM are to be disposed of in waste, the material is logged into the container. Health Physics personnel assigned to the waste generating facilities routinely monitor the waste containers. There is a limit of 100 g of U-235 per barrel and 100 g per box, and any container with over 100 g must be released by responsible management before it is picked up for removal to the Waste Yard.

Outside storage at the Waste Yard is in 30-gallon, or larger, drums or Department of Transportation (DOT) specification wooden boxes. Any cardboard or fiber boxes received are kept in covered storage until they are put into containers suitable for outside storage. Each container is marked by paint and stencil with the identity and quantity of the contained material.

The solid waste operations performed at the Waste Yard are those needed to incinerate, compact or bale the waste and make it ready for shipment to authorized disposal sites. The incoming solid wastes may be segregated into burnables for incineration and nonburnables for compaction. Incineration is described in Section 3.12. The resulting incinerator residue is either held for possible reclamation of the contained SNM or it is put into the nonburnable waste cycle.

The compactable waste is compacted into bales. The location of this operation are shown in Fig. I 3.11.1. This operation is accomplished using power actuated equipment with any resultant dust drawn off by a hood that exhausts into a high-efficiency air filter system. All additions of SNM-bearing waste to any accumulation, such as a compacted bales, are done with strict observance of applicable limits on the SNM content.

Procedures prohibit opening containers of dry waste while outside, except when bagged material may be added to containers that hold only bagged material. The bags used are made of substantial plastic with the openings well secured.

All barrels are closed with lids, locking rims, and securing bolts. Shipping boxes are banded and strapped. There has never been a wind in the region of the San Diego site that would be capable of moving or opening these containers. All outside container storage is on asphalt pavement to assure proper drainage and impede corrosion. Corrosion of drums is very low; very little is perceptible when observed over a 3-year span. Drums in storage are checked on a routine basis for signs of leakage and corrosion. At least 10 percent are checked each month and any drum showing signs of deterioration is replaced.

3.11.2 Nuclear Safety

Typical waste containers are 30-gallon or larger volume and occupy at least one square foot of area. No one container may exceed 0.5 g U-235/liter or 100 g U-235 total. For nuclear safety, the assumed areas are those for close packed, minimum area arrays. All containers are stored in a single layer plane array. Each of these storage units, either singly or in mixed array, is less than 160 g U-235/ft2 and less than 250 g U-235/unit, or subcrit, hence, the nuclear safety of the storage is justified on the basis of being more conservative than standard limit Type E.

Uranium wastes and scraps, enriched to less than 20% U-235, may be stored outdoors. Such storage may be in 55-gallon or larger metal barrels with maximum content of 350 gm U-235/ barrel. The effective area density of a close packed array of these barrels is 114.94 g U-235/ft^2. The nuclear safety of this storage is based upon standard limit Type F.

Nuclear isolation is not required between the above types of outdoor storage because all are less than the area density limit of 160 g ft^2 in standard limit Type E and those units that exceed the unit mass limit of 250 g are justified as safe in the array under standard limit Type F and no credit has been taken for the absorption of neutrons in the U-238 in the low enrichment uranium.

SNM in approved shipping containers may be temporarily stored outdoors while awaiting transport or unloading. All limits applicable during transport shall be observed in this storage. Each barrel shall be closed with a bolted locking ring. Each container shall have an identifying serial number printed on it. Written records of the identity and quantity of material, by container serial number, shall be maintained.

Liquid wastes are subject to the same SNM limits imposed on the 55-gallon drums. In each case, the SNM content of liquid is established by sampling and analysis before the liquid is added to an accumulation that is not in an "always safe" geometry. Authorized signature release procedures are utilized to control this phase of the operations and to assure that the basic limits are observed. At any subsequent point where wastes may be held that cannot be flushed after each load, such as underground holding tanks, another SNM determination is made prior to subsequent transfer; this sample is based on a thorough air sparge followed by sampling and analysis. Vessels, such as 55-gallon drums and the tank transport trailers, are flushed after each use and undergo a routine gamma sensitive survey to detect possible SNM accumulation. The evaporation ponds are subject to the 350 g U-235 limit and are individually safe on the basis of standard limit Type A, Section 5.5, Part I.

The SNM in each pond is well distributed over the pond area either in solution or as sediment. An array of adjacent ponds, each containing 350 g of U-235, is safe in that the effective area density of the contained SNM is very low, on the order of 1 g/ft^2. If the materials in two adjacent ponds become agglomerated in optimum configuration on each side of the 6-in. concrete separating wall, it would amount to only 85% of the minimum critical mass, ignoring the effect of the intervening concrete.

3.11.3 Radiological Safety

All operations at the Waste Yard are monitored by gamma sensitive criticality alarms, in conformance with 10 CFR 70.24. These alarms are equipped with local lights and warning horns plus remote alarms which signal into the central security office.

Health Physics makes contamination and radiation surveys in the Waste Yard monthly, or more often if circumstances indicate it would be desirable, to determine if there are significant radiation or contamination levels.

All operations that might expose personnel to airborne particulate radioactivity are monitored by portable air samplers and subsequent counting of the resulting samples.

Suitable protective clothing and equipment are used where there is a splash or dust hazard.

The evaporation ponds are enclosed by wire mesh screening to prevent the entry of small animals and birds. These ponds are never allowed to go to dryness unless the pond has been cleaned; this prevents the residue from becoming powdered and airborne.

3.12 RESERVED

3.13 RESERVED

3.14 TRANSPORTATION AND SHIPPING

Within the license provisions established in Part II, NMA assures compliance with applicable regulations in transportation and shipping activities including preparation of shipments, transfer to commercial carriers, on-site movements of SNM, and transportation between facilities at the San Diego Site.

3.14.1 Administrative Procedures

Physical movements of SNM are accomplished in accordance with internal written procedures issued or approved by LSNC, and in compliance with the criteria governing transportation and shipping of SNM in GA's approved security plan, "Fixed Site and Transportation Plan for the Protection of Special Nuclear Material of Moderate and Low Strategic Significance."

3.14.2 Packaging

Preparation of shipments of SNM for transport is made in compliance with 10 CFR Part 71. Each container must be generally or specifically licensed and meet requirements of governmental regulations. NMA assures compliance with the license and regulations.

3.14.3 On-Site Transportation

With the exception of SNM in the form of waste, all material movement on-site requiring a transportation vehicle between facilities is the responsibility of NMA. Normally, a pickup truck is utilized to transport the material. If services from other internal company organizations are required, such services are under the supervision of NMA. Packaging for on-site movements depends on the kind and quantity of material and the type of vehicle used.

On-site movement of SNM meets the following criteria:

1. Packaging may be in accordance with 10 CFR 71 or as otherwise approved by Nuclear Safety within License Specifications, Part II.

2. Containers may be standard DOT-approved containers, NRC licensed containers, or those approved by LSNC within License Specifications, Part II.

3. Licensee's personnel will handle all SNM and drive the vehicle.

4. Radiological safety will be assured before movement.

5. Material transfers and/or signature procedures are utilized to document each movement.

Whenever the licensee transports SNM as a private carrier, such shipments shall be in accordance with applicable DOT and AEC regulations.

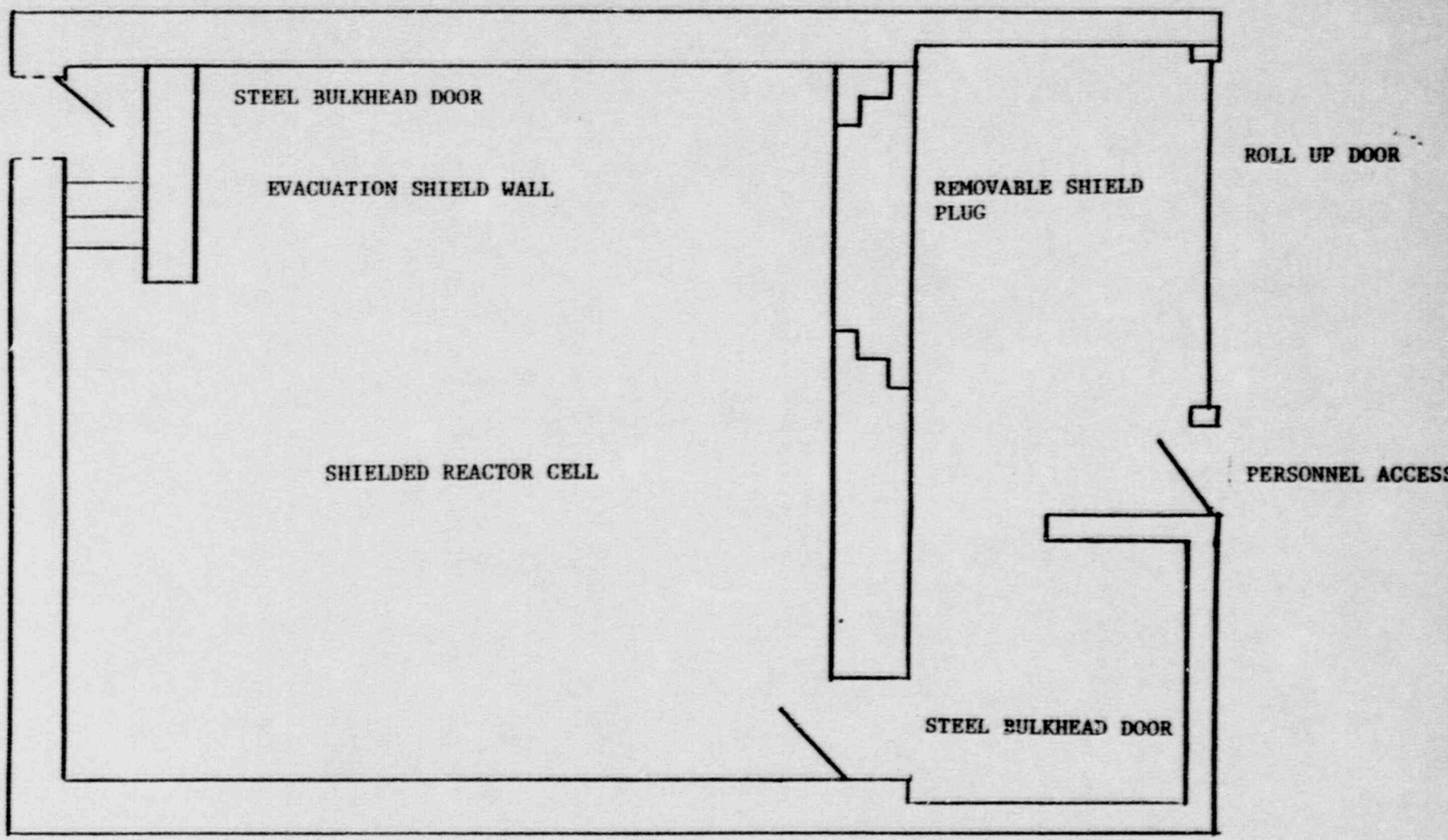


Fig. I 3.3-1 ECF REACTOR BUILDING PLAN VIEW

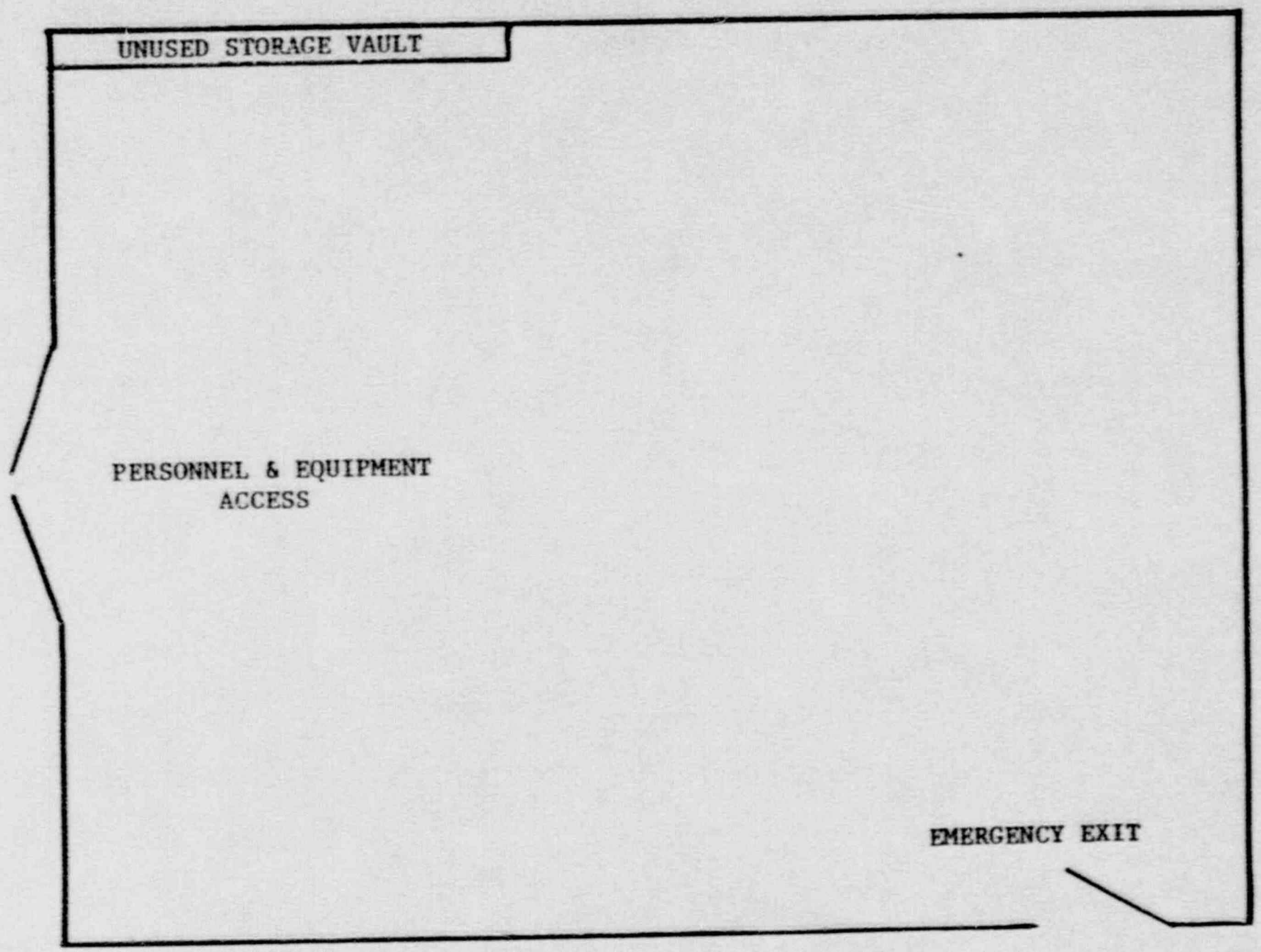


Fig. I 3.3-2 ECF ASSEMBLY BUILDING FLOOR PLAN

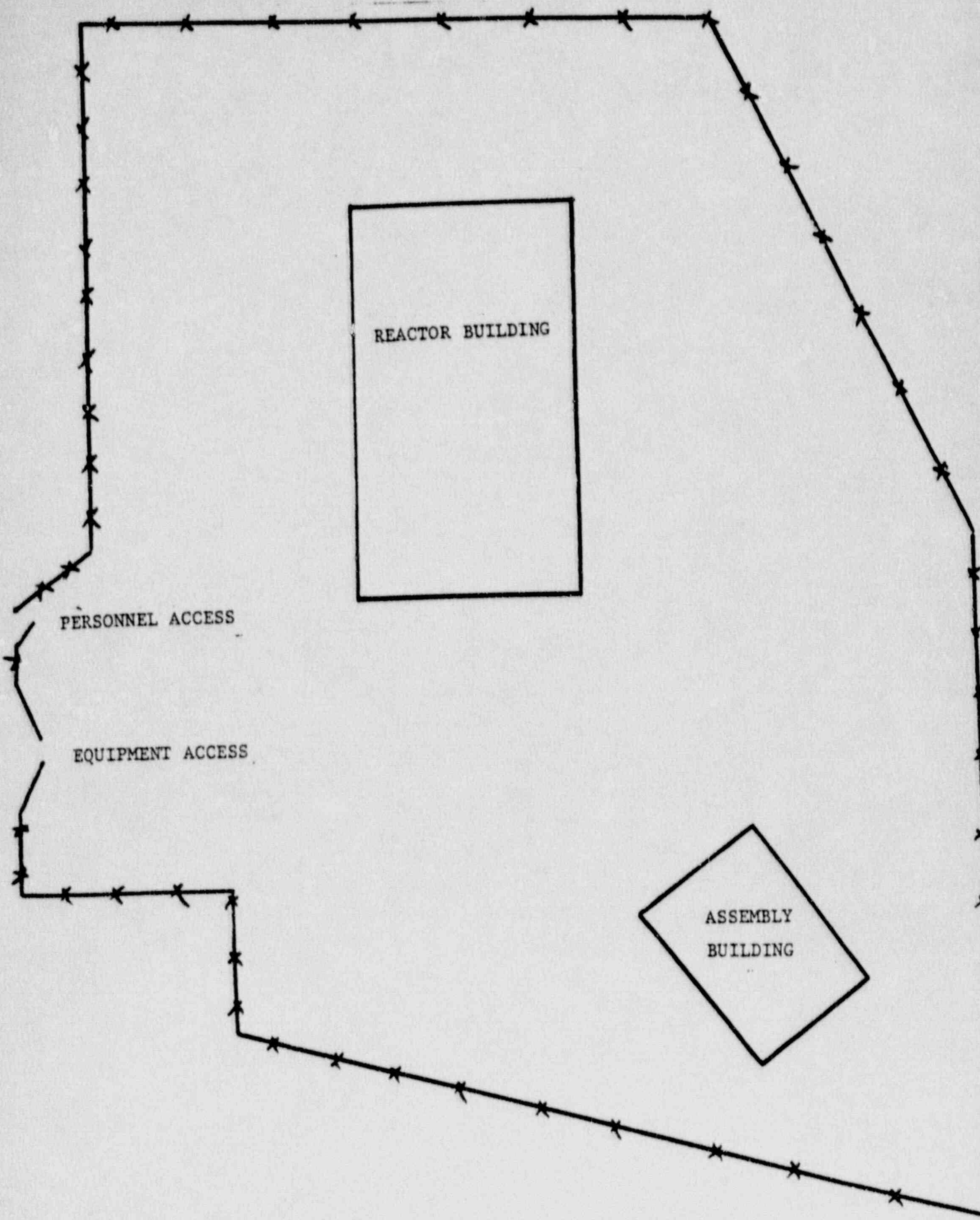


Fig. I 3.3-3 ECF FACILITY FENCE & BUILDING LAYOUT

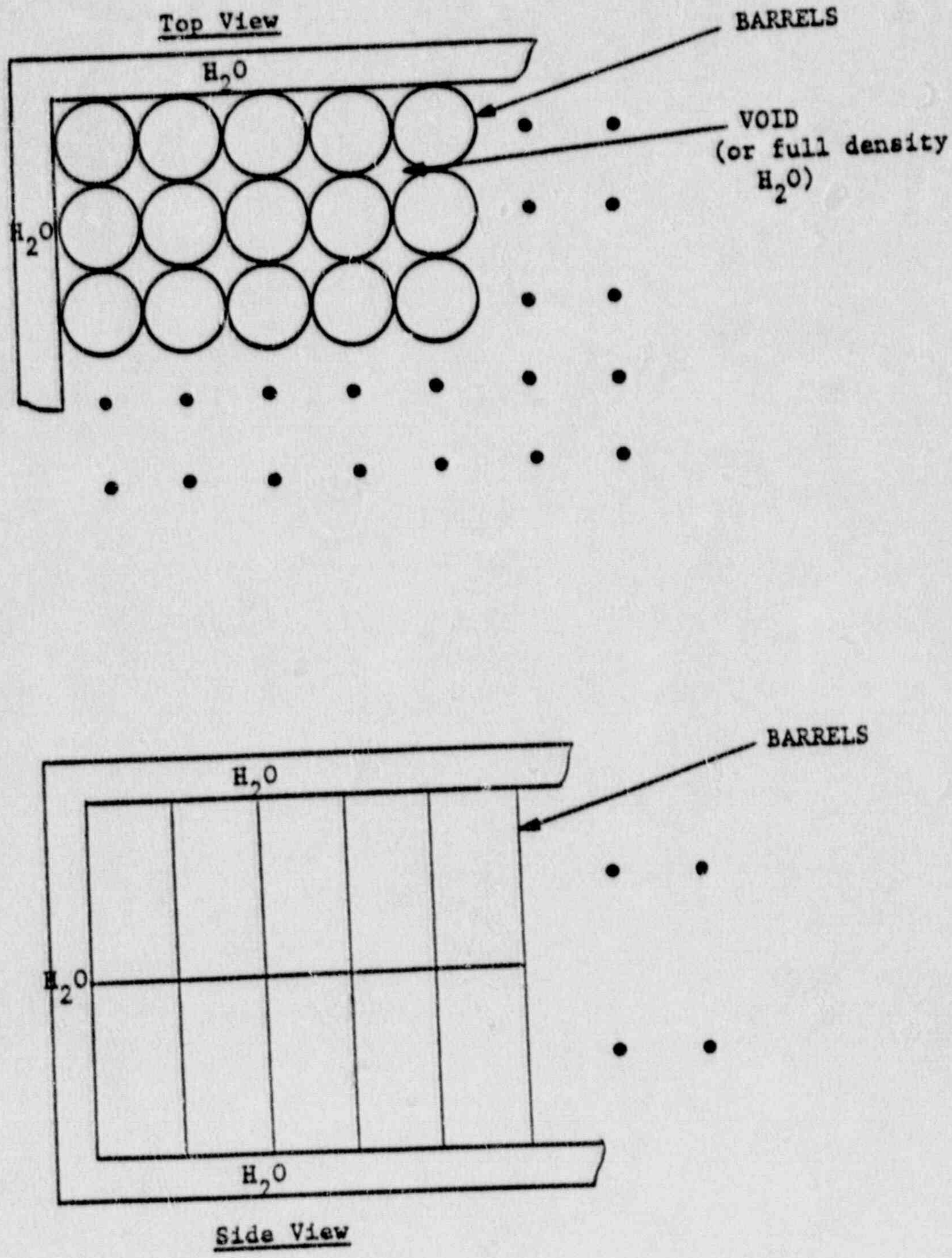


Fig. I 3.3-4 GEOMETRY FOR 23 X 14 X 2 BARREL ARRAY

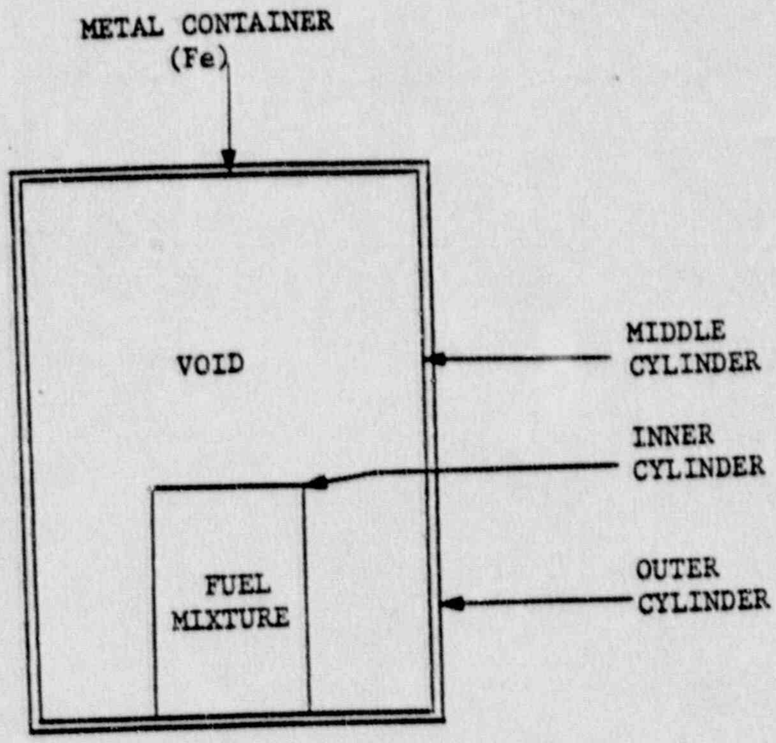


Fig. I 3.3-5 INDIVUDUAL BARREL GEOMETRY

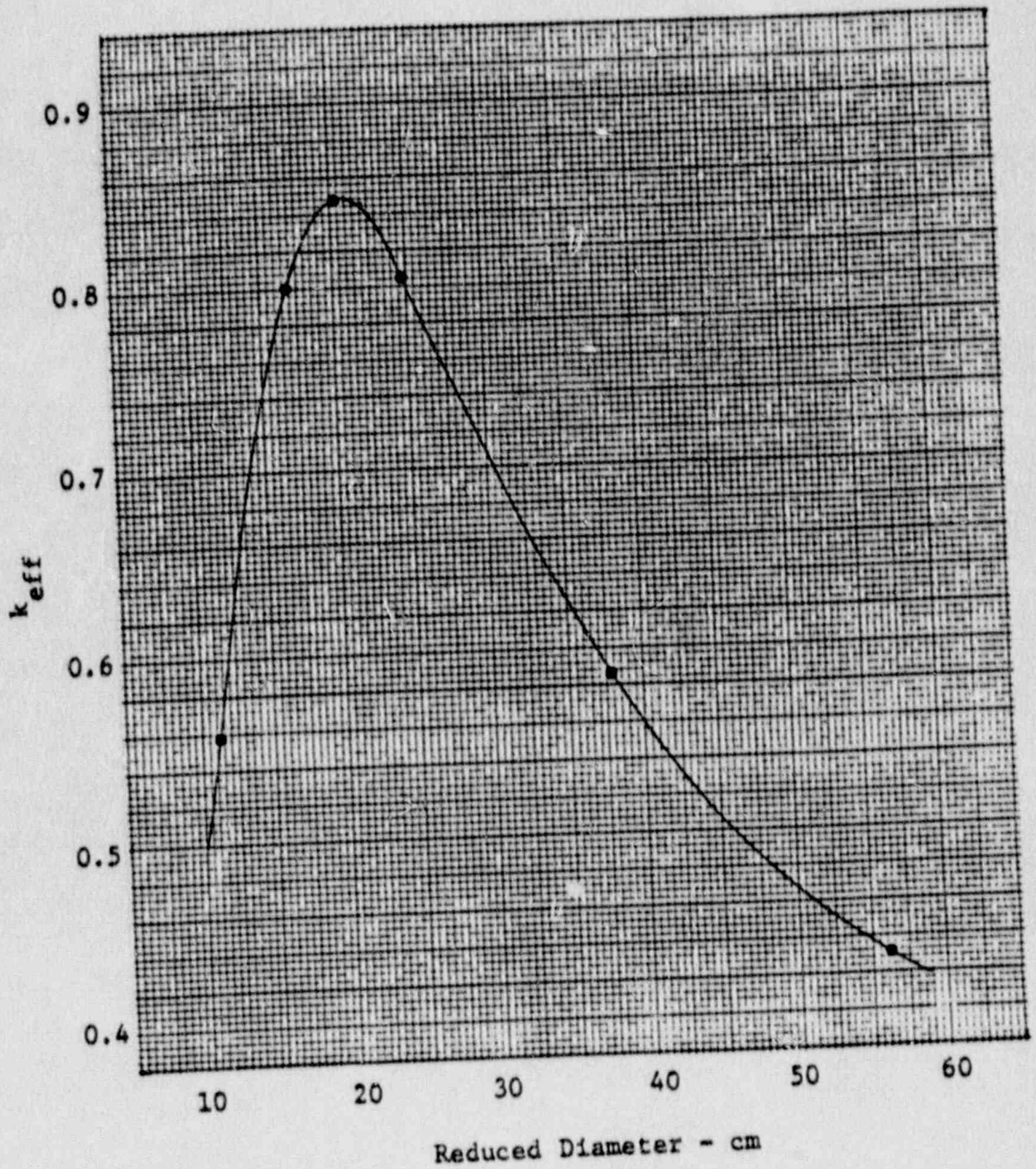


Fig. I 3.3-6 Plot of Reduced Diameter Versus k_{eff} of Array

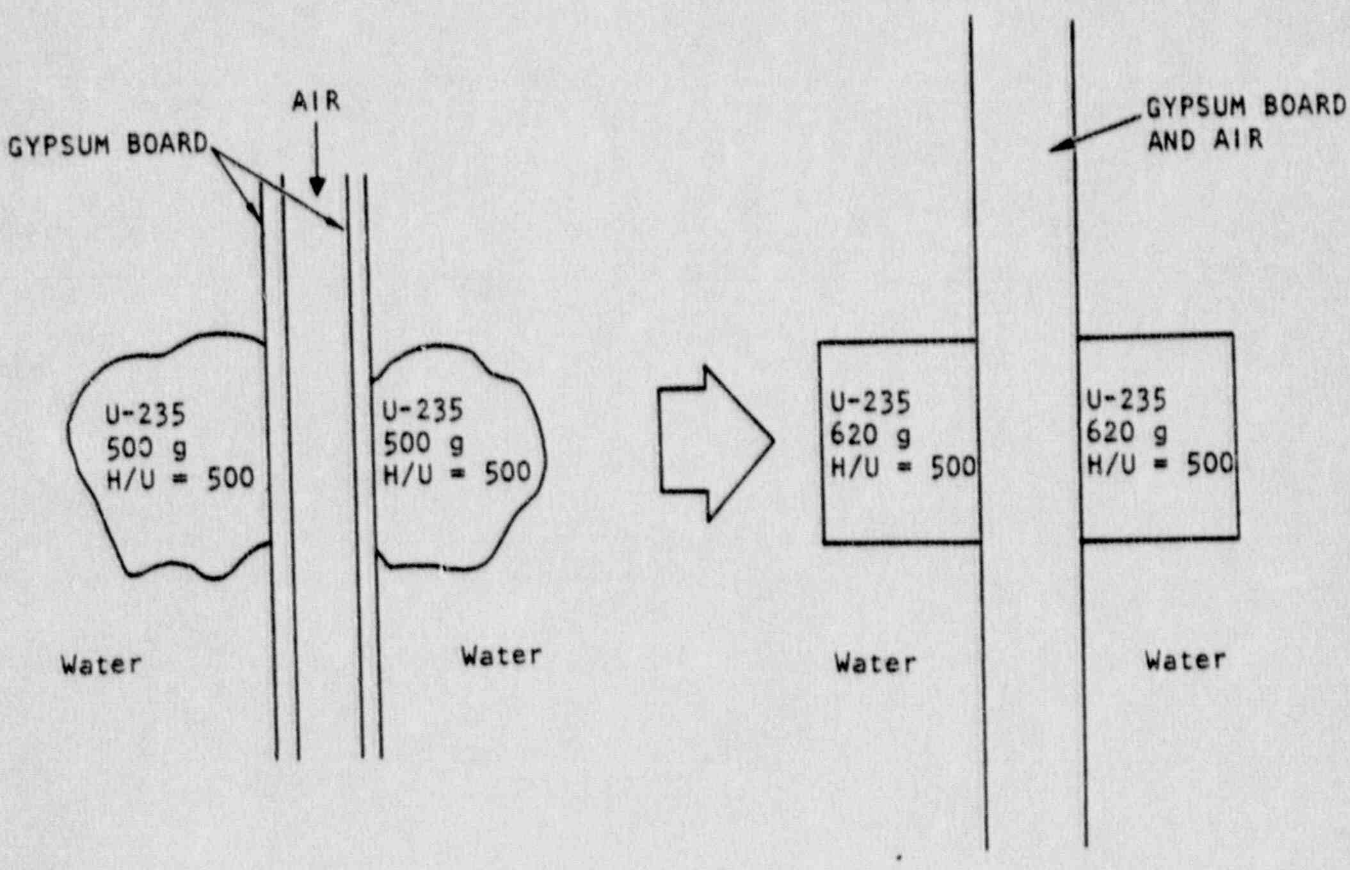


Fig. I 3.4-1. Models used

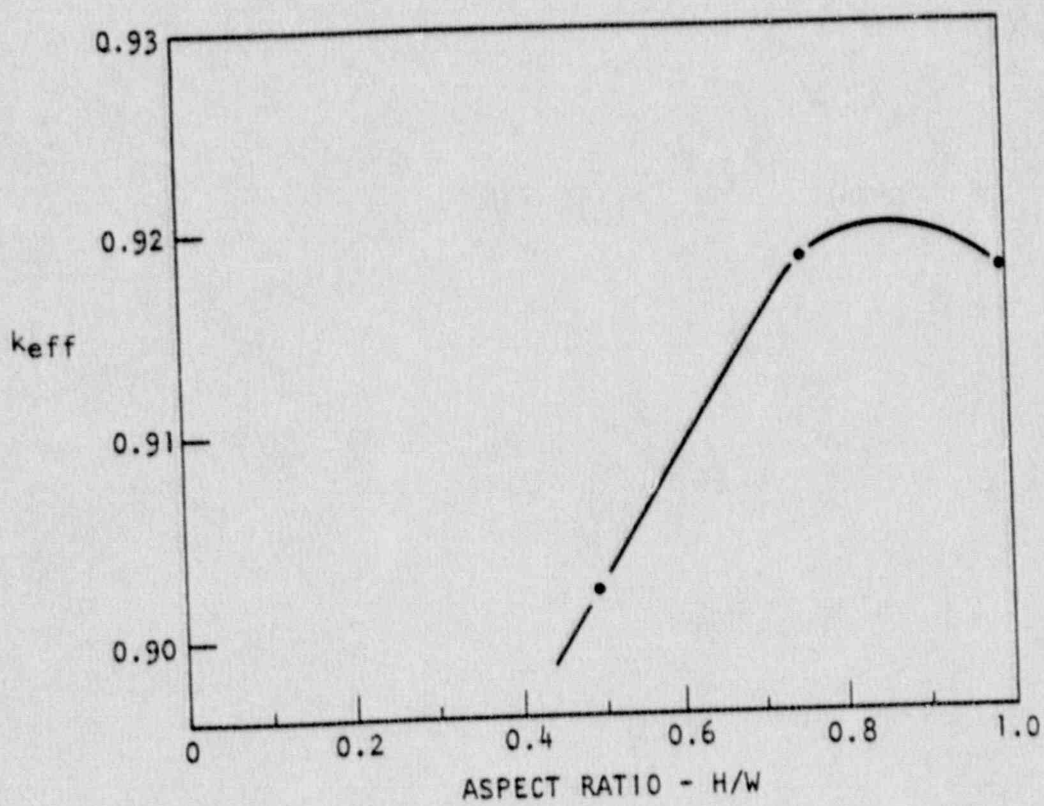


Fig. I 3.4-2. Reactivity versus aspect ratio

No.	Hot Cell[1]	Material	Form	Station Enclosed	Prefilter	HEPA
1	Hi Level Cell	U, Th, Fission and By-products	Solids, Particles, Solutions and Slight Quantity of Dry Powders	x	x	x
2	Low Level Cell			x	x	x
3	Metallography			x	x	x
4	Other	Contaminated Equipment Repair	Solid & Liquid	x	Fume Scrubber	x

[1] Cells use a common HEPA filter system with no flow alarm, blower failure alarm, high particulate radiation alarm, high gas radiation alarm, fire alarm, filter loaded (ΔP) alarm. The system is continuously monitored and has a stack radiation alarm.

TABLE 3.5-3
HOT CELL PROCESS CONTAINMENT & VENTILATION

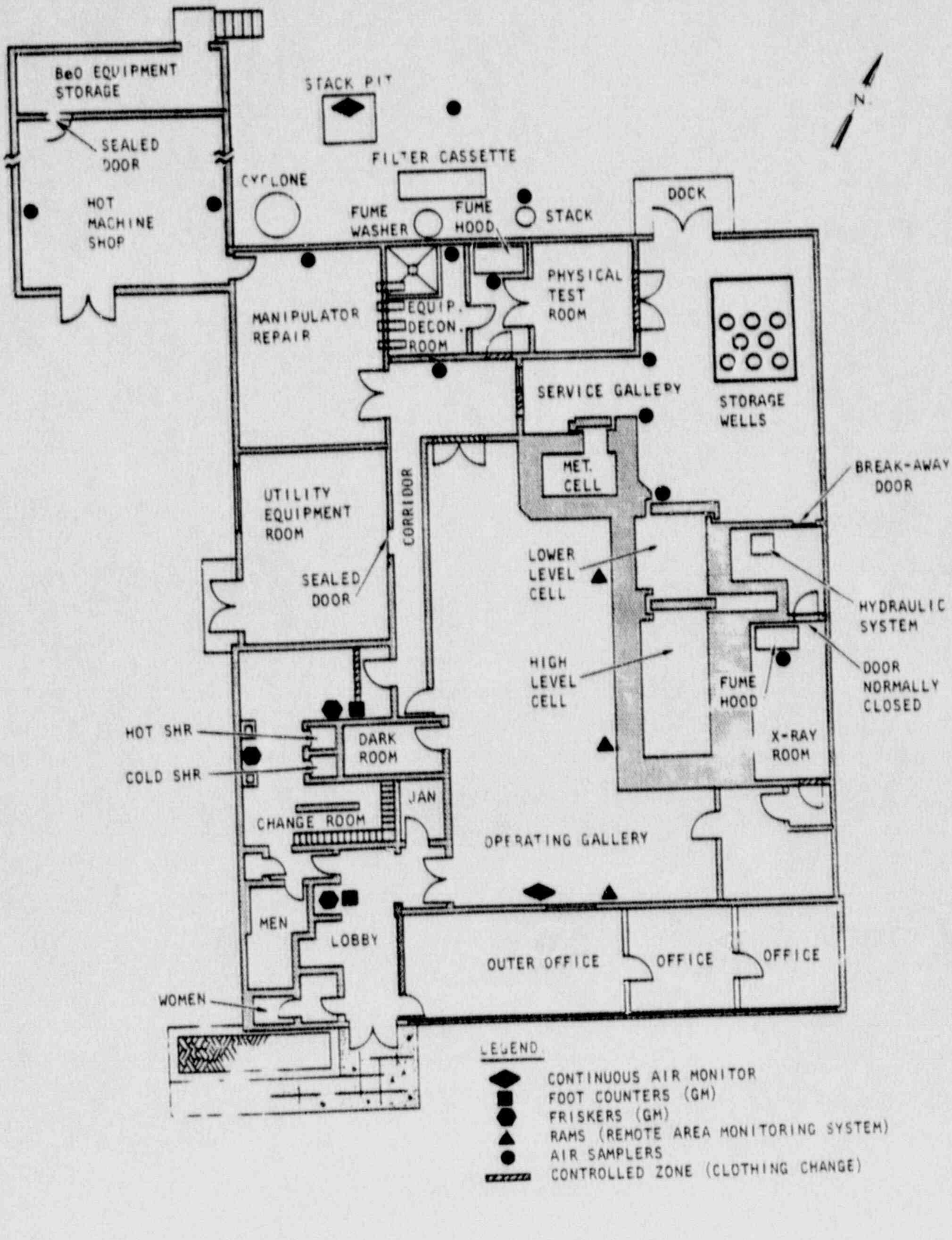


FIG. 1 3.5-1 HOT CELL FACILITY FLOOR PLAN

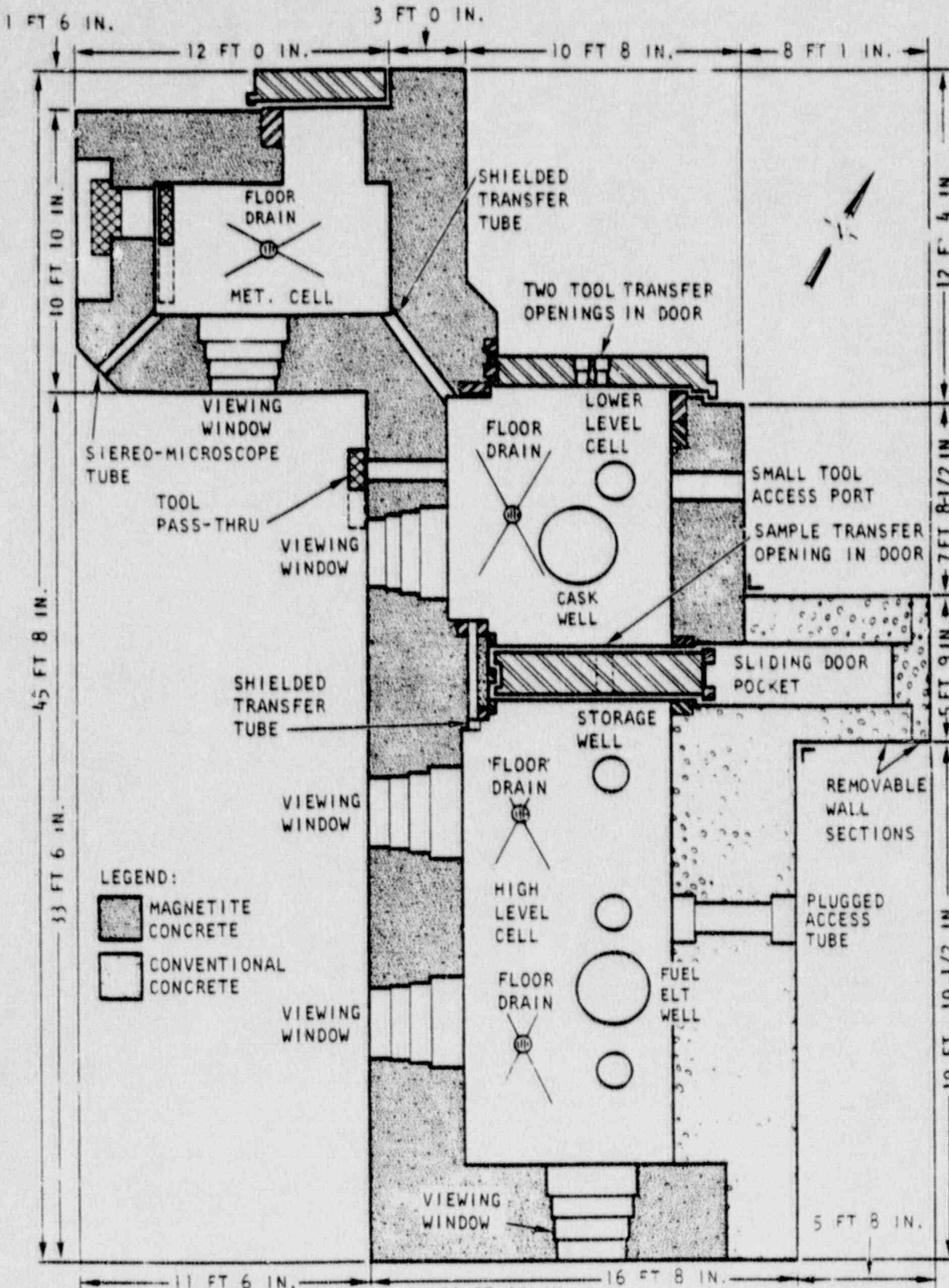


FIG. 1 3.5-2. PLAN VIEW OF THE HOT CELLS

TRIGA FUEL FABRICATION BUILD

SNM PROCESSING STATIONS AS OF O

GA-A12001, FIG I 3.9-2

DATA ELEVATIONS ARE 0.00 TO 20.00 FEET

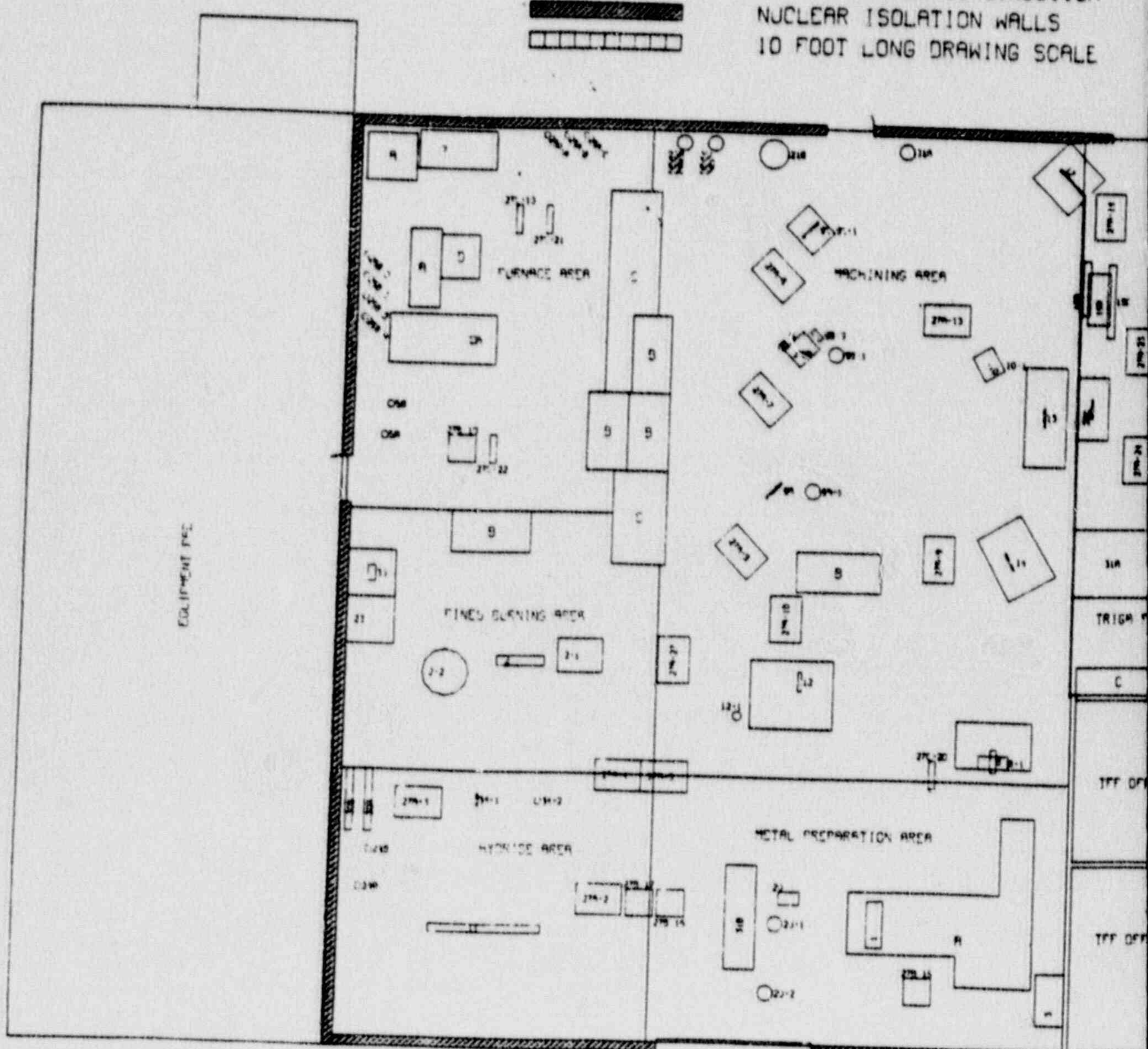
PLATFORM EDGE OR AREA OUTLINE

THIN OR SINGLE SURFACE WALLS

STANDARD WALL CONSTRUCTION

NUCLEAR ISOLATION WALLS

10 FOOT LONG DRAWING SCALE



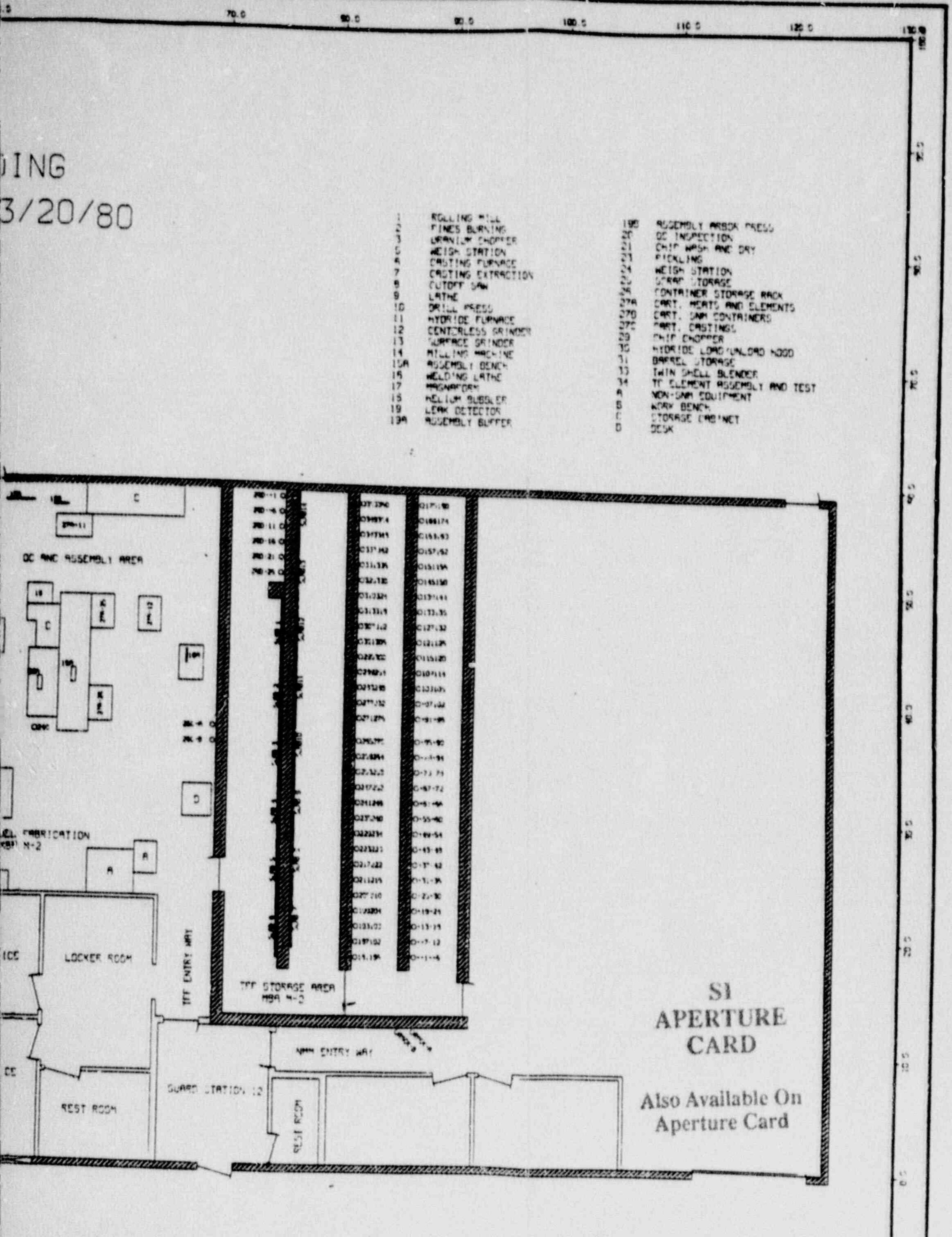


Fig. I 3.7-2. TRIGA Fuel Fabrication Building

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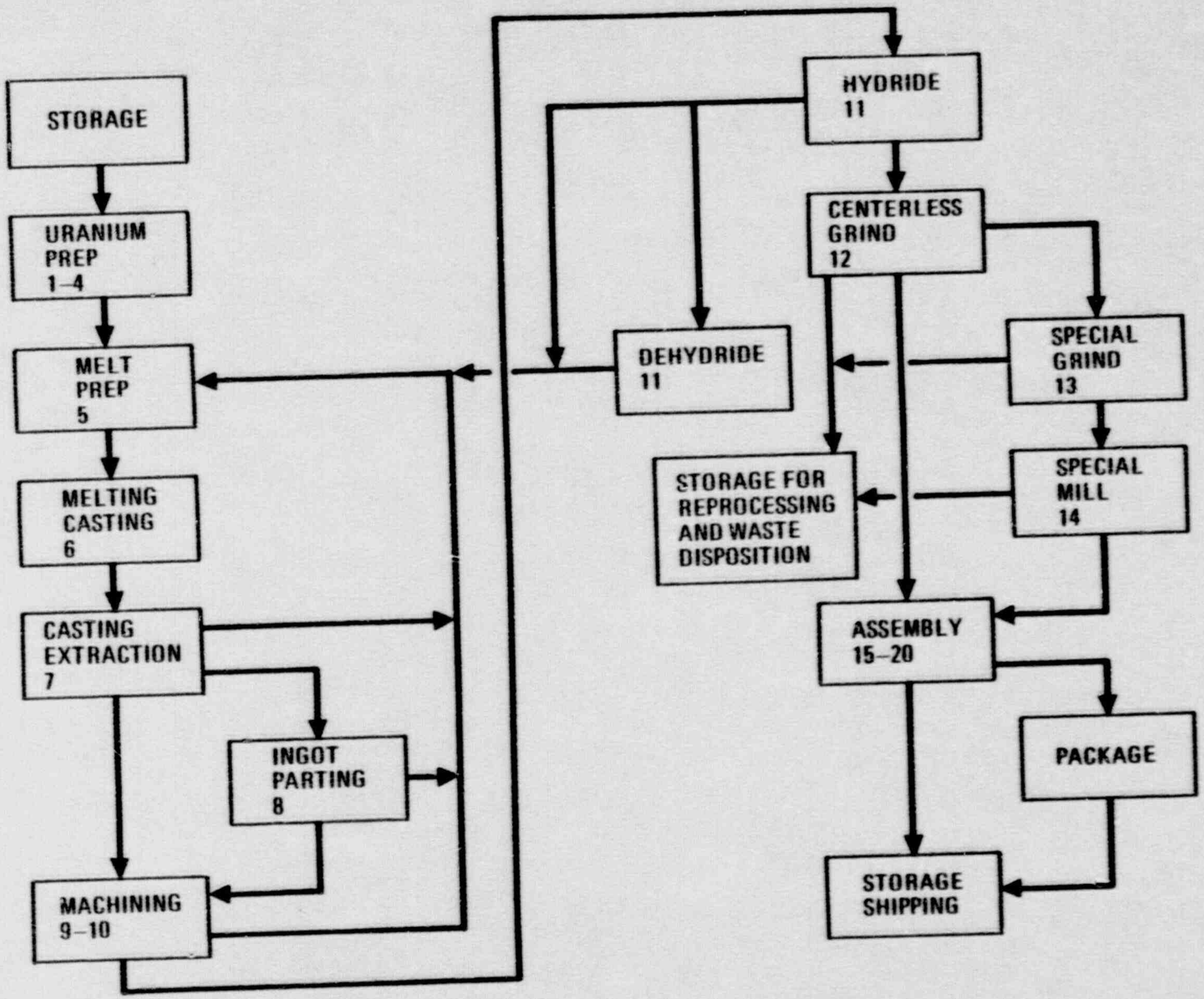


Fig. I 3.7-3. TRIGA fuel fabrication process

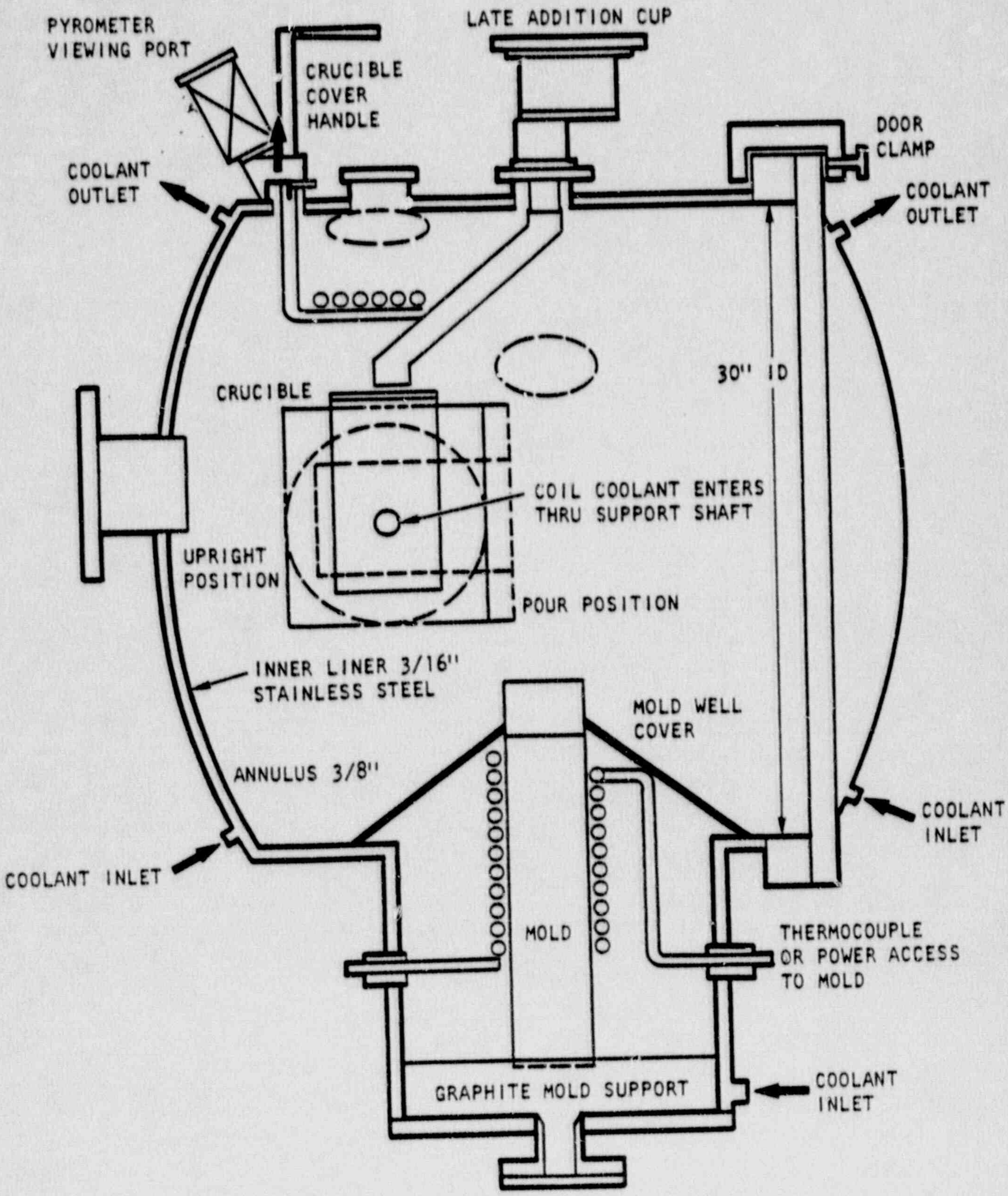


Fig. I 3.7-4. Induction Casting Furnace

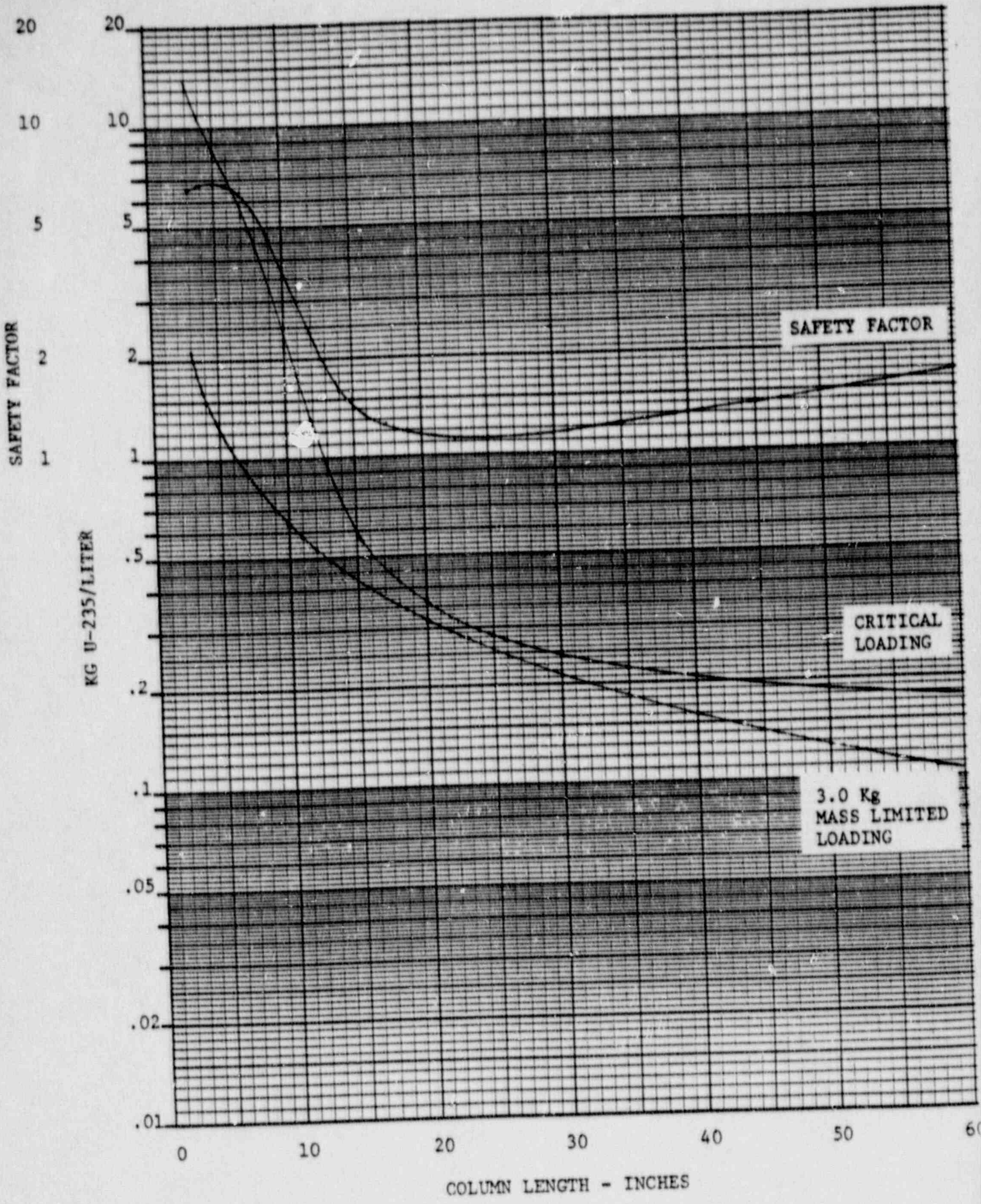
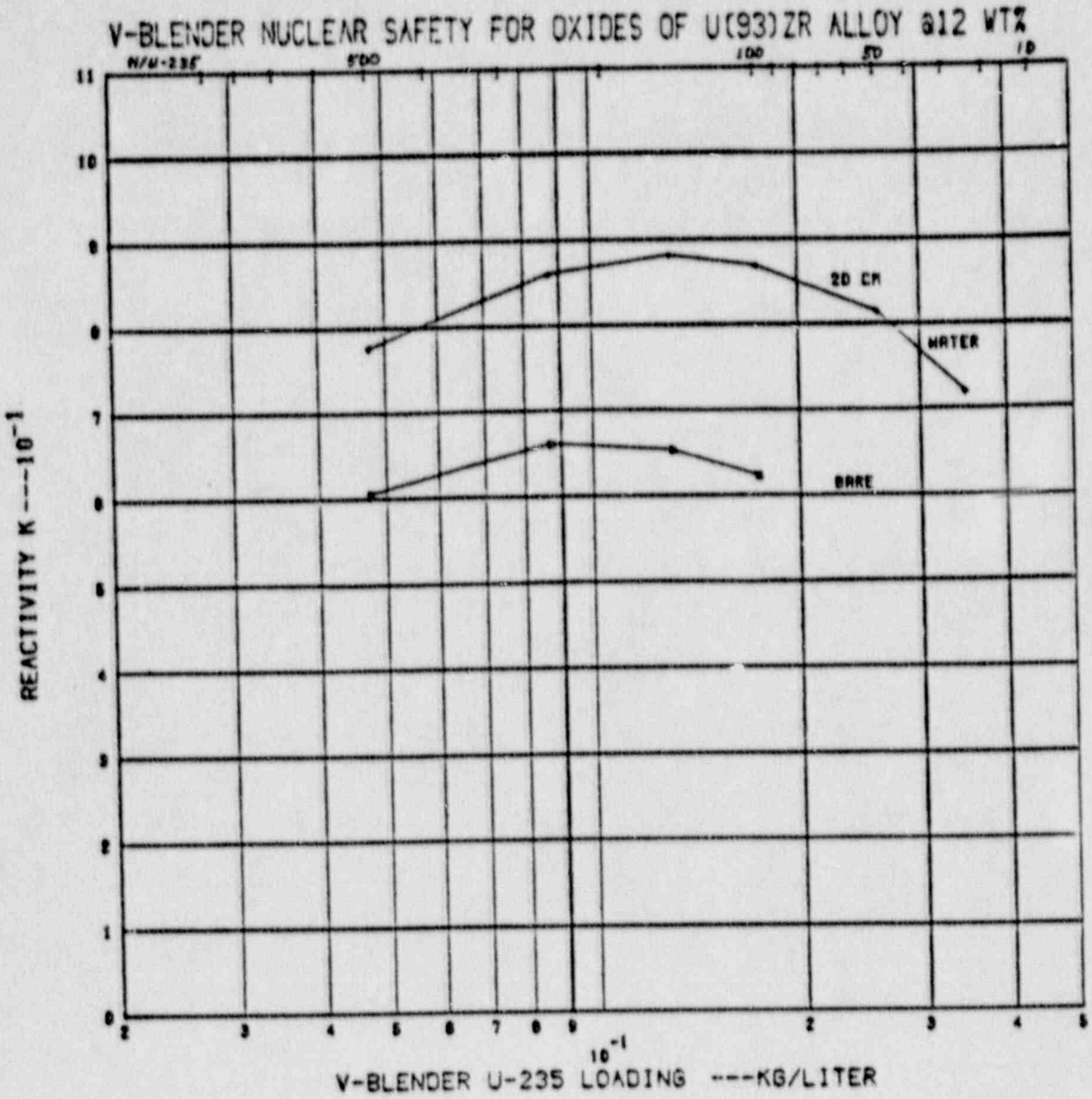


Fig. I 3.7-5 SAFETY OF MASS-LIMITED U-235 - WATER MIXTURES IN WATER-REFLECTED 6.063 INCH CYLINDERS.



V-BLENDER NUCLEAR SAFETY FOR OXIDES OF U(93)ZR ALLOY @12 WT%
20 CM
WATER
BARE
REACTIVITY K ---10⁻¹
V-BLENDER U-235 LOADING ---KG/LITER

Fig. I 3.7-6

TO BE PROVIDED LATER

Fig. I 3.11-1 Waste Yard and Adjacent Facilities

4. RADIOLOGICAL SAFETY

4.1 Health Physics Facilities and Equipment

In addition to the radiation detection and survey equipment mentioned in Section 4.2 of Part II, Health Physics has and maintains various supporting facilities and instrumentation as follows:

4.1.1 Health Physics Laboratory

A laboratory and counting room are maintained by Health Physics and contains the following major items of detection and assay instrumentation:

1. X-ray Energy Spectrometer (XES).
2. Gamma-ray spectroscopy systems; a (GeLi) detector system and High Purity Germanium Detector system are available.
3. Two low level automatic alpha/beta/gamma counting systems.

All systems are directly linked to an ND-6600 computer; the input data is processed by the computer after receiving manual input for the specific sample, such as identification and volume; then output is produced by the computer in a previously determined, formatted array.

Item (1) utilizes the identification of the element, e.g., uranium and thorium, and the known specific activity to convert to maximum permissible concentration (MPC).

4.1.2 Calibration Facility

This facility utilizes a source of approximately 30 Ci Cs-137 that produces a beam of radiation of known intensity. Calibration of this source is traceable to the National Bureau of Standards. The facility is used to calibrate radiation monitoring equipment and to deliver a known dose of gamma radiation to thermoluminescent dosimeters (TLDs), pocket dosimeters, film dosimeters, and other dosimetry devices.

Instrument calibration is performed on a routine basis to ensure the reliability of the instrumentation. Calibration and other pertinent data are maintained in log books.

4.1.3 Computer Systems

Health Physics has access to a time shared Univac 1110 with remote terminal and maintains a Nuclear Data 6600 computer which is linked to the two low level alpha/beta/gamma counting systems, the gamma spectroscopy system, and the X-ray spectrometry system. The Univac 1110 is used for the more complex calculations and for generating required reports under 10 CFR 19 and 20. The systems have many programs written and available to the user.

Health Physics also has access to GA's VAX systems. The radiological training records, the internal monitoring scheduling program, and other Health Physics records are stored on these systems.

4.1.4 Emergency Van

The emergency van is equipped with a two-way radio and emergency equipment, a 35mm camera, a battery-operated tape recorder, protective clothing, four Scott Air paks, and air samplers. Both alpha and beta-gamma survey meters, including an Eberline Gadora or the equivalent, with a range to 5000 R/hr, are carried in the vehicle. In addition, a trailer mounted 2.5 kw gasoline powered portable generator is available in the event of power failure. It can be towed to the scene. The generator has an eight (8) hour supply of fuel.

4.1.5 Environmental Survey Vehicle

A pick-up truck with camper shell is used for environmental surveying. It is equipped with a two-way radio.

4.1.6 Meteorological Equipment

There are two 30-ft towers, one for General Atomics' Main Site (Torrey Pines Mesa) and the other for GA's Sorrento Valley site. Each has a low-threshold wind sensor and recorders (see Section 2.3.2, Part 1). A portable mechanical weather station is also available.

4.1.7 Respiratory Protective Equipment

When respiratory protective equipment is used, the criteria of Section 4.1.6 of Part II shall apply. Such use will be in accordance with applicable portions of Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection" and NUREG-0041, "Manual of Respiratory Protection against Airborne Radioactive Materials."

4.2 PERSONNEL CAPABILITIES

4.2.1 Health Physics

Although operational safety is a direct responsibility of operating departments, the Health Physics group provides skilled personnel, equipment, and services to these departments, performs reviews, and approves and constantly monitors operations to assure compliance with radiological safety criteria established by regulation and company policy (Section 4.3.1, Part I). Health Physics Technicians are responsible for all phases of radiological safety in their assigned areas such as contamination surveys, airborne radioactivity evaluations, and surveillance of special operations using special nuclear, source, or by-product materials, or radiation machines.

The position of Manager, Health Physics requires a minimum of a B.S. degree in an applicable technical field and a minimum of five years of varied health physics experience at the professional level. This, coupled with a thorough understanding of all federal, state, and company radiological health regulations, license requirements, and applicable codes, satisfies the minimum requirements of this position. A resume of the individual who currently holds this position is in Section 1.3, Part I.

Assignments for the Health Physics Technicians are usually rotated once each year. This rotation provides a wider, more varied experience for the technicians and enables them to replace or supplement each other as needed.

Continuous training of Health Physics personnel, particularly the Health Physics Technicians, is accomplished through:

1. Group sessions on specific subjects and open forum discussions.
2. Staff meetings.
3. On-the-job training.

A Laboratory technician is responsible for processing various materials to determine radioactivity concentrations. Laboratory technicians are required to be high school graduates with college course work in science and some familiarity with laboratory procedures. Upon completion of a 16-hour Radiological Safety Orientation course, the new technician receives extensive on-the-job training under the direction of a professional staff member (see Section 1.3.2, Part I).

A Records and Reports Coordinator is responsible for a variety of Health Physics programs including the external and internal monitoring programs, the coordination of Work Authorizations, reporting personnel exposures required by 10 CFR 19 and 20, maintaining all Health Physics records and reports including inventories, sealed source leak tests, Radiological Work Permits, etc. A Records and Reports personnel are required to be high school graduates. College with course work in business and some experience in records maintenance and processing are desirable qualifications.

4.2.2 Criticality and Radiation Safety Committee

The Criticality and Radiation Safety Committee is responsible for review and auditing of established radiological policies and criteria. A minimum of five members are appointed with the collective membership representing substantial experience in the fields of nuclear physics, health physics, and security, as well as appropriate experience in other disciplines such as chemistry, metallurgy, engineering, and material accountability. Each member has a technical degree and a minimum of five years of applicable experience. For non-technical members, a minimum of five years experience in an appropriate field is required. The resume of the Chairman is included in Section 1.3, Part I.

4.3 RADIATION PROTECTION PROCEDURES

The following describes the basic rules and procedures that are applicable to radiation protection. The information in this section supplements the data contained in Section 4, Part II.

4.3.1 Radiological Safety Guide

A Radiological Safety Guide is maintained by Health Physics to provide a current and concise source book covering radiological safety practices and procedures established by the licensee. The Guide, in addition to describing the radiological safety program, covers the procedural needs for establishing an activity involving radioactive materials, the personnel work rules which must be employed, the kind of personnel monitoring which will be used, the records requirements, etc. It specifies the need for special review of untried operations before commencing activities. The Guide also identifies various detection programs, such as the bioassay program designed to detect and measure radiation exposures from internally deposited radioactive materials.

The Guide is provided to each individual who expects to utilize and be responsible for radioactive material or radiation machines, and this individual is charged with the responsibility of seeing that personnel working under his direction abide by the rules and regulations. The individual user at all times is further charged not only with the responsibility of his own safety but also with the safety of others and the protection of equipment and facilities.

It is the responsibility of the Manager of Health Physics to maintain the Guide. Changes to the Guide are approved by the Manager of Health Physics.

4.3.2 Contamination Control and Measurement

Surface contamination is controlled by containment. Cross contamination is limited by employing practical handling techniques. When routine contamination control fails, decontamination procedures are used. A reading of 100 DPM/100 cm^2 is readily detectable and is accepted as indicating positive contamination. Surface contamination is detected and evaluated using: large area wipes checked with a survey meter, direct survey, and wipes measured in the laboratory or on wipe counting equipment. Airborne contamination is controlled by containment of the radioactive material.

Devices used in controlling airborne contamination are hoods, glove boxes, facility ventilation systems, high efficiency particulate air filters, soot filters, and fume scrubbers. The techniques used for contamination measurement are:

1. Air samplers located inside a fuel fabrication facility have their filters changed normally once each working shift. At other facilities, air samples are changed weekly. The filters are counted and evaluated in the Health Physics Laboratory. Samples are measured by two different methods. The first method is used for the analysis of samples containing highly enriched uranium and/or thorium from the Sorrento Valley Fuel Manufacturing Facility. These samples are analyzed using the X-ray Energy Spectrometer (XES) which determines the quantity of elemental uranium and thorium on the filter paper and relates it to the MPC using the specificactivity of enriched U-235 and thorium. In the second method the samples are counted and evaluated at least twice. The first count takes place after a minimum of 4 hours decay time. This gross count gives an indication of the immediate condition in the facility. The second and final count occurs after a 72 hour delay. This method is used mainly for the analysis of mixed fission and mixed activation products.

2. More frequent sample changes are accomplished and other analysis routines are initiated as required during nonroutine operations or accident situations.

3. Internal personnel radiation exposure is evaluated through the bioassay program and in vivo counting (see Section 4, Part II).

4. Environmental air samplers located exterior to the facility, (see Section 4.5, Part I) are changed once a week and counted once 7 days later.

5. External personnel radiation exposure is evaluated through the use personnel monitoring devices and by the use of portable and fixed site radiation survey equipment and External radiation

exposures are kept within the limits specified in Title 10 Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation."

4.3.3 Radiological Surveys

Radiological surveys are conducted with the following two objectives in mind:

1. To determine the radiological hazards involved in a new operation.

2. To ensure that operations in process remain under proper controls.

The frequency and types of surveys are determined by the Health Physics Technician and the operating supervisor in the area, subject to compliance with license specifications and the approval of the Manager, Health Physics, and based on the type of operation to be performed, the hazards involved, and the personnel performing the operation.

4.3.4 Posting and Labeling

Posting and labeling are accomplished in accordance with applicable federal regulations (10 CFR Part 19 and 20).

4.3.5 Reports and Records

Governmental Reports

Reports, notification of incidents, etc., whether oral or in writing, are in accordance with 10 CFR Part 19 and 20 or other applicable regulations. Such reports comply with governmental regulations as promulgated by the federal, state, and local governments.

Health Physics Technicians

Health Physics Technicians maintain records so that information results of monitoring surveys and day-to-day activities. Monthly reports of significant events, problems, accomplishments and changes are submitted to the Manager, Health Physics.

Health Physics Laboratory

The Health Physics Laboratory maintains records so that information concerning routine samples submitted for analysis may be retrieved.

Personnel Monitoring

Information concerning the results of internal or external personnel monitoring programs, plus additional personnel information, is retained in personnel monitoring folders, on microfilm, or on computer tape. Copies of reports concerning the individual are also a part of these records. Copies of the monitoring program results are distributed to Health Physics Technicians operating department supervisory personnel.

4.3.6 Waste Disposal

Wastes of high specific activity are kept in a concentrated form for collection, storage, and preparation for disposal. Primary wastes are collected in suitable vessels. Containers are provided for solid waste. Waste collection vessels are appropriately marked in accordance with 10 CFR Part 20.

When containers are filled or when major sources are discarded so that it is desirable to remove waste from the controlled area, the waste is transferred to the Nuclear Waste Processing Facility. Solid radioactive waste is subsequently disposed of by licensed disposal companies.

4.3.6.1 Fuel Manufacturing Facility

A system has been installed for controlled disposal of low-level contaminated liquid wastes collected in the Fuel Manufacturing Facility tunnel. It consists of two 5-in. diameter collection lines, filters, and two 1000-gallon hold-up tanks with pump and valving for transferring liquid waste.

The upper 5-in. line, which has a capacity of approximately 375 gallons, is the primary collection point. It empties by gravity flow into the lower pipe, which has a similar capacity. After emptying the upper line into the lower line, a composite sample is collected for analysis.

The water is then pumped into one of the hold-up tanks through a series of filters. A second composite sample is collected on the downstream side of the filter to compare activities and filtering efficiency. If necessary, the liquid may be recycled back through the filter to further reduce the level of radioactivity before release to the sanitary sewer. The filters are replaced routinely to avoid loss of filtering efficiency.

Periodic surveys of the 5-in. hold-up lines are made to detect buildup of particulate activity in the lines. No significant buildup of activity has developed in the line to date.

4.3.6.2 Nuclear Waste Processing Facility

Radioactive liquid and solid waste are transferred to the Nuclear Waste Processing Facility. (See Section 3.11, Part I, for a detailed description).

Low level liquid waste not suitable for sewerage disposal is absorbed or mixed with concrete in 55 gallon drums and transferred to a authorized burial facility.

Solid waste is compacted (if possible) and placed in approved shipping containers and transferred to an authorized burial facility.

4.3.7 Criticality Accident Warning Alarm System

The specifications governing the use of criticality accident warning alarm systems, for compliance with 10 CFR 70.24, are set forth in Part II, Section 4.2.1.4.

There are two types of criticality accident alarm systems. Typically, the first type of alarm consists of master units, Eberline Model RM-12, or equivalent and several remote detector probes. The second type consists of a detector probe with a built-in check source and a remotely located readout. The systems meet the requirements of 70.24(a)(1) or (2).

The locations are selected throughout the facility so that all operations involving SNM, other than those for which exemption has been granted, are conducted within 120 ft air-equivalent distance of a criticality detection probe. The preset alarm points are not less than 5 mRem/hr nor more than 20 mRem/hr (if under 70.24(a) (2). The units trigger clearly audible local alarms, generally klaxon hor. s with a distinctive tone. Alarms are also generated at the main site control security office.

All criticality detectors and associated alarm systems are tested monthly. Temporary portable criticality alarms are used if an installed system fails and cannot be immediately returned to service.

The first type of criticality accident alarm system uses AC trickle-charged batteries for power and the second type is AC powered and connected to an emergency power bus. Audible alarm is provided within each master unit. The large local warning horns are AC line powered and cannot sound under power failure conditions. The central security station alarms are provided with emergency power.

During the course of research and development operations, intentional radiation levels are sometimes necessary. Occasionally, such an operation might be planned that would cause a criticality alarm to trip. The safety of such operations may be enhanced if the noise and bother of an unnecessary alarm horn is avoided. The basis for such exemption from the criticality alarm requirement of 10 CFR 70.24 is if the following conditions are met:

1. Each operation which requires a preplanned radiation level that would trip a nearby alarm shall be documented and approved according to the procedures set forth in Part II, Section 3 with additional provision that,

2. The radiation level is constantly measured and under observation during the interval of bypass of the criticality alarm, and

3. The criticality alarm system is tested for operability at the time it is returned to service, and

4. The bypassing or inactivation shall be performed only by Health Physics personnel utilizing a key lockout and tagging procedure, and

5. Any nonrelated operation involving SNM that is dependent upon the criticality alarm involved in the bypassing shall be suspended during the period of bypass.

4.4 EMERGENCY CONTROL

An Emergency Plan and a Radiological Contingency Plan are maintained by the licensee. The objective of the plan is to minimize the risk to employees and the general public and to minimize damage to or loss of the use of facilities and equipment in the event of internal accidents such as accidental criticality, fire, explosion, or natural occurrences which are judged credible for the site. The plan specifies the objectives to be met by more detailed procedures and assigns organizational and individual responsibilities to achieve such objectives. (See Section 8, Part I.)

4.5 EFFLUENT CONTROL

The licensee is engaged in many programs involving the use of radioactive materials, including operation of reactor facilities not covered under this license application. The basic concepts of radiological hazards control have been complete containment of radioactive materials and rigid operational controls; these have kept effluent releases and external radiation levels to a minimum.

The environmental surveillance program provides the information necessary to determine the effectiveness of radiological safety, provides sufficient background information to allow meaningful assessment of the potential hazards of a radioactive material release should it occur, and provides tangible evidence that releases to the environment comply with the as low as reasonably achievable "ALARA" requirement of 10 CFR 20.

The definition of "as low as reasonably achievable " in the Code of Federal Regulations is: . . . "as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to the benefits to the public health and safety and in relation to the utilization of atomic energy in the public interest."

Our environmental monitoring program indicates that for practical purposes we have no impact on the environment. Airborne radioactivity concentrations at the restricted/unrestricted area boundary of the Fuel Fabrication Facility (our largest source) run in the low percent unrestricted area MPC range on an annual basis. All air effluents go through high efficiency particulate air filters, soot filters, or fume scrubbers before being released. Additional filters or fume scrubbers would have no practical effect on the general public exposure.

Under GA's City of San Diego discharge permit, radioactivity concentrations in liquid effluents must meet the limits specified in the State of California Radiation Control Regulations before release into the sanitary sewerage system. The wastes are filtered, held up and sampled before release. The effluent concentrations have consistently measured in the low percent range. Considering the point of release, the low levels of release and the volume of the San Diego Sewage System (~90 million gallons/day) as compared to GA's main site release (about 50 thousand gallons/ day) the liquid effluent releases to the sewer have no measurable impact on the general public.

The sampling program consists of three subprograms: air sampling, sewage sampling, and annual sampling surveys of soil, vegetation, water, and external gamma radiation. From time to time changes may be made in the routine sampling stations to better evaluate changing conditions at the site. The number of stations may, within applicable specifications, change to improve the overall effectiveness of the monitoring program as a whole.

Direct external radiation is measured by the use of a portable insturment (i.e. a microR meter). Specially packaged environmental thermoluminescent or film dosimeters provide additional information on the integrated dose at selected air sampling locations and other locations around GA's sites.

The results of the effluent monitoring are reported in semiannual reports. Section 6 of the demonstration volume also contains information on the environmental monitoring program.

4.6 RESULTS OF INTERNAL AND EXTERNAL RADIATION EXPOSURES FOR THE PREVIOUS FIVE YEARS (1984 THROUGH 1988)

4.6.1 External Radiation Exposures

Summaries of external radiation exposures for GA employees and for contractors/subcontractors/visitors to GA's facilities for the past five years (1984 through 1988) are provided in Appendix A of this section.

4.6.2 Internal Radiation Exposures

Summaries of internal radiation exposures of personnel for the past five years (1984 through 1988) are provided in Appendix B of this section. These summaries include the results of U-235 lung counts and U-235 urinalysis results.

4.7 AIR SAMPLE RESULT SUMMARY

Air sample result summaries for the past four years (1984 through 1988) for Building 37 (HTGR Fuel Fabrication Facility) and Building 22 (TRIGA Fuel Fabrication Facility) are provided in Appendix C of this section.

APPENDIX A

SECTION 4 OF THE DEMONSTRATION VOLUMES

EXTERNAL RADIATION EXPOSURE SUMMARIES

FOR THE YEARS 1984 THROUGH 1988

GENERAL ATOMICS

Ref: LRQ:89:23
March 10, 1989

Director, Office of Nuclear Regulatory Research
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1988:
(GA Technologies Inc personnel)

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121 - 1194
Licensee No: SNM 696, R-39, R-67

This report is submitted in accordance with section 20.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	409
0.001 - 0.099	22
0.100 - 0.249	13
0.250 - 0.499	5
0.500 - 0.749	1
0.750 - 0.999	1
1.000 - 1.999	1
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	452

10955 JOHN JAY HOPKINS DRIVE, SAN DIEGO, CA 92121-1194 PO. BOX 85608, SAN DIEGO, CA 92138-5608 (619) 455-3000

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1988:
Contractors/Visitors

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121 - 1194
Licensee No: SNM 696, R-39, R-67

This report is submitted in accordance with section 20.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	192
0.001 - 0.099	18
0.100 - 0.249	4
0.250 - 0.499	3
0.500 - 0.749	1
0.750 - 0.999	0
1.000 - 1.999	0
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	218

Very truly yours,

Laura R. Quintana

Laura R. Quintana
Manager, Health Physics

cc: U.S. N.R.C. Region V
K. E. Asmussen
R. N. Rademacher

GENERAL ATOMIC COMPANY
P.O. BOX 81608
SAN DIEGO, CALIFORNIA 92138
(714) 455-3000

Ref: LRQ:88:39
March 15, 1988

Director, Office of Nuclear Regulatory Research
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1987:
(GA Technologies Inc personnel)

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121 - 1194
Licensee No: SNM 696, R-39, R-67

This report is submitted in accordance with section 20.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	449
0.001 - 0.099	33
0.100 - 0.249	12
0.250 - 0.499	6
0.500 - 0.749	4
0.750 - 0.999	0
1.000 - 1.999	0
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	504

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1987: Contractors/Visitors

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121 - 1194
Licensee No: SNM 696, R-39, R-67

This report is submitted in accordance with section 20.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	208
0.001 - 0.099	26
0.100 - 0.249	7
0.250 - 0.499	2
0.500 - 0.749	6
0.750 - 0.999	0
1.000 - 1.999	0
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	249

Very truly yours,

Laura R. Quintana

Laura R. Quintana
Manager, Health Physics

cc: U.S. N.R.C. Region V
K. E. Asmussen
R. N. Rademacher

GA Technologies

GA Technologies Inc.
P.O. BOX 85608
SAN DIEGO, CALIFORNIA 92138
(619) 455-3000

March 27, 1987

Director, Office of Nuclear Regulatory Research
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1986:
(GA Technologies Inc personnel)

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121 - 1194
Licensee No: SNM 696, R-39, R-67

This report is submitted in accordance with section 20.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	533
0.001 - 0.099	48
0.100 - 0.249	12
0.250 - 0.499	19
0.500 - 0.749	6
0.750 - 0.999	1
1.000 - 1.999	2
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	621

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1986:
Contractors/Visitors

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121 - 1194
Licensee No: SNM 696, R-39, R-67

This report is submitted in accordance with section 20.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	333
0.001 - 0.099	49
0.100 - 0.249	25
0.250 - 0.499	5
0.500 - 0.749	4
0.750 - 0.999	3
1.000 - 1.999	0
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	419

Very truly yours,

Laura R. Quintana

Laura R. Quintana
Manager, Health Physics

cc: U.S. N.R.C. Region V
K. E. Asmussen
R. N. Rademacher

GA Technologies

GA Technologies Inc.
P.O. BOX 85608
SAN DIEGO, CALIFORNIA 92138
(619) 455-3000

March 27, 1986

Director, Office of Nuclear Regulatory Research
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1985:
(GA Technologies Inc personnel)

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121
Licensee No: SNM 696, R-39, R-67

This repor' s submitted in accordance with section 2C.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	360
0.001 - 0.099	93
0.100 - 0.249	36
0.250 - 0.499	18
0.500 - 0.749	4
0.750 - 0.999	0
1.000 - 1.999	2
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	513

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1985: Contractors/Visitors

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121
Licensee No: SNM 696, R-39, R-67

This report is submitted in accordance with section 20.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	241
0.001 - 0.099	48
0.100 - 0.249	14
0.250 - 0.499	7
0.500 - 0.749	2
0.750 - 0.999	0
1.000 - 1.999	0
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	312

Very truly yours,

Laura R Quintana

Laura R. Quintana
Supervisor
Health Physics

bcc: U.S. N.R.C. Region V
K. E. Asmussen
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P.O. BOX 85608
SAN DIEGO, CALIFORNIA 92138
(619) 455-3000

March 21, 1985

Director, Office of Nuclear Regulatory Research
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1984:
(GA Technologies Inc personnel)

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121
Licensee No: SNM 696, R-39, R-67

This report is submitted in accordance with section 20.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	530
0.001 - 0.099	256
0.100 - 0.249	51
0.250 - 0.499	24
0.500 - 0.749	7
0.750 - 0.999	0
1.000 - 1.999	1
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	869

RECORDED ANNUAL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 1984: Contractors/Visitors

Licensee Reporting: GA Technologies Inc., 10955 John Jay Hopkins Drive, San Diego, California 92121
Licensee No: SNM 696, R-39, R-67

This report is submitted in accordance with section 20.407 (a)(2) of 10CFR20.

Annual Dose Ranges (Rem)	No. of Individuals in Each Range
0.000 - 0.000	558
0.001 - 0.099	62
0.100 - 0.249	7
0.250 - 0.499	4
0.500 - 0.749	0
0.750 - 0.999	0
1.000 - 1.999	0
2.000 - 2.999	0
3.000 - 3.999	0
4.000 - 4.999	0
5.000 - 5.999	0
6.000 - 6.999	0
7.000 - 7.999	0
8.000 - 8.999	0
9.000 - 9.999	0
10.000 - 10.999	0
11.000 - 11.999	0
12.000 +	0
TOTAL	631

Very truly yours,

Laura R Quintana

Laura R. Quintana
Supervisor
Health Physics

bcc: U.S. N.R.C. Region V
F. O. Bold
T. R. Colandrea
W. R. Mowry

APPENDIX B

SECTION 4 OF THE DEMONSTRATION VOLUMES

INTERNAL RADIATION EXPOSURE SUMMARIES

FOR THE YEARS 1984 THROUGH 1988

BIOASSAY RESULTS - 1988

A. URINALYSIS - A total of 58 samples were analyzed for enriched uranium during 1988. The minimum detectable amount is 4% of the Maximum Permissible Level (MPL). There was one (1) positive result.

Results:

57 results were below the minimum detectable amount (4% MPL) and one (1) result was above at 15.86%.

Other:

Sr-90/Y-90	9 counts
Tritium	42 counts

Results for Sr-90/Y-90 were very low. Results for tritium analysis were very low except for one individual; (levels were below permissible levels). This individual was required to wear an air hood during work with large quantities of tritium at the tritium extraction experiment.

B. U-235 LUNG COUNTS - A total of 34 lung counts for U-235 were conducted during 1988. The typical minimum sensitivities for U-235 are 30 - 60 micrograms. Nine (9) results were positive.

RESULTS:

25 were reported as 0 micrograms
4 were between 30 - 50 micrograms
1 was between 51 - 60 micrograms
3 were between 61 - 70 micrograms
1 was between 121 - 130 micrograms

The highest value (128 micrograms) represents about 51% of the Maximum Permissible Lung Burden (MPLB) for 93% enriched uranium. The MPLB is 253 micrograms.

Breakdown:

Twenty-two (22) counts were conducted 1/26/88 and 1/27/88.

17 were reported as 0 micrograms (below the minimum level)
2 were between 30 - 50 micrograms
2 were between 61 - 70 micrograms
1 was between 121 - 130 micrograms

Twelve (12) counts were conducted 10/6/88

8 were reported as 0 micrograms
2 were between 30 - 50 micrograms
1 was between 51 - 60 micrograms
1 was between 61 - 70 micrograms

BIOASSAY RESULTS - 1987

A. URINALYSIS - A total of 114 samples were analyzed for enriched uranium during 1987. The minimum detectable amount is 4% of the Maximum Permissible Level (MPL). There were six (6) positive results.

Results:

6 results were below the minimum detectable amount (4% MPL) and six (6) results were above it as follows: 10.5%, 9.7%, 8.0%, 7.4%, 4.7%, and 4.3%.

B. U-235 LUNG COUNTS - A total of 66 lung counts for U-235 were conducted during 1987. The typical minimum sensitivities for U-235 are 30 - 60 micrograms. nine (9) results were positive.

Results:

57 were reported as 0 micrograms
3 were between 30 - 50 micrograms
5 was between 51 - 60 micrograms
1 was between 61 - 70 micrograms
0 was between 71 - 80 micrograms

The highest value (63 micrograms) represents about 25% of the Maximum Permissible Lung Burden (MPLB) for 93% enriched uranium. The MPLB is 253 micrograms. All results were below the investigative level of 100 micrograms.

Breakdown:
Thirty (30) counts were conducted 1/27/87 and 1/28/87.

23 were reported as 0 micrograms (below the minimum level)
2 were between 30 - 50 micrograms
4 were between 51 - 60 micrograms
1 was between 61 - 70 micrograms

Thirty-six (36) coounts were conducted 8/10/87 and 8/11/87.

34 were reported as 0 micrograms
1 was between 30 - 50 micrograms
1 was between 51 - 60 micrograms

BIOASSAY RESULTS - 1986

A. URINALYSIS - A total of 130 samples were analyzed for enriched uranium during 1986. The minimum detectable amount is 4% of the Maximum Permissible Level (MPL). There were fourteen (14) positive results.

Results:

116 results were below the minimum detectable amount (4% MPL) and fourteen (14) results were above it as follows: 38.73%, 11.7%, 9.74%, 9.0%, 8.9%, 7.9%, 6.9%, 6.5%, 6.3%, 6.2%, 5.3%, 5.1%, and 4.8%.

B. U-235 LUNG COUNTS - A total of 48 lung counts for U-235 were conducted during 1986. The typical minimum sensitivities for U-235 are 30 - 60 micrograms. Seven (7) results were positive.

Results:

41 were reported as 0 micrograms
2 were between 30 - 50 micrograms
1 was between 51 - 60 micrograms
2 were between 61 - 70 micrograms
1 was between 71 - 80 micrograms
1 was between 81 - 90 micrograms

The highest value (84 micrograms) represents about 33% of the Maximum Permissible Lung Burden (MPLB) for 93% enriched uranium. The MPLB is 253 micrograms. All results were below the investigative level of 100 micrograms.

Breakdown:
Nineteen (19) counts were conducted 2/5/86 and 2/6/86.

18 were reported as 0 micrograms (below the minimum level
1 was 59 micrograms

Twenty-nine (29) counts were conducted 8/7/86 and 8/8/86.

23 were 0 micrograms
2 were between 30 - 50 micrograms
0 were between 51 - 60 micrograms
2 were between 61 - 70 micrograms
1 was between 71 - 80 micrograms
1 was 84 micrograms

BIOASSAY RESULTS - 1985

A. Urinalysis - A total of 200 samples were analyzed for enriched uranium during 1985. The minimum detectable amount is 4% of the Maximum Permissible Level (MPL). There were three (7) positive results.

Results:

193 results were below the minimum detectable amount (4% MPL) and seven (7) results were above it as follows: 38.5% (recount was 0), 10.3%, 6.4%, 5.7%, 5.4%, 5.1% and 4.6%.

B. U-235 Lung Counts - A total of 118 lung counts for U-235 were conducted during 1985. The typical minimum sensitivities for U-235 are 30 - 60 micrograms (ug). Forty-four (44) results were positive.

Results:

74 were reported as 0 ug
22 were between 30 - 50 ug
8 were between 51 - 60 ug
0 were between 61 - 70 ug
7 were between 71 - 80 ug
3 were between 81 - 90 ug
1 was between 91 - 100 ug
1 was between 101 - 130 ug

The highest value (121 ug) represents about 48% of the Maximum Permissible Lung Burden (MPLB) for uranium which is 93% U-235. The MPLB is 253 micrograms.

Five (5) of the individuals with the highest results were re-counted. The results were all lower. Both count results are included in this summary.

Breakdown:

Sixty-six (66) counts were conducted 2/7/85 - 2/12/85.

39 were 0 ug (below minimum detectable amount)
13 were between 30 - 50 ug
7 were between 51 - 60 ug
0 were between 61 - 70 ug
4 were between 71 - 80 ug
1 was between 81 - 90 ug
2 were between 91 - 100 ug

Fifty-two (52) counts were conducted 7/26/85 - 7/31/85.

35 were 0 ug (below minimum)
9 were between 30 - 50 ug
1 was between 51 - 60 ug
0 were between 61 - 70 ug
3 were between 71 - 80 ug
2 were between 81 - 90 ug
1 was between 91 - 100 ug
1 was between 101 - 131 ug (121 ug)

BIOASSAY RESULTS - 1984

A. Urinalysis - A total of 303 samples were analyzed for enriched uranium during 1984. The minimum detectable amount is 4% of the Maximum Permissible Level (MPL). There were three (3) positive results.

Results:

300 samples were below the minimum detectable amount (4% MPL)and three (3) samples were above it as follows: 7.3%, 5.1%, and 5%.

B. U-235 Lung Counts - A total of 149 lung counts for U-235 were conducted during 1984. The typical minimum sensitivities for U-235 are 30 - 60 micrograms (μg). Fifty-one (51) results were positive.

Results:

98 were reported as 0 μg
29 were between 30 - 50 μg
15 were between 51 - 60 μg
5 were between 61 - 70 μg
1 was between 71 - 80 μg
1 was between 81 - 90 μg

The highest value (81 μg) represents about 32% of the Maximum Permissible Lung Burden for uranium which is 93% U-235, which is 253 μg.

Breakdown:

Seventy-eight (78) counts were conducted 3/19/84 - 3/22/84.
51 were 0 μg (below minimum)
16 were between 30 - 50 μg
4 were between 51 - 60 μg
5 were between 61 - 70 μg
1 was between 71 - 80 μg
1 was between 81 - 90 μg (highest value - 81 μg)

Seventy-one (71) counts were conducted 9/11/84 - 9/14/84.
47 were 0 μg (below minimum)
13 were between 30 - 50 μg
11 were between 51 - 60 μg (highest value - 60 μg)

APPENDIX C

SECTION 4 OF THE DEMONSTRATION VOLUMES

AIR SAMPLE RESULTS FOR BUILDING 37 AND 22 FOR THE YEARS 1985 THROUGH 1988

AIR SAMPLE RESULTS - 1988

1. Building 37 - HTGR Fuel Fab Facility

There were no samples exceeding the Maximum Permissible Concentration (MPC) for U-235 during 1988. All area averages (air sample results averaged in a particular location) were <10% of MPC. The averages for each shift for the entire facility were all <2% of MPC. The facility averages were as follows:

	1st Qtr 1988	2nd Qtr 1988	3rd Qtr 1988	4th Qtr 1988
Day	<1	<1	<1	<1

The results met the requirements of our "minimum bioassay program" (no individual sample to exceed 1000% of the MPC and averages must be <10%). All samples measured for thorium were <25% of the MPC. Facility averages were all less than 0.5% of the MPC.

2. Building 22 - TRIGA Fuel Fab Facility

No air samples exceeded the MPC for U-235 during 1988. Area averages were well within the MPC. All values met the requirements of our "minimum bioassay program."

AIR SAMPLE RESULTS - 1987

1. Building 37 - HTGR Fuel Fab Facility

There were no samples exceeding the Maximum Permissible Concentration (MPC) for U-235 during 1987. All area averages (air sample results averaged in a particular location) were <10% of MPC. The averages for each shift for the entire facility were all <2% of MPC. The facility averages were as follows:

	1st Qtr 1987	2nd Qtr 1987	3rd Qtr 1987	4th Qtr 1987
Day	<1	<1	<1	<1

The results met the requirements of our "minimum bioassay program" (no individual sample to exceed 1000% of the MPC and averages must be <10%). All samples measured for thorium were <25% of the MPC. Facility averages were all less than 0.5% of the MPC.

2. Building 22 - TRIGA Fuel Fab Facility

No air samples exceeded the MPC for U-235 during 1987. Area averages were well within the MPC. All values met the requirements of our "minimum bioassay program."

AIR SAMPLE RESULTS - 1986

1. Building 37 - HTGR Fuel Fab Facility

   There were no samples exceeding the Maximum Permissible Concentration (MPC) for U-235 during 1986. All area averages (air sample results averaged in a particular location) were <10% of MPC. The averages for each shift for the entire facility were all <2% of MPC. The facility averages were as follows:

	1st Qtr 1986	2nd Qtr 1986	3rd Qtr 1986	4th Qtr 1986
Day	1	1	<0.5	<0.5

   The results met the requirements of our "minimum bioassay program" (no individual sample to exceed 1000% of the MPC and averages must be <10%). All samples measured for thorium were <25% of the MPC. Facility averages were all less than 0.5% of the MPC.

2. Building 22 - TRIGA Fuel Fab Facility

   No samples exceeded the MPC for U-235 during 1986. Area averages were well within the MPC. All values met the requirements of our "minimum bioassay program."

AIR SAMPLE RESULTS - 1985

1. Building 37 - HTGR Fuel Fab Facility

Two samples exceeded the Maximum Permissible Concentration (MPC) for U-235 during 1985. One sample collected on 3-14-85 at the QC Lab area measured 206% of the MPC and another sample collected on 4-30-85 at the South Mezzanine area measured 170% of the MPC. Both results were investigated to determine the cause and action to take to prevent a recurrance as required by our SNM-696 license specifications. All area averages (air sample results averaged in a particular location) were <10% of MPC. The averages for each shift for the entire facility were all <2% of MPC. The facility averages were as follows:

	1st Qtr 1985	2nd Qtr 1985	3rd Qtr 1985	4th Qtr 1985
Graveyard	1	2	-	-
Day	1	2	1	<0.5
Swing	1	2	-	-

The results met the requirements of our "minimum bioassay program" (no individual sample to exceed 1000% of the MPC and averages must be <10%). All samples measured for thorium were <25% of the MPC. Facility averages were all less than 0.5% of the MPC.

2. Building 22 - TRIGA Fuel Fab Facility

No samples exceeded the MPC for U-235 during 1985. Area averages were well within the MPC. All values met the requirements of our "minimum bioassay program."

COPY NO._____

VOLUME II

PART I
DEMONSTRATION VOLUME
SNM-696 MATERIAL LICENSE RENEWAL
GENERAL ATOMICS
SAN DIEGO SITE

Submitted November 1989

U. S. Nuclear Regulatory Commission
Docket No. 70-734

5. NUCLEAR SAFETY

5.1 INTRODUCTION

This section describes the formal procedures used in criticality evaluations. The rules, procedures, and philosophy presented have evolved over a period of years. A description is given of the basic assumptions used in assessing criticality safety. The calculational methods used are described, and the accuracy of these methods is verified. The safety factors that must be used in criticality evaluations are specified. The criticality specification limits given in Section 5, Part II, are applied to the referenced data and the operating curves are given. Units and geometries that have high utilization in the licensee's operations are described and justified.

5.2 CRITICALITY LIMITS

5.2.1 Basic Assumptions

The following general guidelines are used when considering criticality limits. To ensure that the analysis of the criticality safety of a proposed operation is conservative and considers all conceivable errors, the following assumptions are used. For each operation it must be shown that at least two simultaneous, unlikely, accidental, and independent events must occur before a criticality hazard could exist.

Where administrative controls are necessary, a concerted effort is made to assure that the probability of a serious human error is highly unlikely.

The following specific assumptions must be applied:

1. <u>Mass</u> - Double batching must be considered possible in all cases unless there are physical constraints to prevent it.

2. <u>Geometry</u> - The most reactive configuration that the fuel could credibly assume must be used in the analysis. In an unrestricted situation this is a sphere. In a restricted geometry situation this may not be the case.

3. <u>Volume Distribution</u> - Dispersal of the fuel material in the total volume available must be considered unless this is judged incredible. Possible agglomeration or lumping of the fuel must also be considered.

4. <u>Moderation</u> - Optimum possible moderation must be assumed in all criticality analyses. Water flooding of all operations must be considered unless positive physical constraints are present to prevent flooding, or no source of water exists. For water-moderated systems, optimum moderation occurs with hydrogen-to-uranium (H/U) ratios near 500/1. The actual optimum value of the H/U ratio depends upon the geometry and composition of the system being studied. As a consequence the range of possible H/U values for each operation must be considered, and the most reactive ratio must be used in the criticality analysis. Optimum moderation for carbon systems occurs at very dilute mixtures with C/U ratios of about 20,000/1. Using criticality data on carbonwater-uranium systems from Ref. 5.2-1, it can be readily shown that in the range of C/U ratios used, the addition of carbon to a uranium-water mixture reduces the reactivity. Therefore, an analysis that ignores the carbon would be

conservative. Nevertheless, the effect of carbon on the criticality safety of each situation where carbon might be present must be considered.

5. Enrichment - Most of the fuel operations performed at the Flintkote Avenue Facilities and many of the other SNM activities at the San Diego site use uranium enriched to 93.5 wt % U-235. As a consequence all criticality analyses must assume fully enriched uranium unless it can be positively established that at a particular station a lower enrichment cannot be exceeded, or that the accidental mixing of uranium of different enrichments is not credible. If higher enrichment alone can cause criticality, the above criteria must be considered insufficient.

6. Reflection - Full water reflection must be considered in each criticality analysis unless it can be shown that such reflection is not credible. The combination of partial density water reflection with interaction between neighboring fuel regions must be considered. Where credible, reflection by carbon or concrete must be considered. The close proximity of a person is equivalent to partial water reflection.

7. Interaction - The effects of interaction between fuel regions must be considered unless the regions are isolated as defined in Section 5.5, Part II, of this application. Interaction must consider optimum moderation. A partial density water reflector must be considered if partial water densities are conceivable and interaction through such partial reflectors shall be considered.

8. Poisons - The presence of neutron poisons or absorbers

may not be assumed in the criticality analysis unless it can be shown that it is not possible for such poisons to be accidentally excluded; that is, unless (1) the absorber is a fixed permanent part of the structure of the operation being considered, or (2) the absorber is an integral portion of the fuel mixture and its presence has been checked and verified at a previous step in the manufacturing process.

5.2.2 Specific Limits

The procedure for performing criticality safety analyses has three levels of sophistication, with increasing calculational effort. Where a high degree of conservatism can be accepted, a simple analysis is employed. Where such a degree of conservatism is not warranted or a simple analysis is not appropriate, more refined analytical methods are employed.

5.2.2.1 Simple Mass or Geometry Limits

Many of the operations described in Section 3, Part I, of this application are amenable to categorization under uniform and highly conservative assumptions. The nuclear safety justification for these types of operations is based on simplified curves and charts (Section 5.4), and the basic description of each such type of operational limit is cataloged in Section 5.5.

In some cases the degree of conservatism used in the tabulated limits is unnecessary, and adhering to the limits imposes an unacceptable administrative, operational, or economic penalty. In many situations the operation in question can be demonstrated as being nuclearly safe by detailed use of the same curves and charts (Section 5.4) used to support the basic tabulated stations and thus the same degree of conservatism is assured. If these limits are used with carbon present, it must be shown that the presence of the carbon makes the system less reactive. Other limits may be obtained by applying the specified safety factors to published data on critical systems. A great deal of information of this kind is available and additional data are continually being published. References 5.2-1 through 5.2-5 are typical criticality data reports. The data from such reports can sometimes be adapted to slightly different situations by means of calculations.

When utilizing published criticality data, the persons performing and reviewing the criticality analyses ensure that the following conditions are met:

1. The published data are applicable to the case being analyzed.
2. The cases used are the most reactive situations that could occur.
3. Conceivable accident conditions are considered and included.
4. Proper safety factors (see Section 5.4) are applied.
5. Calculations do not contain numerical errors.

5.2.2.2 Use of Uranium at Other Than Full Enrichment

For operations using fully enriched Uranium, the uranium is assumed to be composed of 93.5 wt % U-235 and 6.5 wt % U-238. Fully enriched uranium actually contains about 1 wt % U-234 and 0.3 wt % U-236; these nuclides have higher thermal and epithermal absorption cross sections than U-238, and thus the 6.5 wt % U-238 assumption is conservative.

The standard limits presented in Section 5.5 and the data in Figs. I 5.4-1 through I 5.4-17 were derived using this fully enriched uranium. In some cases, use of U-235 at other than full enrichment may be desired. In these cases the standard limits may be changed in accordance with the procedures described below.

5.2.2.2.1 Enrichment Greater Than 93.5 wt %

If it is desired to use the standard limits for uranium of greater than 93.5 wt % U-235, these limits must be reduced to account for the concomitant reduction in the fraction of U-238 in the uranium. The reduced limits may be obtained from the following formulae:

$$\text{Mass limit} = \text{mass limit}_{93.5}/1.089$$

This reduced limit is applicable to 100% U-235 and may be safely used for lower enrichments. It was obtained by considering the thirteen critical experiment calculations presented in Table I 5.3-4, Section 5.3.4.2.1. In all of these cases (which cover a full range of critical systems from fast spectrum uranium metal spheres to soft spectrum overmoderated systems, from bare to fully reflected units, and from no moderator to water and/or carbon moderation), the maximum fractional absorptions occurring in U-238 are 2.0%. The minimum loss of neutrons due to leakage is 19%. For subcritical systems this leakage loss will be even higher. Thus the maximum effect upon k_{eff} of neutron absorptions in the U-238 is 2% x (100 - 19%) = 1.6% k; that is, if the U-238 were completely removed from the system, k_{eff} would be increased by no more than 1.6%.

An alternative method to compensate for a reduction in U-238 absorptions is to reduce the fissions by reducing the U-235 mass limit. Note that this also reduces the absorptions still further. Conservatively assuming that no neutrons are absorbed in the moderator materials, but that 98% are absorbed in U-235 and 2% in U-238, the elimination of the U-238 absorptions may be balanced by a reduction in the U-235 mass by a factor of 1.089;

i.e.,

$$k_{eff} = \frac{\text{fissions (U-235)}}{\text{absorptions (U-235) + absorptions (U-238) + leakage}}$$

5.2.2.2.2 Enrichment Less Than 93.5 wt %

If the uranium enrichment is below 93.5 wt %, the increased fractional absorptions in U-238 make the standard limits increasingly conservative. Thus these limits may be safely used for any enrichment less than or equal to 93.5 wt %. Use of these limits for systems of low enrichment may impose an unwarranted degree of conservatism. The standard limits may be increased if it can be demonstrated that presence of uranium above a given low enrichment is not credible. The increased limits may be obtained by calculation using the methods described in Section 5.3, by use of published data such as Fig. 21 through 24 of TID-7028 (Ref: 5.2-2), or use of DP-1014 (Ref: 5.2-5) for U and UO_2 systems with enrichments 5% and less, in which case the validity and applicability of the data shall be evaluated as set forth in Section 5.2.2.1.

5.2.2.3 Detailed Calculations

In those cases where there are no applicable published criticality data, detailed numerical calculations are necessary. Computer calculations using an appropriate, conservative model are performed to determine the multiplication factor, mass or volume limits, or other pertinent factors for the system. The computer methods used are described in detail in Section 5.3.2. These computations and the recommendations based upon them are reviewed in detail by Nuclear Safety and the CRSC. These groups ensure that the following criteria are met:

1. The model used is a reasonable, conservative

approximation to the physical system to be studied.

2. The system studied is the most reactive configuration that could conceivably occur.

3. The effects of possible errors and accidents are considered.

4. The proper safety factors (Section 5.4) are included.

5. The methods and data used are applicable to the situation (Section 5.3).

6. The computations do not contain numerical errors.

5.3 METHODS

This section describes the methods currently used in criticality safety analyses. The technology of nuclear criticality analysis is constantly being improved, and analysis is not limited to the methods described here. Rather, this section demonstrates the general level of sophistication and accuracy that is to be maintained as a minimum. Any methods of analysis used under this license must be of comparable or better accuracy, or more conservative, than the methods described here.

5.3.1 Hand Calculations

Since a wide variety of criticality data on simple systems is available, hand calculations are of limited utility. They are used primarily to extend published data to similar situations with slightly different geometries and to obtain conservative estimates of k_{eff} for simple systems using published nuclear data. The basic assumptions discussed in Section 5.2.1 must be used in analyses using hand calculations, and the safety factors defined in Section 5.4 must be applied.

5.3.1.1 Geometry Changes

Criticality information for systems reported in the data on critical assemblies may be used for slightly altered geometries as long as the appropriate geometric buckling corrections are made. The buckling used is that of the fundamental mode in one-group diffusion theory:

Spheres: $B^2 = \left(\frac{\pi}{\tilde{R}}\right)^2$

Cylinders: $B^2 = \left(\frac{\pi}{\tilde{H}}\right)^2 + \left(\frac{2.405}{\tilde{R}}\right)^2$

Rectangular parallelepipeds: $B^2 = \left(\frac{\pi}{\tilde{H}_1}\right)^2 + \left(\frac{\pi}{\tilde{H}_2}\right)^2 + \left(\frac{\pi}{\tilde{H}_3}\right)^2$

where $\tilde{R}$ - radius + σ, cm

$\tilde{H}$ = height + 2σ, cm

σ = effective extrapolation length including reflector effects, if any.

5.3.1.2 k_{eff} Estimates

For systems with simple geometry and simple composition, the data from Ref. 5.2-3 may be used to obtain a conservative estimate of k_{eff}. Part II of this reference tabulates infinite multiplication factor (k), Fermi age ( ), squared diffusion length (L^2), and geometric buckling (B^2) for water solutions of fully enriched uranyl fluoride (UO_2F_2). These may be used as follows to obtain a conservative estimate of k_{eff}:

$$k_{eff} = \frac{k\infty}{(1 + B^2)\ (1 + L^2B^2)}$$

For hydrogenous systems the effect of the fluorine on k_{eff} is negligible. Thus, these tables may be safely used for water-UO_2 systems and for mixtures of water and UO_2 with other absorbers.

5.3.2 Computer Calculations

The computer methods and codes currently being used for criticality analyses have been developed over a period of years and have been demonstrated to give good agreement with experimental results. This section sets forth the guidelines used to ensure that the methods are used correctly and that their results are properly interpreted. The basic concept to be applied is that the criticality safety of the system being analyzed is demonstrated when the calculated effective neutron multiplication for the most reactive credible configuration obeys

$$k_{eff} + 2\sigma - k_{bias} \leq 0.95.$$

In this relation, is the statistical uncertainty, if any, in the calculated result and k_{bias} is the maximum bias, $k_{cal} - k_{exp}$, as determined by application of the analytical method to well-established experimental data or benchmark calculations of similar geometrical form and material content. If k_{bias} is non-negative, it is taken to be 0.0.

Since the codes currently being used are periodically updated to improve their accuracy and utility, new bias determinations may be necessary from time to time. Bias changes can similarly be expected when new methods are developed to be used as alternatives to the ones discussed below. Because the criteria for evaluating criticality safety specifically takes the uncertainty of the analytical method into account through the bias and statistical 2 , it is not necessary to require that an alternative method be equally or more accurate than the one it replaces.

5.3.2.1 Cross Sections

Each calculational method is best described as a combination of the way in which the nuclear cross sections are generated and the way in which they are used. At the present time, all of the codes used in criticality analyses use cross sections from reactor physics nuclear data files; most of the data are from the ENDF/B sets. This fine-group information is collapsed into broadgroup cross-section sets using the zero-dimensional spectrum codes of the GGC series (GGC-5 currently (Ref. 5.3-1) or the MICROX Code (Ref 5.3-2)). These codes use Doppler-broadened and self-shielded 9000-group resonance cross sections with collision densities obtained from solution of Nordheim's integral equations to calculate resonance integrals. These are converted to effective absorption cross sections, which are then used to obtain resonance-corrected 99-group epithermal cross sections. These are used in the B1 approximation to the transport equation to obtain a fast spectrum. The spectrum is used to collapse the 99-group cross sections to whatever broad-group structure is desired. In the thermal range, 101 fine-group data are used in the B1 transport approximation to calculate the thermal spectrum. This spectrum is used to collapse the cross sections to the desired broad-group set. Either diffusion or transport cross-section sets may be obtained.

It would be unrealistic and unnecessary to perform a full spectrum calculation for each separate criticality analysis. It is important, however, that the spectrum used to obtain broad-group cross sections be close to that which will obtain in the system to be analyzed. In particular, the degree of moderation and the resonance parameters must be considered. The degree of moderation is indicated by the hydrogen-to-fissile isotope (H/X) and/or the carbon-to-fissile isotope (C/X) ratios. The use of cross sections averaged over a spectrum of different moderation than the case to be studied can result in an error in the calculated multiplication of the system. The magnitude and possibly the sign of the error may depend upon the cross sections, the moderation of the system, and the group structure used. The effect is generally small but must be considered.

A series of calculations to obtain the calculated multiplication of several critical assemblies was performed using cross sections of varying degrees of moderation. Of interest was the error in the calculated multiplication due to the use of cross sections averaged over a spectrum other than that of the assembly being studied. The assemblies calculated were homogeneous spheres of uranium, water, and graphite. The degree of moderation ranged from H/U-235 and C/U-235 = 0 up to H/U-235 = 1300 and C/U-235 = 20,000. The calculations were done using GGC-5 cross sections and the 1DFX transport code described in Section 5.3.2.2. In these calculations the 9-group energy structure shown in Table I 5.3-1 was used.

TABLE I 5.3-1
BROAD-GROUP CROSS SECTIONS USED WITH 1DFX IN CRITICALITY CALCULATIONS

Group	Energy Range (eV) Upper	Lower
1	1.492×10^7	1.832×10^5
2	1.832×10^5	9.611×10^2
3	9.611×10^2	1.760×10^1
4	1.760×10^1	3.928
5	3.928	2.382
6	2.382	0.414
7	0.414	0.100
8	0.100	0.040
9	0.040	0.000

This study showed that for this group structure and these simple systems, the error in k_{eff} is less than 1% if the H/U-235 or C/U-235 ratio of the cross sections is within a factor of two of that of the assembly.

The presence of resonance absorbers in the spectrum used to obtain broad-group cross sections is also important. The presence of resonance absorbers such as U-238 or Th-232 depresses the resonance flux and results in reduced broad-group resonance cross sections. If cross sections for these absorbers obtained at "infinite dilution" amounts are used in calculations involving substantial quantities of these materials, the resonance absorption will be overestimated and thus k_{eff} will be underestimated. This is avoided by using cross sections averaged over the correct resonance spectrum, by applying self-shielding factors to the infinite dilution cross sections, or by omitting the resonance absorber from the calculation entirely.

5.3.2.2 Transport Codes

Most criticality computations for simple geometric systems are performed using one or two dimensional transport theory codes. The two most commonly used are those in the 1DF series (Ref. 5.3-3), DTFX for one dimensional analyses and TWOTRAN (Ref. 5.3-4) for two dimensions. Both of these are discrete ordinate, spatially finite difference, multigroup transport codes and typically use linearly anisotropic (P_1) scattering cross sections. The codes are capable of calculating effective neutron multiplication factors or of making searches for size, fuel concentrations or poison concentrations.

Constraints - The primary constraint imposed on the transport codes is that they are limited to systems with spherical, cylindrical or rectangular symmetry. For these types of systems, accuracies of 1% or better are achievable. An extensive series of criticality calculations has been performed to develop the following guidelines for the requirements necessary to obtain these accuracies.

Quadrature Required - S_4 quadrature is generally adequate. For the homogeneous systems of the simple geometries that are frequently used in criticality analyses, the difference in k_{eff} as calculated using S_4 and S_{16} quadrature is only a few tenths of a percent. For metal systems of complex geometry, a higher degree of angular resolution may be required (Ref. 5.3-5).

Group Structure - The discrete ordinate method using consistent P_N approximation cross sections is known to be sensitive to energy group structure (Ref. 5.3-6). For all except metal systems, the use of few energy groups overpredicts the multiplication due to underestimation of the fast leakage. Since this error is on the conservative side, no constraints need be made upon the group structure.

Order of Anisotropy - Linearly anisotropic (P_1) scattering cross sections are sufficient. The error incurred by use of P_1 data is on the order of one-half of one percent (Ref. 5.3-7 and

5.3-8).

Space Mesh - The calculated value of multiplication is fairly insensitive to the space mesh used. A saturated space mesh is reached as the mesh size approaches 3 thermal/transport (Ref. 5.3-5).

5.3.2.3 Diffusion Codes

For analyses of fairly large systems, one- or two-dimensional diffusion theory methods are sometimes employed. The codes most commonly used at present are GAZE-2 (Ref. 5.3-9) in one-dimension and GAMBLE (Ref. 5.3-10) for two-dimensional calculations. These codes use finite difference approximations for space derivatives and handle energy dependence by a multi-group approach. The codes may be used to calculate k_{eff} or to search for size or for fuel or poison concentrations.

Constraints - Diffusion theory is known to do a poor job of calculating the neutron flux behavior within several mean free paths of any material boundary or discontinuity. The system multiplication is less sensitive to this effect than is the flux. The results presented in Section 5.3.4 show reasonable agreement between diffusion theory and transport theory even for fairly small systems. As a rule of thumb, diffusion theory is best used when the characteristic dimensions of the system are larger than 20 mean free paths. The results presented in Section 5.3.4 indicate that although transport methods always yield conservative results, the diffusion methods may underestimate k_{eff} by up to 2%. As a result, caution must be exercised when using diffusion codes. In the regions where underestimates may occur, bias determinations should be based on experimental results which are closely representative of the system being analyzed. If any doubt still exists as to the suitability of diffusion theory, the results should be verified by performing a transport calculation.

Group Structure - Diffusion theory is much less sensitive to energy group structure than is transport theory. No constraints need be imposed.

Space Mesh - As in transport methods, saturation of the space mesh should be approached.

5.3.2.4 Monte Carlo Codes

Criticality analyses of systems of fissile materials in irregular geometrical shapes are currently performed by Monte Carlo methods. The codes used at the present time are KENOII (Ref. 5.3-11) and KENOIV (Ref. 5.3-12), a multigroup Monte Carlo criticality program developed by Oak Ridge. KENO (in both versions) uses pseudo random number generators to simulate and follow neutron trajectories. Collison points for the neutron paths are determined by sampling from the appropriate distributions for the number of mean free paths and the (vector) direction from the initial position. At each collision point, absorptions and fissions are accounted for by statistical weights which are modified by the absorption or fission probabilities at the point. Output from KENO consists of the k_{eff} for the system, the corresponding statistical uncertainty (standard deviation), and the leakage, absorption and fissions for each energy group.

Constraints - KENO contains a special geometry package which allows easy description of systems of cylinders, spheres and cuboids arranged in any order with only one restriction. This restriction is that each geometrical region must be described as completely enclosing all regions interior to it. Alternatively, the program can use the generalized geometry package developed for the 05R Monte Carlo Code (Ref. 5.3-13). This package allows any system that can be described by a collection of planes or quadric surfaces, arbitrarily oriented and intersecting in arbitrary fashion.

Other than the geometry limitations, the major constraint is the computer time required to solve a given problem. This depends on several factors with the major one being the number of collisions the average neutron undergoes. Computer times thus increase substantially for water moderated or reflected systems.

Group Structure - KENO uses the same cross-section sets as the DTFX and TWOTRAN transport codes. At the present time, the energy group structure employed in Table I 5.3-2 is used.

TABLE I 5.3-2
ENERGY GROUP STRUCTURE
USED IN KENO CALCULATIONS

Group	Lower Energy (eV)	Lower Lethargy
1	1.00×10^{7}	0.0
2	3.68×10^{6}	1.0
3	8.21×10^{5}	2.5
4	1.83×10^{5}	4.0
5	6.74×10^{4}	5.0
6	1.50×10^{4}	6.5
7	3.35×10^{3}	8.0
8	9.61×10^{2}	9.25
9	3.54×10^{2}	10.25
10	1.30×10^{2}	11.25
11	4.79×10^{1}	12.25
12	1.76×10^{1}	13.25
13	3.93	14.75
14	2.38	15.25
15	0.414	17.00
16	0.10	18.42
17	0.04	19.34
18	0.00	--.--

Weighing Factors - In the treatment of absorption in KENO, decisions are made based on the statistical weight associated with a given neutron and on upper and lower limits associated with the weights. The upper limit is designated as WTHIGH. If a neutron's statistical weight, say WT, exceeds WTHIGH, the neutron is split into two neutrons, each with half the original weight. This is done to reduce the variance due to a high weight neutron traveling from a low importance, high average weight region to a high importance, low average weight region. The lower limit for the statistical weight is WTLOW. When WT is reduced to below WTLOW, Russian roulette is played to determine if the neutron survives. If not, tracking of that neutron is terminated and the next one begun. If so, WT is set equal to a third input parameter, WTAVG, and the tracking is resumed.

The relative values of WTAVG, WTLOW and WTHIGH translate essentially into the variance of the computed k_{eff} per unit computer time. Based on the study of the optimum values that is presented in Ref. 5.3-11, the weighing factors shown in Table I 5.3-3 are the ones typically used.

5.3.3 Interaction Effects

Units of fissile material may be considered isolated from one another if they are separated by distances greater than or equal to those defined in Section 5.5, Part II. If these separation limits are not maintained, interaction between units is possible. Several methods are available for determining the effects of this interaction; those in current use are discussed below.

TABLE I 5.3-3

WEIGHING FACTORS USED IN KENO

Weight	Fissile System	Reflector Region
WTAVG	0.500	1.000
WTLOW	0.167	0.333
WTHIGH	1.500	3.000

5.3.3.1 Arrays - Tabulated Data

Precise limits for use with regular arrays of units of fissile material are specified in Section 5.5. The size, weight, and moderation of each unit, as well as the array spacing and maximum number of units, are specified. Other similar published data are available on criticality limits for arrays.

5.3.3.2 Solid Angle Method

For arrays or nonisolated single units, the interaction solid angle method provides a convenient, conservative method for calculating interaction limits. The use of this method to demonstrate the safety of interacting fissile units is discussed in detail in Ref. 5.3-14, 5.3-15 and 5.3-16. The method and its limits are specified in Section 5.5, Part II. Briefly, the maximum solid angle subtended upon any unit by all other units is calculated. The interaction is critically safe if this angle is less than that given by the following relation:

REACTIVITY RANGE	T
$k_{eff} \leq 0.3$	6 steradians
$0.3 \leq k_{eff}$ 0.8	$(9 - 10\ k_{eff})$ steradians
$k_{eff} > 0.8$	0 steradians

where k_{eff} is the effective neutron multiplication of the unit being considered. If the interaction solid angle for a system of fissile units exceeds the above allowed limit, then the nuclear safety of the system must be established by other means.

The general expression for the solid angle subtended by an object; about a point 0 is

$$\Omega_i(0) = \int_A \frac{\underline{n \cdot dA}}{r^2}$$

where A is the entire surface (area) of the object (dA is directed normally outward) which is visible to 0, n is a unit vector directed to point 0 from the point at dA and r is the corresponding distance from 0 to dA. The total solid angle (T) subtended by N objects about the point 0 is

$$\Omega_T = \sum_{i=1}^{N} \Omega_i(0) - \text{Overlap}$$

"Overlap" means the contributions to the total solid angle which are common to more than one of the N objects; that is, the solid angle shadowed by the object closer to the point 0 on the more distant objects.

In practice the integral for the individual i(0)'s is difficult to complete and closed expressions exist for only a few simple geometric types. Each of the several different methods currently being used to determine the individual interaction solid angles depend somewhat on geometry and the usefulness of each is strongly dependent on the level of accuracy required. Examples of these are,

1. exact calculations for simple systems of spheres, cuboids and cylinders using closed algebraic expressions,
2. rather conservative overestimates for more general systems using an area/(distance)^2 relationship, and
3. computerized numerical calculations using series approximations or numerical integration routines.

Only the most obvious forms of complete shadowing are taken into account by methods 1 and 2 whereas some numerical calculations, in particular numerical integration, allows a treatment of even partial shadowing. The following paragraphs give a general description of the use of each of these three above-mentioned methods and in particular gives a validation of the currently used numerical integration code (SOLNEW).

5.3.3.2.1 Exact Calculations

Exact calculations of the solid angles subtended by spheres and cuboids can be made by geometrically scaling or transforming the equations for perpendicularly-oriented circles and rectangles. These are

$$\Omega = 2\pi * \left(1 - \frac{R}{R^2 + r^2}\right) \quad \text{, for circles}$$

and

$$\Omega = 4 \, \mathrm{Sin}^{-1} \frac{A * B}{\sqrt{R^2 + A^2} * \sqrt{R^2 + B^2}} \quad \text{, for rectangles}$$

In these equations r is the radius of the circle, 2A and 2B are the dimensions of the rectangle and R is the (perpendicular) distance from the center of the surface to the subtended point. For spheres and arbitrarily-oriented cuboids which are not perperndicular to the line between the surface centers and the subtended point, these equations are transferred by

i. determining an effective r for spheres

$$r_{new} = Rr \Big/ \sqrt{R^2 - r^2} \quad \text{and} \quad \Omega_{sph} = 2 * \left(1 - \frac{R^2 - r^2}{R}\right)$$

and

ii. extending the rectangular surfaces of cuboids to the perpendiculars and subtracting the solid angle contributions for the extended areas which do not lie on the surface of the cuboid.

In addition to these two formulas, numerical routines exists for determining the solid angles subtended by arbitrarily-oriented right circular cylinders to an accuracy of better than 10^{-4} sr. These routines involve the computation of Taylor series' expansions and are discussed further in Ref. 5.3-17.

5.3.3.2.2 Solid Angle Estimation

Assuming that the geometry of the surface area (A) of a given object is independent of the distance from the subtended point (r), the equation for the subtended solid angle is

$$\Omega = \frac{A}{r^2}$$

By insuring that A is overestimated and r is underestimated, this formula can be used, conservatively, as an estimate of the solid angle for arbitrary types of objects. For example, for spheres of radius r,

$$\Omega_s = \frac{\pi r^2}{(R-r)^2}$$, R is the center-to-center distance,

and for rectangles

$$\Omega_r = \frac{2A * 2B}{R^*} \text{ Cos } \theta$$

where R* is the closest distance, 2A and 2B are the dimensions and is the angle between the normal to the surface and the vector directed from the center to the subtended point.

5.3.3.2.3 Numerical Calculations

Several different ways exist for the numerical computation of the individual $\Omega_i(0)$'s. The easiest and most often used methods, when the geometries are simple and when shadowing need not be corrected for, are straightforward Taylor series expansions. Methods which specifically allow the taking of object-object shadowing into account are more difficult however and usually involve simplifying assumptions or numerical approximations. An example of this is the computer code SOLNEW which has been developed to calculate shadowing corrected interaction solid angles on a plant-wide basis.

The numerical method used in SOLNEW is to wrap a unit sphere around the subtended point and perform mappings of each of the interacting objects onto a two-dimensional grid on the sphere. The two-dimensional grid is defined in theta and phi space such that each region, defined by the increments of and on the surface of the unit sphere, has an area equal to 4 /NM, with N and M being the degree of subdivision in the theta and phi grids, respectively. Numerical integration is then performed by adding up the number of grid points inside (or turned "on" by) the mapping and multiplying by 4 /NM sr. To correct for shadowing, the interaction objects are ordered by increasing distance from the center of the unit sphere and the binary status (e.g., on/off) of the grid is saved, point-by-point for the entire calculation. Secondary grids are used to numerically evaluate those areas in a given station to station case where one, two, and more than two other stations in the data set are in between and cause shadowing. In order to assure conservatism, the grid points on the unit sphere are swept from the center of the mapping of the object outward in such a way as to use the minimum displacement from the center-most point of the mapping. This in effect maps the surface onto a slightly larger surface on the unit sphere--and thus result in a slightly larger and hence conservative solid angle.

The Theta/Phi grid, which is defined by the condition Area $\phi = 4\pi/NM$, is in reality a two-dimensional mesh which is used for numerical integration. Increased values of N and M, the Theta and Phi grid sizes, respectively, thus result in calculated solid angles which converge to the true value. In SOLNEW the Theta and Phi grids are independently defined by

1. $\phi = 2\pi/M$

and

2. $$\phi_i = \int_{\theta_i}^{\theta_{i+1}} \sin\theta \, d\theta = \cos\theta_i - \cos\theta_{i+1}$$
where $0 \leq i \leq N$

SOLNEW explictly calculates the individual $_{i's}$ before each calculation. A characteristic of the Theta grid is that the individual 's are much bigger for angles around 0 or π than for values of near $\pi/2$. As a consequence, solid angles calculated for objects located immediately above or below a given reference point tend to be much more conservative (i.e., larger than the true value) than those for objects located to the sides.

<u>Constraints</u> - Computerized solid angle of interaction codes, such as SOLNEW, do not permit judgmental variations in treatment and certain constraints should be observed to assure valid results.

Mesh - Validation has covered the range 108/216 to 432/864 in the theta (latitutde)/phi (longitude) mesh. The 108/216 value is the coarsest mesh to be used in interaction approvals; it is also the most conservative. Finer meshes may be used where more accuracy is desired. The correct standard calculation is based on a 216/216 mesh.

Station Size - The overall size of any station shall be selected to enclose all possible positions of the SNM within the normal operational confines. Exact dimension of a process vessel may be used if it has a stable geometry and location. Stations composed of several parts may be evaluated in parts rather than as a whole. Alternatively, a station with an excessively large dimension or which has an abnormal spatial relationship to another station should be arbitrarily divided into parts to facilitate conservative analysis.

Large Arrays - Systems of SNM with large dimension in one or two directions, such as fuel storage arrays, which have other stations closer than one-half the major dimension of the array shall be analyzed by parts. In the case of storage arrays a parallel cylinder approximation is acceptable for analysis by parts. Interaction calculations may not be used to justify arrays themselves, but rather to evaluate the effect of single stations near arrays.

Isolation Walls - The current solid angle analysis codes do not contain subroutines to evaluate the effects of nuclear isolation walls. This is to be handled at the present time by manual editing and correction of the code output or by analyzing separate groupings of process equipment and manually combining into the overall facility analysis.

Interaction Distance - Specifications require that solid angle analysis include all stations within 12 feet or which intercept 0.005 steradians unless they meet some isolation criteria. The interaction distance must be large enough to assure that the above criteria are met.

5.3.3.3 <u>More Advanced Calculations</u>

In general, most types of interacting systems not directly analyzable by the solid angle method can be analyzed by straight-forward Transport or Monte Carlo Calculations. The former of these is particularly suited to the analysis of infinite systems or systems with regular repeated subunits allowing reflective boundary conditions to be used. Although limited to finite systems, Monte Carlo calculations can, on the other hand, model interacting systems with less pronounced symmetries and are particularly useful for treating irregular configurations such as interacting process stations or storage arrays.

In addition to these methods, two interacting systems may be analyzed by hand calculations if the neutron multiplication factors for each of the isolated assemblies are known. This is done by multiplying the fractional interaction solid angles by the probability that fission takes place because of the interaction and that a fission neutron returns to the initial source. The k_{eff} of the interacting systems is then determined from this modified leakage rate and from the corresponding leakage probability.

5.3.4 <u>Validation of Methods</u>

5.3.4.1 <u>Introduction</u>

The calculational methods discussed and referenced in the foregoing paragraphs have been validated by application to experimental systems and by comparisons with the results of other methods. Particular emphasis is given to the fact that all of the methods use the same kind of cross sections; ENDF/B sets collapsed into broad-group cross section sets using the GGC or MICROX zero-dimensional spectrum codes as discussed in Section 5.3.2.1. The types of systems considered in the validations include:

1. Bare and fully water reflected single units such as solid uranium metal spheres, uranium plus water cylinders, etc.

2. Systems moderated over large ranges by water and carbon; specifically for H/U-235 and C/U-235 ratios from 0 to 1000 for the former and 20000 for the later.

3. Homogeneous and heterogeneous lattices and systems.

4. Systems reflected or moderated by concrete.

5.3.4.2 Validation of Transport and Diffusion Codes

For the validation of the transport and diffusion codes, two sets of comparisons were performed. One was the study of a large set of bare and water reflected critical spheres of homogeneously mixed uranium, water and graphite. The other was the study of several lattice assemblies with fuel compositions similar to those found in the manufacture of HTGR fuels.

5.3.4.2.1 Uranium, Water and Graphite Spheres

A large number of criticality experiments and reference calculations on uranium, water, and graphite spheres have been reported. A comprehensive set of these data has been analyzed using the normal methods applied to criticality studies (1DFX

TABLE I 5.3-4
CALCULATED MULTIPLICATION FACTORS FOR URANIUM, WATER, AND GRAPHITE SPHERES

Case	H/U	C/U	Ref.[a]	Bare (B) or Reflected (R)	1DFX Transport Calculations (P_1, S_4)						GAZE Diffusion Calculations				
					2 Groups	5 Groups	9 Groups	12 Groups	18 Groups	22 Groups	2 Groups	5 Groups	9 Groups	12 Groups	18 Groups
1	0	0	5.2-2	R	1.060	1.130	1.034	1.057	1.051						
2	20	0	5.2-2	R	1.194	1.077	1.027	1.009			1.063	1.053	1.014		
3	126	0	5.3-18	R			1.039						1.011		
4	500	0	5.2-2	R	1.160	1.056	1.038	1.019	1.014		1.013	1.011	1.006	1.006	
5	573	0	5.2-2	R			1.030	1.011	1.005	1.014					1.006
6	573	0	5.2-2	B			1.022								
7	1000	0	5.2-2	R			1.023	1.005					0.977		
8	0	316	5.2-1	R		1.025	1.022					1.118	0.988		
9	0	1271	5.2-1	B	1.049	1.038	1.032	1.072			1.007	1.013	1.015	1.016	
10	0	5091	5.2-1	B			1.009						0.994		
11	0	20371	5.2-1	B									0.990		
12	335	316	5.2-1	R	1.156	1.062	1.052	1.032			1.025	1.019	1.012	1.012	
13	1340	1271	5.2-1	R			1.014	1.006					0.996		

[a] All cases calculated were taken at sizes indicated to be exactly critical in the cited reference.

transport and GAZE diffusion calculations). The results of these analyses, shown in Table I 5.3-4, verify the accuracy of the criticality analysis methods being used. The k_{eff} for Case 1, a reflected uranium metal sphere, is overpredicted by about 5%. Some of this error may be attributed to uncertainty in reading the critical volume from Fig. 9 in TID-7028 (Ref. 5.2-2). This uncertainty amounts to about ± 3% k. Since in all cases the transport calculations overestimate the experimental reactivities, the biases for these types of systems are all taken to be zero. The same is true for the GAZE results except in the cases of carbon moderated systems or water moderated systems with H/U-235 ratios of 1000 or greater. For the latter of these systems the maximum bias is -0.023 and for the former is -0.012.

5.3.4.2.2 HTGR Lattice Calculations

A number of lattice critical assemblies have been analyzed by the GAZE diffusion code using a 30 broad group energy structure. The corresponding critical lattice experiments have been performed in the HTGR program. The results of the analyses, which are presented in Table I 5.3-5, were that the neutron multiplication factors were consistently overestimated by 1 to 2 percent. From the table, the bias for GAZE on these types of systems is taken to be -0.001.

TABLE I 5.3-5
CALCULATED[a] MULTIPLICATION FACTORS
FOR HTGR LATTICE CRITICAL ASSEMBLIES

Case	C/U	Ref.	Multiplication	Multiplication
1	5000	5.3-19	1.013 ± 0.003	1.023 ± 0.005
2	2500	5.3-19	1.014 ± 0.003	1.017 ± 0.005
3	1718	5.3-19	1.013 ± 0.003	1.013 ± 0.005
4	859	5.3-19	1.013 ± 0.003	1.012 ± 0.005
5	432	5.3-19	1.016 ± 0.003	1.019 ± 0.005

(a) Using 30-group GAZE analyses.

5.3.4.2.3 Conclusions Based on the Transport and Diffusion Code Validations

Since the standard method used in these validations was to generate broad group averaged cross sections by a single zero-dimensional spectrum calculation and then use those in the transport or diffusion theory calculations, it follows that the above results also verify that the method for generating the cross-sections is correct. In addition, it can be concluded that when used according to the guidelines discussed in Sections 5.3.2.2 and 5.3.2.3, the transport and diffusion theory codes are accurate and suitable for criticality analyses. The validation made in 5.3.4.2.1 and 5.3.4.2.2 were made for one-dimensional codes; 1DFX for transport theory and GAZE for diffusion theory. Since the two-dimensional codes TWOTRAN (transport theory) and GAMBLE (diffusion theory) use the same theoretical foundations, numerical algorithms and basic nuclear data as their one-dimensional counterparts, it may be inferred that these are also suitable, although the appropriate accuracies and biases must still be determined.

Table I 5.3-4 shows that the 1DFX results are sensitive to energy group structure. As was mentioned in Section 5.3.2.2, this is expected when the S_N discrete ordinate method is used with consistent P_N cross sections. Table I 5.3-4 shows that with the exception of the solid metal sphere (Case 1), the use of few energy groups results in an overestimate of k_{eff}. Diffusion methods, on the other hand, are very insensitive to group structure. Thus, it is not necessary to place any restrictions upon the group structure to be used for criticality studies.

The results obtained by diffusion theory agree well with those obtained using transport theory over a wide range of systems. Caution must be exercised when using diffusion theory, however, as it can underestimate the system multiplication factor by up to 2%. Transport calculations, on the other hand, are always conservative.

5.3.4.3 Validation of KENOII

Since KENO is a criticality code which is generally available to the whole of the nuclear field, the validation studies that have been made to date by other users have largely employed Hansen-Roach cross sections rather than ENDF/B data. There are at least two reasons for this. One is that KENOII was specifically designed to be used with S_N type cross sections and the Hansen-Roach sets were a well known and widely used form of these. The second is that since the Hansen-Roach sets were so well known, their accuracy was well established over the applicable ranges. ENDF/B cross sections, on the other hand, require some form of intermediate editing to generate the appropriate broad group cross sections. Since the ways in which the intermediate editing is performed vary widely from laboratory to laboratory, the resulting cross section sets are not nearly as widely known or applied.

There is considerable evidence from the above mentioned studies that KENOII plus Hansen-Roach cross sections is a valid and acceptable method for use in criticality analyses. Rather extensive compilations of the data leading to this conclusion are given in Ref. 5.3-20 through 5.3-22. In these studies, the maximum negative bias evidenced over an extensive variety of experimental systems is less than -0.029 (Ref. 5.3-22). For most of the cases, the biases are much less than this and are in fact usually within one or two times the statistical uncertainties.

As part of the present validation of KENOII using MICROX or

GGC-5 generated broad group cross sections from ENDF/B data, some credit is taken for the fact that both the code and the cross sections have been independently verified. KENOII has been validated in the studies using Hansen-Roach cross sections and MICROX and GGC-5 have been validated by the success of DTFX and GAZE calculations. In addition to these points, however, several sets of KENO-broad group calculations have been made as part of the present study of experimental systems or systems which have also been analyzed by one dimensional transport calculations. These are discussed in the following sections. In all the calculations, P_1 anisotropic cross sections generated by MICROX and the 18 energy group structure shown in Table I 5.3-2 were used.

5.3.4.3.1 Comparisons with Experimental Systems

One of the first checks made of KENOII with ENDF/B cross sections was the calculation of the multiplication of the water reflected sphere of fully enriched UO_2F_2 plus water with the minimum critical mass. According to TID-7028 (Ref. 5.2-2), this is a sphere with a radius of 6.2 inches, 820 gm of fully enriched U-235 and an H/U-235 ratio of 500. Using these values, the result of the KENOII calculation was a k_{eff} of 1.0298 ± 0.01082.

A second water reflected critical system from TID-7028 (p. 92) to be analyzed was a critical assembly of two fully enriched UO_2F_2, plus water cylinders whose surfaces were in contact. The cylinders were 15.2 cm in diameter, 23 cm high and were con-structed of 0.16 cm thick aluminum. Each of the cylinders contained 3.167 kg U-235 with a H/U-235 ratio of 29.9. The result of the KENOII calculation was k_{eff} of 1.0010 ± 0.00520.

As part of the criticality analysis of the storage vaults discussed in Section 3.1.3.2 and 5.5.7, an analysis was made of several experimental critical arrays in TID-7028 (p. 109) involving water and concrete reflection and isolation. These arrays are shown in Fig. I 5.3-1, although calculations were not made for systems 5, 6 and 8. The individual containers in these calculations were 15.2 cm in diameter, 127 cm high aluminum cylinders, 0.16 cm thick and contained 8.85 kg of fully enriched U-235 and water. The H/U-235 moderation ratio was 59. Materials and densities for the concrete, which was taken to be 140 lbs/ft^3 Portland Common, were taken from Ref. 5.3-21. Table I 5.3-6 shows the results of the calculations, all of which have positive biases.

5.3.4.3.2 <u>Comparisons with Transport Calculations</u>

Table I 5.3-7 shows the results of KENOII and DTFX calculations for several simple unreflected subcritical systems with fully enriched uranium and water. In addition to this, calculations were made for a somewhat more complex system consisting of a set of seven coaxial cylinders modeling two fuel zones separated by iron and water and reflected radially by water. The dimensions and constituents of each zone are shown in Table I 5.3-8. The uranium was fully enriched with a U-235 density of 0.052 gm/cm^3 and the H/U-235 moderation ratio in the fuel regions was 500. Rather than both calculations being k_{eff} determinations, the DTFX calculation was a search for the minimum critical height for the assembly. The result was a height of 25.047 cm. Using this height, a KENOII calculation was made for the assembly and the resulting k_{eff} was found to be 1.0069 ± 0.0142.

5.3.4.3.3 <u>Conclusions about the Validatin of KENOII</u>

The results in the previous sections shown excellent agreement between the results of KENOII calculations and the experimental systems or transport calculations. For the former of these, no negative bias has been evidenced. For the latter, there are slight negative biases but these are difficult to interpret since the DTFX calculations are known to be conservative. As a final remark, it can be noted that excellent agreement and consistency has been realized between the DTFX, GAZE and KENOII results, a point that is taken to be additional verification of all three methods.

TABLE I 5.3-6

KENOII ARRAY CALCULATIONS

Array Number*	Description	k_{eff}	σ
1	20.3 cm Air Gap	1.0229	0.01145
2	20.3 cm Concrete Gap	1.0588	0.00547
3	15.2 cm Water Gap	1.0102	0.00852
4	Bare Array, No Gap	1.0325	0.00545
7	20.3 cm Concrete Reflector	1.0393	0.00528

*See Fig. I 5.3-1

TABLE I 5.3-7
KENOII - DTFX COMPARISONS

Geometry	Dimensions* (cm)	Mass U-235 (kg)	H/U-235	DTFX k^{eff}	KENOII k_{eff}
CUBOID	12.7, 12.7, 44.45	1.6	100	0.4565	0.4551 ± 0.00672
			117	0.5724	0.5676 ± 0.00606
CYLINDER	10.2, 20.4	0.350	500	0.6891	0.7232 ± 0.01262
SPHERE	9.51	3.6	23.5	0.6107	0.6005 ± 0.00442
CYLINDER	8.75, 15.74	3.6	24.6	0.6070	0.6055 ± 0.00358

*LWH for Cuboids
R,H for Cylinders
R for Spheres

TABLE I 5.3-8
COAXIAL CYLINDER GEOMETRY

Zone	Outer Radius (cm)	Constituents
1	10.16	Uranium + Water
2	10.98	Iron
3	12.56	Water
4	13.37	Iron
5	28.25	Uranium + Water
6	29.07	Iron
7	49.07	Water

5.3.4.4 Validation of KENOIV

KENOIV, the revised version of the KENO monte carlo criticality code, is generally available to the nuclear industry. An extensive body of validation studies exists for the code employing Hansen-Roach cross-sections, and with broad group cross sections generated by the AMPX code system from the ENDF/B cross section libraries. KENOIV has been demonstrated to give the same results as prior versions of KENO; therefore, the studies validating KENO apply to the revised version. These studies are compiled in references 5.3-12 and 5.3-20 through 5.3-22. The maximum negative bias with Hansen-Roach cross section is stated to be -.029 (Ref. 5.3-22). In most cases the bias is less than twice the statistical uncertainty.

The present validation of the version of KENOIV is a demonstration of equivalent results for published test cases using Hansen-Roach cross sections, and with the version KENOII using broad group cross sections generated by MICROX from the ENDF/B libraries for selected critical systems. The set of Hansen-Roach cross sections used is described in Ref. 5.3-22. The MICROX code was used to generate P_1 anisotropic cross sections with the 18 energy group structure shown in Table I 5.3-2.

5.3.4.4.1 Comparisons with Published KENOIV Calculations

The results of a sequence of runs using the published sample data sets and Hansen-Roach 16 group cross sections is shown in Table I 5.3-9. These results verify that the KENOIV version converted to run on the UNIVAC 1110 gives results consistent with the original version.

TABLE I 5.3-9

Comparison of KENOIV UNIVAC 1110 Version with Published Results*

	Published		GA	
Sample Problem	# Skipped/ Total Generations	k_{eff}	# Skipped/ Total Generations	k_{eff}
1. 2C8 Bare	3/103	0.999±.004	3/52	1.002±.004
5. 2C8 15.24 cm Paraffin Refl.			3/52	1.005±.007
6. 2C8 15.24 cm Paraffin Refl. Automatic Refl.	3/103	0.995±.006	3/52	1.008±.008
16. Generalized Geometry Grotesque	3/37	1.001±.009	3/62	0.994±.005
19. 4 Aqueous 4 Metal Mixed Box Calculation	3/103	0.998±.006	3/103	1.00±.006

*Ref. 5.3-12

5.3.4.4.2 Comparison with Experimental Systems

The KENOIV program was used to calculate the k_{eff} of some simple critical systems, using MICROX cross sections. The systems used were the minimum critical sphere and cylinder from TID-7028 (Ref. 5.2-2). Calculations were made for both the Bare system and systems surrounded by a 20 cm water reflector. The results are shown in Table I 5.3-10.

In addition, the system k_{eff} was calculated for selected planar arrays of $U(92.6)O_2(NO_3)_2$ cylinders from TID-7028 Fig. 74. The arrays computed are the three arrays of the first row of Fig. 5.3-1 and the second array of the last row. The results of the calculations are shown in Table I 5.3-11.

5.3.4.4.3 Comparison with Transport Calculations

A comparison study was made of several subcritical and critical systems using the transport code DTFX, the prior version of KENO and KENOIV. The results are shown in Tables I 5.3-12, 13. For graphite systems a number of calculations were made for the critical systems calculated by W. R. Stratton using the transport code DSN (Ref. 5.2-6). These results are shown in Table I 5.3-14. The two highest C/U-235 ratio data points indicate a conservative overstatement of the k_{eff}.

5.3.4.4.4 Conclusion

The KENOIV code as converted to run on the UNIVAC 1110 is in agreement with the published results using Hansen-Roach 16 group cross sections. In addition the code results are in excellent agreement with the experimental results using 18 broad group cross sections generated by the MICROX code. The results of KENOIV calculations are shown to be in agreement with DTFX and

TABLE I 5.3-10

KENOIV Comparison with Experimental Systems

System[1]	Mass U-235 (kg)	H/ U-235	Dimensions (cm.)		Generations Skipped/ Total	k_{eff}
				r		
Sphere	1.39	580		19.46	5/28	1.027±.008
Sphere Reflected	.82	500		15.56	5/41	1.009±.007
			r	h		
Cylinder	1.51[2]	580	18.11	32.59	5/47	1.027±.006
Cylinder Reflected	.836[2]	500	14.17	25.50	5/47	1.002±.009
Cylinder Generalized Geometry	1.51[2]	580	18.11	32.59	3/53	1.029±.007
Cylinder	2.026[2]	1000	23.96	43.12	5/37	1.029±.007
Cylinder	2.00[2]	250	15.06	27.10	5/103	1.030±.006
Cylinder	2.19[2]	200	14.84	26.71	5/55	1.038±.009
Cylinder	3.92[2]	100	13.91	25.05	5/78	1.018±.008
Cylinder	6.90[2]	50	13.40	24.13	5/98	.998±.006

[1]All fuel bodies surrounded by 1/16" Fe container.

[2]The critical mass from TID-7028 (Ref. 5.2-2) Fig. 13 is increased by a factor of 1.09 from TID-7028 Fig. 1 for a cylinder of h/d = 0.9.

Table I 5.3-11

KENOIV Comparison with Experimental Systems

Array Description[1]	Generations # Skipped/ Total	k_{eff}
4 x 2 (20.3 cm air) 4 x 2	7/120	1.027±.006
4 x 2 (20.3 cm concrete) 4 x 2	7/109	1.055±.005
4 x 2 (20.3 cm containing 15.2 cm H_2O) 4 x 2	7/120	1.016±.005
Concrete 4 x 2 + 2	7/113	1.032±.006
Single Cylinder[2]	7/120	0.649±.005
Single Cylinder 20 cm H_2O Reflector[2]	7/60	0.982±.007

[1]Units are 15.2 cm dia x 127 cm high cylinders of aqueous U(92.6) O_2 $(NO_3)_2$ solution at 384 g/liter U-235 and H/U-235 of 59. The solution container of 1.6 mm thick aluminum was included and the water container of 3.2 mm thick aluminum was neglected in the calculations.

[2]Calculated results only.

Table I 5.3-12

Method Comparison

Geometry	Dimensions[1] (cm)	Mass U-235 (kg)	H/U-235	DTFX k^{eff}	KENOII k^{eff} Δk	KENOIV k^{eff} Δk	Generations # skipped/total
CUBOID	12.7,12.7,	1.6	100	0.4565	0.4551±0.0067	0.4530±0.0045	5/120
	44.5		117	0.5724	0.5676±0.0061	0.5734±0.0047	5/120
CYLINDER	10.262, 20.524	0.350	500		0.625±0.0068		
	10.232, 20.262	0.343	500	0.5882			
	10.2,20.4	0.343	500			0.6115±0.0061	5/47
			C/U-235				
SPHERE	55.455	83.5	316.2	1.022[2]		1.0130±0.0072	5/55
	58.192	24.1	1271.2	1.032[2]		1.0104±0.0072	5/67
	63.524	7.84	5091.	1.009[2]		1.0179±0.0096	5/48

[1]LWH for Cuboids
R, H for Cylinders
R. for Spheres

[2]k_{eff} from 1DFX calculation using 9 group cross sections.

Table I 5.3-13

Method Comparison - Coaxial Assembly

COAXIAL CYLINDER GEOMETRY[1]

Zone	Outer Radius (cm)	Constituents
1	10.16	Uranium + Water[2]
2	10.98	Iron
3	12.56	Water
4	13.37	Iron
5	28.25	Uranium + Water[2]
6	29.07	Iron
7	49.07	Water

	Calculated k_{eff}
KENOII	1.0069±0.0142
KENOIV	1.0096±0.0075

[1] System height (25.047 cm) obtained from DTFX search for minimum critical height.

[2] Fuel zone - U(93.5), U-235 density 0.052 g/cm^3, H/U-235 = 500.

Table I 5.3-14

Calculation of Critical Systems Containing Graphite*

C/U-235	H/U-235	Critical radius (cm)	Mass U-235 (kg)	k_{eff}	Generations # skipped/total
77.46		44.720	175.135	1.005±.005	5/82
157.04		51.184	131.294	0.995±.007	5/67
157.04	27.917	30.767	22.81	1.024±.008	5/61
316.2		55.455	83.49	1.013±.007	5/55
316.2	10.99	44.470	40.90	0.992±.007	5/76
634.54		45.846	57.214	0.999±.008	5/46
1271.2		58.192	24.119	1.01±.007	5/67
5091.2		63.524	7.843	1.018±.010	5/48
20371.		83.006	4.375	1.069±.010	5/39
40742.		105.521	4.494	1.078±.014	5/24

*Ref. 5.2-1.

DSN transport in agreement with DTFX and DSN transport calculations for aqueous and carbon moderated systems respectively. The data, other than the twoconservative highC/U-235 ratio points, are distributed over the entire moderator ratio span of interest and do not show any significant trends. The two standard deviation lower limit of the average of the critical system results is 0.9870. The bias for all H/U-235 and C/U-235 ratios is therefore taken to be -0.013.

5.3.4.5 Validation of SOLNEW

To validate SOLNEW a series of calculations were made of systems of spheres, cylinders, and cuboids for which exact calculations could be made. In the use of SOLNEW, a right-handed coordinate system is assumed with the Z axis in the upward vertical direction. The data sets placed the objects in all directions and in a number of rotated angular positions to permit tests of the adequacy of the code in all directions and to verify that the necessary Euler transformations were made. In every case SOLNEW yields a conservative, i.e. larger, solid angle than the exact value.

Comparisons were also made between SOLNEW and SNAKE (Ref. 5.3-23). SNAKE is a code, of limited versatility, that uses methods similar to those used in exact calculations (Ref. 5.3-17); it also performs calculations using simplified approximations (Ref. 5.3-15 and 5.3-16). SNAKE is not capable of performing Euler transformations so not all test cases could be compared, however, in every case tested, SOLNEW produced results more conservative than either value produced by SNAKE.

Finally all SOLNEW calculations made in actual applications for the first three years of usage were compared with the results from the code SOLOLD. This code is capable of operating from the same data sets as used for SOLNEW and performs all Euler transformations, but it uses a simple projected area over distance squared approximation and radically overstates nearby objects. This extensive testing, consisting of at least 50,000 individual comparisons, did reveal a few isolated SOLNEW search logic faults in the polar and near polar regions with unusual station orientations. These faults were corrected, and the use of SOLOLD was discontinued after a year of fault free comparison.

5.3.4.5.1 <u>SOLNEW Including Indirect (Reflector) Effects</u>

A deficiency within solid angle analysis in determining interaction effects for SNM stations is that it ignores the contribution of neutrons indirectly scattered into the station from reflectors in the vicinity. Since the allowable solid angle is conservatively estimated based on experimental data, including some partial reflection, and since it is always used with the conservative assumption that each station involved with the interaction analysis is in the most reactive configuration possible, this is generally acceptable. However, because some of the in-process storage arrays are located adjacent to concrete walls, an analysis was generated to evaluate the reactivity effects associated with this indirect contribution.

The analysis was made with KENO for the explicit arrays of 5" cylinders adjacent to a concrete wall, including the concrete floor, as configured in Fig. 5.3-2. The number of cylinders varied from 1 to 5, the distance to the concrete wall varied from 0" to 48" from the surface of the cylinders, and the cylinders were in their most reactive condition, but with an <u>H/U ratio of only 19</u> to maximize the effect of the scattered neutrons.

The most reactive H/U ratio for cylinders with uranyl solutions (nitrates or fluorides) as evidenced by critical experiment data given in the Nuclear Safety Guide, reference 5.3-16, is about 50. However, homogeneous metal-water mixtures for under-moderated systems are more reactive with a lower H/U ratio because of additional volume available for uranium and hydrogen. See Fig. 2.3 of that reference. For this reason, a criticality search was done on a single 5" cylinder holding the uranium content at 10 kg U-235 and varying the height and water volume. The most reactive configuration for a bare cylinder was about 66 cm tall with a H/U-235 ratio of about 19. Since the lower H/U ratio will maximize the effect of an adjacent reflector and satisfy the most reactive requirement, this configuration was selected for the analysis.

Prior to performing the analysis on the array of cylinders, the analysis was done on a single 5" cylinder with a maximum U-235 loading allowed (10 kg) both reflected and unreflected. The calculated k_{eff} for the bare cylinder was k = 0.575 (DTFX) and k = 0.581 ± .003 (KENO). This is consistent with the bare k_{eff} assumed for interaction analysis of 0.580. The fully reflected cylinder had a k_{eff} of 0.910 ± .004 with kENO, which is also consistent with that defined in Section 5.5, Standard Limit C.

An analysis was also made for an array of 5" cylinders with 12" surface to surface separation and no reflector present. This confirmed the adequacy of the solid angle method in the absence of a reflector. The interaction coefficient (defined as $\Delta k/k/\Omega$) for the adjacent cylinders was calculated to be 0.081 with the explcit analysis and is estimated at 0.167 using the expression (9 - 10 k_{eff}) for a k_{eff} of 0.6. The calculated k_{eff} for the array was 0.605 ± .003 with KENO.

The results for the calculation of the array with the adjacent reflector at various distances from the surface of the cylinders is given in Table I 5.3-15. Included in this table are the results for the unreflected case. Given in the table are the calculated values of F(I, J) for J = 1 to 5. F(I, J) is the probability that a neutron born in cylinder I causes a next generation fission in Unit J, which may also be interpreted as the increase in reactivity (Δk) in Unit J due to neutrons born in cylinder I. Note that for the case with no reflector, the fission probability for the cylinders shadowed by an adjacent cylinder is very small, essentially 0 for cylinders 4 and 5 in the array. However, in the presence of a reflector, the coupling coefficients between cylinders are significantly larger than for the unreflected array. The differences are due to the neutrons scattering off the concrete wall, and because of the very low H/U of the system, thermalization within the concrete and then reentry into the cylinders. The purpose of the analysis was to characterize these reactivity effects associated with this indirect contribution.

An interaction coefficient for the cylinders in the array was defined as ($\Delta k/k/\Omega$). The reactivity change ($\Delta k/k$) was obtained from the F(I, J) terms given in Table I 5.3-15. Using a solid angle as calculated with the SNAKE code, the interaction coefficients were calculated and are shown in TAble I 5.3-16. These coefficients include both the reactivity effects due to direct neutron transfer and indirect or scattered neutron transfer. By subtracting the direct effects obtained from the array with no reflector, the interaction coefficients associated with the presence of the reflector are obtained.

TABLE I 5.3-15
CALCULATED VALUES OF F(I, J) FOR THE REFLECTED ARRAYS (5 Cylinder)

F(I, J) at Various Surface-to-Surface Distances
Between Cylinders and the Vertical Wall

J	Distance from Wall (Inches) 0	3	6	9	12	24	48	No Reflector
1	0.639	0.617	0.582	0.575	0.569	0.569	0.572	0.574
2	3.71-2	3.78-2	3.71-2	3.30-2	3.09-2	2.56-2	2.31-2	1.77-2
3	2.22-3	4.77-3	7.2-3	8.50-3	6.79-3	5.29-3	3.25-3	2.70-4
4	7.10-4	1.00-3	2.4-3	3.1-3	3.37-3	2.35-3	1.81-3	-0
5	6.77-5	4.20-4	4.8-4	1.10-3	1.84-3	2.0-3	5.37-4	-0
k_{eff}	0.708±.003	0.678±.003	0.656±.003	0.647±.003	0.634±.003	0.625±.003	0.621±.003	0.605±.003

TABLE I 5.3-16
CALCULATED VALUES OF INTERACTION COEFFICIENTS FOR THE REFLECTED ARRAYS

$(\Delta k_I/k)/\Omega$ at Various Surface-to-Surface Distance
Between Cylinders and the Vertical Wall

J	No Reflector	Distance from Wall in Inches 0	3	6	9	12	24	48
2	8.08-2	1.694-1	1.726-1	1.694-1	1.507-1	1.411-1	1.169-1	1.055-1
3	4.32-3	3.55-2	7.63-2	1.152-1	1.360-1	1.086-1	8.46-2	5.20-2
4	-0	2.50-2	3.53-2	8.47-2	1.094-1	1.189-1	8.29-2	6.39-2
5	-0	4.22-3	2.62-2	2.99-2	6.86-2	1.147-1	1.247-1	3.35-2

$(\Delta k/k)/\Omega$ = 0.167 from (9-10 k_{eff}) criterion at k = 0.6.

Several conclusions can be drawn from that calculated data:

1. The calculated k_{eff} for the single most reactive unit, including the container, for both the bare and reflected case was consistent with previous data being used. (Section 5.5.c.)

2. The solid angle criterion for an array of cylinders in an open room is conservative and shadowing of individual units is acceptable. (Data for No Reflector case in Table I 5.3-15 and I 5.3-16.)

3. The margin of safety of this criterion is certainly reduced in the presence of a peripheral reflector. However, even for this under-moderated system, H/U-235 about 19, the calculated interaction coefficients for any unit in the array are less than the value of 0.167, which is the value from the criterion for k_{eff} of 0.6, if the reflector is further than 6 inches from the reflector. (Data from Table I 5.3-16.)

An analysis similar to that described above was performed with the KENO code to determine the interaction coefficients associated with the transmission of neutrons through an isolation wall.

A series of KENO IV calculations were carried out to evaluate the effect of neutron interaction between two spherical bodies interposed by a concrete wall. The calculations were performed for three wall thicknesses (6, 8, and 12 inches) and three H/U ratios (23.2, 100, and 500). The wall thicknesses of 6 to 12 inches encompass the whole range of wall found in the manufacturing facilities. The H/U ratio of 23.2 represents the content of the 1-gallon container containing 3.6 kg of U-235 (in a 3.6 liter sphere). At the other extreme, the H/U ratio of 500 represents the content of the optimally moderated sphere containing 350 g of U-235 (mass limit of the Standard Limit Type A). The radius of spheres were adjusted such that the calculated bare k_{eff} was approximately 0.6 so that results of calculations may be compared on the same basis.

In each case, two identical spheres were assumed to be located on opposite sides of a concrete wall with the nearest surface 2 inches from the wall surface.

Results of the calculations are summarized in Table I 5.3-17. The F(I, J) array shown in the table is defined as the probability of a neutron born in Unit I causes a next generation fission in Unit J. The significance of this probability matrix and the calculated interaction coefficients is the same as that described in the previous section.

Although these coefficients are smaller than these for direct interaction, they are definitely not negligible. As expected, the degree of interaction decreases with increasing wall thickness. It is also a strong function of H/U ratio. The interaction coefficients decrease with increasing H/U ratio. This observation may be explained by the fact that the thermalized neutrons coming through the wall are most important to a low H/U (fast) system than a high H/U system.

TABLE I 5.3-17

RESULTS OF CALCULATIONS - NEUTRON INTERACTION BETWEEN SPHERES ON OPPOSITE SIDES OF WALL

Sphere Radius (cm)	H/U Ratio	Wall Thicknes (in)	F(1,1)* or F(2,2)	F(1,2) or F(2,1)	Δk/k**	Ω***	(Δk/k)/Ω
9.25	23.2	6	0.608	6.79-3	1.135-2	0.1411	8.04-2
9.25	23.2	8	0.607	4.31-3	7.205-3	0.1131	6.37-2
9.25	23.2	12	0.608	2.10-3	3.511-3	0.0773	4.54-2
9.7	100	6	0.622	5.78-3	9.418-3	0.1490	6.32-2
9.7	100	8	0.623	3.88-3	6.322-3	0.1200	5.27-2
9.7	100	12	0.622	1.73-3	2.819-3	0.0823	3.43-2
11.72	500	6	0.657	4.09=3	6.290-3	0.1836	3.42-2
11.72	500	8	0.654	3.32-3	5.100-3	0.1502	3.40-2
11.72	500	12	0.650	1.14-3	1.752-3	0.1060	1.65-2

*(F(I,J) = probability of a neutron born in Unit I causes a next generation fission in Unit J

** k/k is calculated by dividing F(1,2) by F(1,1).

***Ω = solid angle (in steradian) of one sphere subtending upon another sphere.

5.4 SAFETY FACTORS

The use of safety factors ensures an additional margin of safety in all operations with nuclear fuel. This margin is intended as a cushion to allow for engineering uncertainty in dimensions or measurements, or, in the case of mass, to allow for possible error.

The safety factor is defined as the ratio of the critical value of a quantity to the maximum allowed value; i.e., it is the inverse of the maximum allowable fraction of the critical value of that quantity. The safety factor is applied to the most reactive credible situation. This situation is defined by the assumptions of Section 5.2.1, which states that all operations must require the occurrence of at least two simultaneous, unrelated, unlikely events before a criticality hazard can exist.

The safety factor is applied to the limiting critical quantity. A proposed operation is studied and the most reactive credible situation is determined. The quantity to be limited is selected and its critical value is determined. This critical value of the limiting quantity is then divided by the safety factor to obtain the maximum value of this quantity that may be used.

Limiting quantities that may be used include mass, volume, system dimensions such as radius or height, uranium density, and the system multiplication factor.

The specific safety factors to be used with each limiting quantity are considered part of the conditions of the license. They are presented in Section 5.4, Part II, of this license application.

5.4.1 Graphic Data

The basic reference for critical dimensions of SNM-water systems is TID-7028 (Ref. 5.2-2). This document is an extensive cross comparison of many critical experiments on a common basis. The agreement between TID-7028 and detailed computer calculations as demonstrated in Table I 5.3-4 gives weight to the use of TID-7028 as a major criticality reference.

It is convenient to use graphical data to justify the safety of simple systems, and Figs. 1 through 12 of TID-7016 (Ref. 5.3-15) and similar data in Ref. 5.3-16 have occasionally been used in this manner. The graphic data presented in the first reference consists of early data only and in the later reference, while it does provide currently recognized subcritical limits, quantitative safety factors are not stated. Since we have already demonstrated the adequacy of TID-7028 as an acceptable criticality reference by the comparison noted above, graphic data was obtained by applying the safety factors given in Section 5.4 of Part II to the critical parameter versus SNM density curves given in TID-7028. The resulting curves are presented herein as Figs. I 5.4-1 through I 5.4-4. The metal-water mixture data are used because in the use of these figures in nuclear safety evaluation by the licensee it is assumed that the SNM exists in the containment vessel as a fine particulate material and the vessel may become water flooded. This is more conservative than assuming solutions, which permit more mass or volume and limit the SNM density to about 1 kg per liter. When it is desired to enter these figures with a H/U-235 ratio rather than the plotted U-235 per liter of mixture, a conversion may be obtained by using Fig. I 5.4-5 which is plotted on the basis of metal-water mixtures.

The area-density concept is of frequent use in storing and handling SNM; this is usually expressed in kilograms of U-235 per foot square of area. The working limits are arrived at by using the water reflected critical slab geometry curves of TID-7028 (Ref. 5.2.2), converting to equivalent kilograms per foot square, applying suitable safety factors, and replotting versus the U-235 density per liter of U-235-water mixture. This plot is shown in Fig. I 5.4-6. The curve, at a safety factor of 2.3, provides double-batch protection under mass control. The area-density concept is used only in those situations that resemble uniform slabs; i.e., the material bearing the SNM occupies a significant part of the area. The data in Fig. I 5.4-6 have sufficient uncertainty to dictate that they only be used at the optimum moderation minimum when they are the sole justification.

The minimum in the curve gives the permissible average U-235 concentration per foot square that is safe without regard to H/U ratio. This occurs at about 0.03 kg per liter, which is equivalent to an H/U ratio of 850, and anything to the right of the minimum is undermoderated. Carbon as a diluent has less moderation ability, per atom, than hydrogen and addition of carbon to an undermoderated U-H_2O mixture in a volume-limited system or a thickness-limited slab results in a loss of reactivity. The effect of carbon dilution in slab geometry is shown in Fig. I 5.4-7, where the analytical data from LAMS-2955 (Ref. 5.2-1) and the experimental data from TID-7028 (Ref. 5.2-2) are combined. In the region of H/U-235 = 1000 and less, the critical thickness increases as carbon is added to a U-235 - water system; hence, the reactivity decreases.

The effect of variations in the H/U-235 and C/U-235 ratios on the critical mass of a bare U-235 - carbon - water sphere is shown in Fig. I 5.4-8, where more data from LAMS-2955 and TID-7028 are combined. A similar data combination has been presented in Fig. 10 of LA-3366 (Ref. 5.4-1The main feature of this figure is the fact that for C/U-235 ratios of 150 or less combined with any H/U ratio, the U-235 - water curve is adequately conservative. However, when the U-235 mass density is less than 0.02kg/liter in large U-235 carbon systems, more detailed consideration is needed.

Similar U-235 - water - carbon system configuration curves derived from LAMS-2955 and TID-7028 are shown in Fig. I 5.4-9 for bare and reflected critical volumes of spheres and in Fig. I 5.4-10 for reflected cylinders. These data also demonstrate the adequacy of the U-H_2O curves for all cases including C up to a C/U-235 ratio of 150.

Figure 53 of TID-7028 shows that U-235 diluted and moderated by other moderators (Be, BeO, D_2O, and C) raises the minimum critical mass compared with a H_2O-moderated system provided the U-235 density in the mixture is greater than 0.02 kg/liter. Large very dilute systems involving Be, BeO, or D_2O are not conservative; however, they are not used in the present operations.

The only large, dilute carbon systems of concern at the San Diego operations involve slab geometries. Additional data from LAMS-2955 and TID-7028 are presented in Fig. I 5.4-11 to demonstrate the safety limits of infinite slab geometries. A direct comparison with U-235 surface density criteria is possible in this figure because the locus of all slab thicknesses for a given mass per unit area lies on a 45° sloping straight line and such a line tangent to a critical geometry curve represents the maximum allowable loading under given conditions before allowing for double-batch or volumetric safety factors. The limiting density for any C/U-235 ratio is 0.067 kg per foot square.

5.4.2 Equipment Size Considerations

Nuclear safety in process equipment used with fully enriched uranium must be based on a combined geometry-mass limit. Without associated mass limits, the safe geometry becomes prohibitively small. The following basic criteria, as specified in Section II 5, must be met in process equipment:

1. SNM mass limit control requires that a safety factor of 2.3 exist to allow for safety if double batching should occur.

2. Full water equivalent reflection must be assumed unless it can be proven impossible - a person is a good partial reflector.

3. Internal flooding must be assumed if possible. The use of water cooling in a piece process equipment makes the flooding assumption virtually mandatory.

4. The safety factor with internal flooding existing must be at least 1.075 if diameter is the controlling limit or 1.136 if thickness is the controlling limit and 1.333 if volume is the controlling limit.

5. If water cooling is used internal to the geometry control surface, simultaneous double batching and flooding safety are required. The safety factor used is 2.3 below critical concentrations with optimum internal moderation.

6. The worst case fully reflected effective reactivity must be below 0.9 when analyzed by hand calculations, and when analyzed by validated computer codes, less than 0.95 minus the statistical uncertainty (if any) and analytical bias.

7. The normal nonreflected effective reactivity must be well below 0.8 to permit some margin for interaction with other nearby process equipment. In addition, it is very doubtful that a unit with a nonflected reactivity of 0.8 would be subcritical if it were to become reflected.

A survey of the safe U-235 (93%) loading of cylindrical process vessels ranging from 5.0 to 8.0 in. in diameter has been carried out using experimental data from TID-7028 (Ref. 5.2-2). This was accomplished by considering the reflected cylinder to be of varying height and performing a geometrical buckling calculation to determine the reactivity equivalent sphere. The spherical critical concentration of U-235 in a homogeneous water mixture was then obtained from Fig. 9 of TID-7028. In each case this is the concentration which would also make the cylinder critical.

The buckling calculations used the standard relationship:

$$\left(\frac{2.405}{r_c + \delta_c}\right)^2 + \left(\frac{\pi}{h + 2\delta_c}\right)^2 = \left(\frac{\pi}{r_s + \delta_s}\right)^2$$

Where r_c = radius of cylinder

h = height of cylinder

rs = radius of sphere

$_c$ = effective extrapolation length for cylinder

$_s$ = effective extrapolation length for sphere

The values of δ_c and δ_s were obtained from Fig. 3 of

TID-7028.

The safety of mass-controlled SNM loadings was determined by distributing a given amount of U-235 over the volume of the cylinders. The safety factor is the ratio of the critical concentration to the load limited concentration. The safety factor generally has a minimum in the range of 15 to 30 in. column height, and this minimum is used to set the maximum permissible loading.

Selected calculation results for cylinders of 5.0, 5.5, 6.0, 7.0, and 8.0 diameters are plotted in Figs. I 5.4-12 through I 5.4-16. Caution should be exercised in the application of these data as they are intended for estimation and scoping purposes.

The data are summarized in Fig. I 5.4-17, where the maximum allowable total U-235 mass under varying circumstances is plotted versus cylinder diameter, in all cases fully reflected. Three curves show, for any H/U-235 ratio, the optimum moderation critical mass and the reduced masses giving safety factors of 1.33 and 2.3. The remaining curves show the masses allowable under conditions where the effective H/U-235 ratio is also a limiting safety criteria. The H/U-235 ratio limit data were derived by using the data of the buckling calculations to determine the height of the cylindrical column that would be just critical at the equivalent U-235 density per liter. This column height was scaled by the safety factor and the resultant contained mass of U-235 determined. This process assumes a collapsed bed of fuel at the selected H/U-235 ratio. Expanded beds, such as occur during fluidizing, have more neutron leakage and a reduced density and are further subcritical, hence safe, than the collapsed bed. Limiting the internal moderation greatly increases the allowable mass; however, care must be exercised in that, if flooding is possible through failure of the containment vessel or via connected pipes or ducts, then a flooded safety factor curve must be used. For example, a H/U-235 ratio limit of 50 in a 6.0-in. cylinder permits an operating limit of 1.75 and the 1.33 flooded safety factor curve is well above it at 2.65 kg. However, the 4.85 kg permissible for a H/U-235 ratio of 10 is well above the 1.33 curve and would actually be critical if flooding could occur; hence, if the system used water cooling external to the structural portion of the geometry containment, the mass limit would be 2.65 kg at a H/U-235 ratio of 10.

5.5 STANDARD LIMITS FOR FULLY ENRICHED URANIUM

Several simple sets of limits find wide usage throughout the operations at the San Diego site. These limits are specified in this section, along with their nuclear safety justification, to simplify the descriptions of present operations in Section 3, Part I. When not referenced otherwise, the multiplication values reported were obtained by a spectrum calculation in accordance with Section 5.3.2.1 followed by a multiplication calculation in accordance with Section 5.3.2.2. For most cases nine energy groups were used. The allowed solid angle is based on the solid angle method of Section 5.3.3.2 and Part II, Section 7.5 using the k_{eff} for the bare geometry.

5.5.1 Standard Limit Type A

Mass limit . . . . 350 g U-235
Volume limit . . . . None
Moderator . . . . H/U or C/U (any ratio)
Reflector . . . . Full water
Safety factor 2.3
k_{eff} bare 0.62
k_{eff} reflected 0.84
Interaction allowed . . . . 2.8 steradians

This is the basic, "always safe" operating limit for fully enriched uranium (Table XII, Ref. 5.5-1). It is safe under all conditions of moderation, reflection, and double batching. The safety of this operating limit is demonstrated by the minimum of the reflected geometry curve in Fig. I 5.4-1. The reactivity values were obtained by performing spectrum calculations in accordance with Section 5.3.2.1, followed by a 1DFX multiplication calculation using the most reactive configuration, a sphere with a H/U-235 ratio of 500.

5.5.2 Standard Limit Types B-1, B-2, B-3 and B-4

Mass limit	3.6 kg U-235 (B-1, B-2, B-3, B-4)
Volume limit	3.6 liters (B-1, B-2, B-3) 1 gallon (B-4) (3.8 liters maximum)
Moderator	C or H to volume limit
Reflector	Full water
Safety factor	2.3 mass, 1.33 volume
Shape B-1	3.6-liter sphere
Mass	3.6 kg U-235
k_{eff} bare	0.626
k_{eff} reflected . .	0.94
Interaction allowed .	2.74 steradians
Shape B-2	5-in. diam x 11.19 in. high (3.6 liters)
Mass	3.6 kg U-235
k_{eff} bare	0.517
Interaction allowed	3.83 steradians
Shape B-3	5.5-in. diam x 9.5 in. high (3.6 liters)
Mass	3.6 kg U-235
k_{eff} bare	0.530
Interaction allowed	3.70 steradians
Shape B-4	1 gallon not spherical (3.8 liters)
Mass	3.6 kg U-235
k_{eff} bare	0.60

k_{eff} reflected . . 0.95
Interaction allowed 3.00 steradians

These operating limits are used for storage and for certain production operations in reactor fuel element fabrication, and they have both a mass and a volume safety factor. Any operating station that utilizes more than one such unit and any station where containers are opened shall have suitable fixtures to prevent spillage and to hold each container in its assigned location on a spacing of at least 16 in. x 18 in. center-to-center.

The 16-in. x 18 in. spacing is justified under the more generalized storage geometry given as standard limit Type G in this section. This limit is safe under any possible combination of C or H moderators within its volume limit, and the container need not be watertight.

The shapes B-1, B-2, and B-3 represent typical applications of this limit. Shape B-1, the spherical and most reactive shape, is utilized when the detail geometry is not specified. Shapes B-2 and B-3 are more conservative than B-1 because of their cylindrical shape, hence higher leakage, and they apply to container geometries that have a high utilization in present operations; these two geometries have lower reactivities and, hence, permit more flexibility in the operations. The values of k_{eff} for each shape are as presented in Ref. 5.5-2 for B-2 and B-3 types and under standard limit Type H for the B-1 geometry.

One gallon containers, as described in shape B-4 may be substituted as appropriate for 3.6 liter containers in any station or in any storage array with the same mass limit. The 1 gallon containers may be of any shape other than spherical. Generally they are: cylindrical or rectangular. The k_{eff} values for shape B-4 are discussed below.

The nuclear safety of these shapes is based upon the experimental data set forth in Fig. 9 of TID-7028, which shows that a 1-gallon, 3.8 liter, spherical container with water reflection would be subcritical for all loadings lower than 4.5 kg U-235 per liter, a total content of 17 kg U-235. On this basis the gallon container has more than an adequate margin of safety for double batching when both moderated and reflected. To test the sensitivity to volume variation against experimental data, reference is made to Figs. 8 and 9 of TID-7028 (Ref. 5.2-2), which indicate that 3.6 kg of U-235 would be just critical when contained in a volume of 5.4 liter with full moderation and reflection. The convention for safety margin in safe-volume control is to limit the allowed volume to 75% of the critical size. This rule would indicate that 4.0 liter would be the largest permissible volume to contain 3.6 kg U-235, and that the gallon container is more conservative than the rule would call for.

Detailed analysis has been performed to establish criticality limits for 1-gallon containers and to demonstrate the equivalence to the 3.6 liter containers under the two conditions of material loading. Several types of containers have been considered, both rectangular and cylindrical geometries and either polyethylene or metal materials. The rectangular containers are made of polyethylene and are characterized by sloping boundaries between adjacent sides and between the sides and bottoms. As a result, they are modeled most appropriately as cylinders rather than as rectangular slabs. Since all of the 1-gallon containers can thus be modeled the same way, buckling and transport calculations have been made to determine the most reactive cylindrical geometry. This was determined to be the 1-gallon cylinder with a diameter of 17.5 cm and a height of 15.74 cm.

Because the 17.5 cm in diameter cylinder is the most reactive case, calculations have been made to determine its keff for U-235 mass loadings in the range of 500 gm to 3.6 kg. The calculations were performed with the one dimensional transport code DTFX and used 18 group P1-S4 cross sections generated by MICROX spectrum code. Moderation by water to the maximum extent possible was assumed. Since a primary use for the gallon container is as a substitute for the more difficult to obtain 3.6 liter containers, the k_{eff} versus U-235 mass curved obtained from the results of the transport calculations has been used to give the U-235 mass limits at the k_{eff} value associated with the 3.6 kg/3.6 liter standards: 0.60.

The 0.60 limiting value for k_{eff} comes about due to the need to restrict reactivity of material in certain storage arrays. Some of the storage associated with certain facilities utilizes concrete isolation walls that are 8 in. thick and the 0.60 limit has been placed on materials stored in these areas. General use is made of the 0.60 value as a limit in order to prevent a problem if materials are moved between storage arrays using different isolation criteria.

The optimum moderation and the most critical configuration of a system containing a mass, M, of U-235 in a volume of 1-gallon occurs when the maximum amount of water that can be added without displacing any of the U-235 is uniformly mixed with the fuel and when the geometry is such as to result in minimum leakage. Assuming that the U-235 is present in the form of fully enriched (93.5%)[1] UO_2, then the maximum moderation ratio is:

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[1] 6.5% U-238

$$H/U\text{-}235 = \frac{2\,V_o\,M_{U\text{-}235}}{M\,M_{H_2O}}\left[1 - \frac{M\,M_{UO_2}}{.935_{UO_2}\,M_U\,V_o}\right]$$

Where V_o = one gallon in cm^3 = 3785 cm^3

UO_2 = density of UO_2 (10.96 gm/cm^3)

M_{H2O} = molecular weight of water

M_{U235} = atomic weight of U-235

M_U = atomic weight of fully enriched uranium

M_{UO2} = molecular weight of UO_2

M = contained mass of U-235

For example, for M = 3.6 kg of U-235, the moderation ratio is 24.6 and for M = 0.5 kg, the ratio is 195.1. The use of a homogeneous UO_2 type fuel is conservative because it doesn't take self-shielding due to particle sizes into effect and it doesn't allow for absorption due to thorium, a common element in HTGR materials.

The geometry which results in minimum leakage for a 1 gallon cylinder can be determined from calculations made at any representative U-235 mass loading. Table I 5.5-1 gives the values and Fig. I 5.5.1 a plot of the results of calculations made for unreflected, water moderated containers with 3.6 kg of U-235 at several diameter to height ratios. As can be seen from the curve, the most reactive case occurs at a diameter of 17.5 cm. it is also apparent from the drawing that cylinders with smaller diameters have greatly reduced reactivities.

With the most reactive geometry established, several cases of mass loadings and reflector conditions were considered:

1. A bare 3.8 liter (1 gallon) UO_2 cylinder with a diameter of 17.5 cm and with U-235 contents of 0.5, 1.0, 2.0, and 3.6 kg.

2. The same cylnder with full water reflection (20 cm of water),

3. 3.6 and 3.8 liter UO_2 spheres, both bare and water reflected.

Calculations

The 18 group P1 cross sections used in the calculations were generated by the MICROX (Ref. 5.3-2) spectrum code. Sets of cross sections were generated at H/U-235 ratios of 10, 25, 50 and 100; these ratios bracket all the cases of interest to within a factor of 2. The 18 broad group energies and lethargies are those given in Table I 5.3-2. An energy independent buckling of B^2 = 0.07 was used in the spectrum calculations and represents the buckling for a 1-gallon sphere.

Table I 5.5-1
EFFECTIVE MULTIPLICATION FACTORS FOR UNREFLECTED CYCLINDERS WITH VARYING DIAMETERS CONTAINING 3.6 KG U-235 AS U (93.5%)

Diameter (cm)	Height (cm)	k_{eff}
12.5	30.8	0.49
15.0	21.4	0.57
17.5	15.7	0.60
20.0	12.0	0.58

The reactivity calculations were performed with the DTFX (Ref. 5.3-3) one-dimension transport theory code using the P_1 - S_4 approximation. All the DTFX runs were simple k_{eff} calculations and in each covergence was required to within 10^{-4}.

Since DTFX is a one-dimensional code, it does not correctly model full water reflection for cylinders. This difficulty was overcome by increasing the container heights by two reflector savings (2). A value of δ = 4.25 was used and determined from published results (Ref. 5.5-3, p. 19) of thickness calculations for just critical bare and fully reflected infinite slabs.

A detailed analysis of the safety of the reference maximum reactivity cylindrical gallon container in GA storage arrays is set forth in Standard Limit Type G. All other Type B containers are then demonstrated to be less reactive in storage arrays.

<u>Analysis Results</u>

The results of the k_{eff} calculations for the unreflected 17.5 cm diameter cylinder with the four different U-235 mass loadings are given in Table I 5.5-2 and plotted in Fig. I 5.5-2.

The values for the unreflected 3.6 liter and 1 gallon spheres are 0.61 and 0.63 respectively. The corresponding water reflected values are 0.93 and 0.95. Since spherical geometries have the minimum possible leakage, these k_{effs} are the upper bounds for any containers with the same total volumes and which contain less than 3.6 kg U-235. Previous calculations have resulted in a k_{eff} of 0.63 for the 3.6 liter sphere; these were made with 9-group cross sections sets, however, and hence no real discrepancy exists. Calculations made with 9-group cross sections are expected to be more conservative than those with 18-groups.

TABLE I 5.5-2
EFFECTIVE MULTIPLICATION FACTORS FOR UNREFLECTED 1-GALLON CYLINDERS WITH VARYING AMOUNTS OF U-235 (17.5 cm diameter x 15.7 cm high)

U-235 Mass (kg)	H/U-235 Ratio	k_{eff}
0.5	195.1	0.53
1.0	96.1	0.58
2.0	46.6	0.60
3.6	24.6	0.60

The calculation of these effective multiplication factors has been based on conservation assumptions which include, where appropriate, moderation by water to the maximum extent possible, optimum geometry, full fuel (UO_2) and water mixing with a no self-shielding of the fuel particles and full reflection by 20 cm of water. The effective multiplication factors are known to be quite sensitive to these assumptions, particularly to the degree of moderation. Appreciable reductions in reactivity occur for less than the maximum amount of water in the container and for less than complete mixing between the fuel and water.

5.5.3 Standard Limit Type C

Mass Limit . . . . 10 kg U-235
Volume Limit . . . . 5-in. cylinder, any length
Moderator . . . . H or C
Reflector . . . . Full water
Safety Factor . . . . 2.3 mass
k_{eff} bare 0.58
k_{eff} reflected 0.95
Interaction allowed . . . . 3.20 steradians

This operating limit is used for reactor fuel production operations. Two typical applications are for furnaces and scrap recovery columns. While the geometry is safe under conditions of water reflection, such reflection is, in general, highly unlikely due to the use of vertical cylinder orientation.

The nuclear safety of this limit is based on the fact that there is no way to arrange 10 kg of U-235 within a 5-in. column that can approach a critical configuration even with double batching. This is demonstrated by considering the 5-in. column as a cylinder of varying height, determining the U-235 concentration required to make the reflected system critical at different heights, and comparing the resulting concentrations with those possible considering the 10 kg mass limit to be distributed in similar column heights. This type of analysis is discussed in Section I 5.4.2, and figs. I 5.4-12 and I 5.4-17 demonstrate the safety of the geometry--mass limit with an included safety factor of 2.3 for double batching errors. This analysis included all possible degrees of internal moderation; hence, no limit is placed upon the H/U-235 ratio.

The reactivity of this unit for purposes of interaction calculations is 0.58 as presented in Ref. 5.5-1, Table XVII.

5.5.4 (Reserved)

5.5.5. Standard Limit Type E

	E
Mass Limit	0.172 kg U-235/ft^2 average
Geometry	Plane array
Moderator	H/U-235 (any); C/U-235 $\leq$ 1000
Reflector	Full Water
Safety factor	2.3
Maximum allowable . . .	250 gm U-235

subcrit (.3 fraction
critical or less)

k_{eff} reflected 0.71
k_{eff} interaction 0.55
Interaction allowed . . . 3.5 steradians

The nuclear safety of this array is based on the minima in the curves in Fig. I 5.4-6 which demonstrates the safety of homogeneous metal-water mixtures in slab array as a function of SNM density per ft^2 versus kilograms per liter of SNM-water mixture. The normal arrays are not homogeneous, but rather heterogeneous.

Using results on arrays reported by Stevenson and Odegaarden (Ref. 5.5-4), Limit E is considered conservative irrespective of moderation or array size based on their conclusions that the safe mass per unit area should be set at less than 200 gm U-235 per ft^2 with a maximum subcritical size of 0.3 unit fraction critical.

The C/U limit of 1000 is assigned on the basis of Fig. I 5.4-11 which demonstrates the safety of this ratio for the U-235 area-density case. The reactivity of the U-235 system for optimum moderation and reflection is 0.71 and for interaction purposes is 0.55 as presented in Ref. 5.5-5.

5.5.6 Standard Limit Type F

Mass limit	350 gm U-235/barrel
Volume limit	55-gallon barrel or larger
Geometry	Plane array, 1 barrel high
Moderator	H/U-235 (any); C/U-235 $\leq$ 1000

Reflector	Water or concrete
Safety factor	2.3 (mass in barrel)
k_{eff} reflected	0.90
Plane array, close packed, 25 x 20 x 1	
k_{eff} bare	0.66
Interaction allowed	2.40 steradians
Linear array, single line, 25 x 1 x 1	
k_{eff} bare	0.64
Interaction allowed	2.60

SNM may be stored in 55-gallon or larger capacity metal barrels in designated areas. Each barrel will be limited to 350 gm U-235, and the nuclear safety of a single barrel is based on Type A in Sec. 5.5.1. Barrels may be placed in a side-by-side arrangement forming single plane arrays. When in a linear array, the barrels are to be in a single straight line. In plane array, the barrels may be on either a rectangular or triangular pitch.

The nuclear safety of arrays of these barrels is shown in the folowing analysis:

Although each storage drum contains 350 gm of U-235 or less and thus by itself is safely subcritical under all situations, the drums may be closely packed and thus can interact with each other. Two situations must be considered:

1. The fuel is homogeneously distributed, making an infinite slab of material. The storage drums are standard 55-gallon drums, 22.5 in. in diameter, 38 in. high with 18 gauge steel walls. The area of a unit cell of the hexagonal close-packed array of these drums is 2825 cm^2. The depth to which the drums will be filled by mixtures of 350 gm of U-235 and water at various H/U ratios is shown in Table I 5.5-3. Also

shown are the maximum safe thicknesses (including an 88% safety factor) of an infinite fully reflected slab of uranium and water at the same H/U ratios, taken from Fig. I 5.4-4.

TABLE I 5.5-3

MAXIMUM SAFE THICKNESS FOR URANIUM-235 WATER SLABS

H/U-235 RATIO	100	200	500	1000	2000
Density (gm/cm^3)	0.257	0.129	0.052	0.026	0.013
Depth for 350 gm U-235 in 55-gallon drum (cm)	0.53	1.06	2.62	5.25	10.50
Maximum safe slab thickness (cm)	4.1	4.6	6.6	13.0	

As shown in Table I 5.5-3, the storage array is safe when the fuel is homogeneously mixed, with full reflection and any degree of moderation.

2. The fuel is agglomerated in the most reactive manner. The worst case is if the fuel in three adjacent drums collects at the center of the junction of the drums; this case was studied in some detail using the model shown in Fig. I 5.5-3.

The triangular void between the drums was modeled as a circular cylinder of the same area. The fuel was assumed to be in the shape of a cylindrical annulus of equal height and outside diameter. The iron from the portion of the drums surrounded by fuel was homogenized in the fuel annulus, and the system was fully water reflected on all sides. Reflective boundary conditions were used to conservatively model the effect of surrounding fuel drums.

A one-dimensional transport theory calculation was performed using the IDF code (Ref. 5.3-2) on this model. The effects of varying the H/U ratio and of varying densities of water in the central hole were studied. The results are shown in Figs. I 5.5-4 and I 5.5-5.

The most reactive situation was found to be the case of 450/1 H/U-235 ratio and full density water in the central hole. Even in this highly improbable situation with optimal configuration, optimal moderation, and optimal reflection, the system is safely subcritical with a k_{eff} of 0.90. The parameters of this most reactive case are shown in Table I 5.5-4.

It is concluded that a plane array containing any number of barrels is safe with regard to criticality consideratoins under any possible situation.

TABLE I 5.5-4

PARAMETERS FOR MOST REACTIVE CASE [a]

Radius (cm)	0.0 – 6.47	6.47 – 15.28	15.28 – 35.28
Region	1	2	3
Material	H_2O	H_2O, U-235(93.5%), Iron	H_2O
Number Density			
H	6.70×10^{-2}	6.673×10^{-2}	6.70×10^{-2}
O	3.35×10^{-2}	$3.336 \times 1^{0-2}$	3.35×10^{-2}
U-235		1.483×10^{-4}	
U-238		1.030×10^{-5}	
Fe		1.112×10^{-3}	

[a] Height, H = 30.56 cm
Height plus reflector savings, H = 36.02 cm
k_{eff} = 0.90

Materials to be stored in barrels may include liquid and solid materials containing uranium or uranium-thorium mixtures. The storage barrels for solid in-process or scrap material will be metal with metal lids and bolted metal clamp rings. Liquids which are corrosive or that are to be held for extended times will be stored in polyethylene liners which are inside metal barrels, with lids and bolted clamp rings as described above.

The nuclear analysis, to establish the non-reflected k_{eff} of finite arrays for interaction purposes, has been done with the Monte Carlo code KENOII (Ref. 5.3-11). The array studied consisted of triangular pitch array, 25 barrels long and 20 barrels wide, for a total of 500 barrels. This array is sufficiently larger than existing storage arrays, 350 barrels, to insure conservatism for all arrays of interest. In addition to the k_{eff} for a single row of 25 barrels was claculated along with that for a single barrel. The results are shown in table 5.5-5.

TABLE I 5.5-5

KENOII RESULTS FOR BARREL ARRAYS

Array	k^{eff}	σ	Generations	# Skipped
25x20x1	0.659	0.0048	1C3	7
25x1x1	0.636	0.0074	49	7
1x1x1	0.625	0.0068	58	7

The following conditions apply:

1. Each barrel contains 350 g U-235 in the form of U(93.5) metal.

2. Optimum moderation by hydrogen is assumed in the fuel region. All space not occupied by the fuel and container walls are filled with moist air.

3. The maximum credible geometry for the fuel in each barrel is a square cylinder.

4. A previous calculation for a two dimensional array shows that the most reactive configuration occurs when the fuel is in the form of an optimally moderated square cylinder and that full water flooding of the array reduces reactivity.

The fuel number densities are given in Table 5.5-6.

TABLE 5.5-6
NUCLIDE NUMBER DENSITIES

	Nuclides	Density (b-cm)-1
Fuel Region H/U-235	H	66.6197×10^{-3}
	O	33.3099×10^{-3}
	U-235	133.329×10^{-6}
	U-238	9.26263×10^{-6}
Metal Container	FE	84.7620×10^{-3}
Moist Air	H	78.9578×10^{-6}
	O	$37.4789 \times 10_{-6}$

The dimensions of a single barrel are given in Table I 5.5-7. A diagram of the barrel and fuel body is shown in Fig. I 5.5-6.

TABLE I 5.5-7
BARREL DIMENSIONS

	Fuel (cm)	Inner (cm)	Outer (cm)
Diameter	20.464	56.515	56.757
Height	20.464	82.868	83.044

In order to calculate a triangular pitch array using KENOII, the generalized geometry package must be used. The system was modeled by constructing a cell that can be replicated in a rectangular array and reproduce the original triangular array. Such a cell consists of a center barrel and the adjacent quadrants of its four nearest neighbors. A cell diagram is shown in Fig. I 5.5-7.

The cross sections used in the calculations were generated using the MICROX spectrum code (Ref. 5.3-2). Specifically

18-group P1 transport cross sections were generated for cylindrical fuel regions with the material densities listed in Table I 5.5-6. The group structure is given in Table I 5.3-2.

Using the MICROX cross sections the k_{eff} calculations summarized in Table I 5.5-5 were performed. In addition calculations were done using the DTFX transport code for the single isolated barrel, homogeneous plane, and minimum critical sphere (Ref. 5.3-3 and 5.2-2). The results are shown in table I 5.5-8.

TABLE I 5.5-8
DTFX CALCULATIONS

	DTF	XKENOII
BARREL	0.588	0.625*
PLANE	0.139	-
SPHERE	0.999	-

*NOTE: These results for the single barrel are significantly lower than those calculated in Section I 3.3 for 3.6:1 Th/U HTGR fuel. The discrepancy is due to the inclusion of thorium and carbon in the fuel without allowing for the volume they occupy.

5.5.7 Standard Limit Type G

Mass Limit: 3.6 kg U-235/container

Volume Limit: 1-gallon, cylinder or less reactive geometry.

Geometry

Single Plane Array: 70 x 9 units
Spacing 16 in. center-to-center, horizontally and vertically; 8 in. surface-to-surface, horizontally.

Pairs of Plane Array	16 in. centers or greater horizontally and 1" vertically.

Reflector	Water or concrete
k_{eff} Reflected	0.936
k_{eff} Interaction	0.656
Interaction Allowed	2.44

Containers of special nuclear material of the standard limit types B-2 through B-4 described in Section 5.5.2 may be stored in a single layer planar array with 16 in. or greater center-to center spacings, provided that the horizontal surface-to-surface separations are 8 in. or greater and that the individual storage bins are at least 8 in. deep. The spacings are to be assured by jigs or fixtures.

Caution: This 16 by 16 inch spacing array has a high reactivity when reflected and, when coupled to a like array through 8 to 12 inches of concrete has excessively high reactivity. For these reasons, it is included here for reference only. All actual storage shall use at least 16 inch centers in the horizontal direction and at least 18 inches in the vertical. See analysis in Section 3.1.3.2.2.

The nuclear safety of these arrays is based upon direct calculations using the KENO Monte Carlo Code discussed in Section 5.3.2. Preliminary to these calculations, 18 group P_1 transport cross sections were generated by the MICROX (Ref. 5.3-2) two region flux spectrum code for several fuel-water mixtures and representative geometries. Using these, one-dimensional transport calculations (DTFX) were made of the reactivities of cylindrical and cuboidal containers with geometries spanning the ranges of the type B containers currently being used. Since water flooding is allowed, the 1-gallon containers with 3.6 kg

U-235 (Type B-4) are the most reactive and consequently these were the values used in the study. The results of the calculations, which are included as part of Table I 5.5-9, showed that in ranges of cylindrical and cuboidal geometries of interest the most reactive unit was the cylinder with a diameter of 6.89 in. (17.5 cm). Notably the typically used 5.0 and 5.5 in. diameter cylinders and the 4.0 in. x 8 in. cuboid (simulating two side-by-side half-gallon containers) were less reactive.

After the single unit calculations, KENOII calculations were made of the reactivities of bare and concrete reflected arrays of each of the containers. The array size was taken to be 70 units by 9 units, to model the biggest array in use, with individual unit spacings of 16 in. center-to-center and no less than 8 in. surface-to-surface horizontally. Concrete reflection was modeled as 8 in. thick slabs on the top, bottom, sides and back and 8 in. thick slabs and 8 in. of water in the front of the 8 in. thick storage rack. The results of the calculations are shown in Table I 5.5-9. Not surprisingly, the most reactive array was the one with the most reactive single units, the 17.5 cm in diameter cylinder. Since it can be inferred that arrays of cylindrical or cuboidal 1-gallon containers 16 in. tall with 3.6 kg U-235 are less reactive than the array of 17.5 cm in diameter cylinders, it follows that no vertical surface-to-surface limit is required for the array.

TABLE I 5.5-9

REACTIVITIES OF SINGLE PLANAR ARRAYS OF 1-GALLON CONTAINERS WITH 3.6 KG U-235

Geometry	Diameter or Length and Width (inches)	Single Unit k^{eff} (DTFX)	Unreflected Array k^{eff} (KENO)	Concrete Reflected* Array k^{eff} (KENO)
Cylinder	5.00	0.50	0.547±0.0034	0.872±0.0050
	5.50	0.54	0.60±10.0040	0.897±0.0050
	6.25	0.59	0.640±0.0040	
	6.89	0.60	0.656±0.0034	0.933±0.0051
	7.50	0.59	0.649±0.0040	0.932±0.0050
Cuboid	4.00 x 8.00	0.56	0.553±0.0033	0.888±0.0047

* Eight in. concrete on the top, bottom, sides and back and eight in. of water in the front.

With the configuration of the most reactive array established, a set of calculations was next made to verify that the array was nuclearly safe given any degree of concrete or water reflection. As in the previous calculations, concrete reflection was realistically modeled as concrete slabs of the specified thickness on the top, bottom, sides and back and on 8 in. water slab on the front. The results of the calculations are shown in Table I 5.5-10 and Fig. I 5.5-8. The values at 12 and 16 in. are considered to be equal because the reactivity cannot peak, then decrease with increasing reflection thickness. The two are averaged to yield an infinite concrete reflected k_{eff} of 0.936 _+ 0.005. in making a fit through the 6 and 8 in. data points, it must be assumed that a smoothly changing function exists. This indicates that infinite reflection exists for 10 in. or more of concrete and that 8 in. is somewhat less. It must be cautioned that, in spite of the infinite reflection equivalence, it must be assumed that interaction through the concrete can occur, and detailed analysis is required to justify a second parallel storage array nearby. Since the validation of KENOII in section 5.3.4.3 showed a positive bias for concrete reflected systems, which incidentally were of similar geometry and moderation the 0.936 is well within the limit necessary for nuclear safety.

TABLE I 5.5-10

CALCULATED MULTIPLICATION FACTORS FOR THE MOST REACTIVE PLANAR ARRAYS OF ONE-GALLON CONTAINERS WITH 3.6 KG U-235

Description of Reflector	Thickness (inches)	KENO k_{eff}
Unreflected	--	0.656±0.0034
Water	8	0.915±0.0052
Concrete	6	0.916±0.0048
Concrete	8	0.933±0.0051
Concrete	12	0.938±0.0052
Concrete	16	0.934±0.0050

5.5.8 Standard Limit Type H

Special nuclear material may be stored in a single plane array on 16 in., or greater, center-to-center horizontal spacings and 8 in., or greater, surface-to-surface spacings. This spacing is to be assured by jigs or fixtures. Vertical spacings are 18 in. or more center-to-center. The individual units in the array must satisfy one of the criteria given in Table I 5.5-11.

TABLE I 5.5-11
MASS AND CONTAINER VOLUME LIMITS FOR INDIVIDUAL UNITS

Degree of moderation (H/X) More Than	Degree of moderation (H/X) Not More Than	U-235	Pu	U-233
		Mass Limits (Kilograms)		
-	2	10.0	2.5	2.8
2	3	9.0	2.5	2.5
3	5	7.3	2.5	2.2
5	8	5.2	2.5	1.8
8	15	3.6	2.4	1.3
		Volume Limits (liters)		
15	-	3.6	2.4	1.3

Special nuclear material stored under the above mass limits with an associated moderation limit shall be stored in watertight metal containers. The nuclear safety of these storage criteria is based upon direct calculation using the methods of Section 5.3.2. A zero-dimensional spectrum calculation followed by a one-dimensional 1DFX transport theory multiplication calculation was performed for the most reactive unit of each of the cases described above. Nine energy groups were used in the calculations with S_4 quadrature and P_1 scattering. Thirty uniform space intervals were used in the fuel region, twenty in the 20 in. thick water reflector. Spherical geometry was assumed. The U-235 was 93.5% U-235, 6.5% U-238. The U-233 and Pu-239 were 100%. The results of these calculations are given in Table I 5.5-12.

TABLE I 5.5-12
CALCULATED MULTIPLICATION VALUES FOR INDIVIDUAL STORAGE UNITS

Fuel	Mass (kg)	H/X Ratio	Sphere Radius (cm)	Multiplication Bare	Multiplication Reflected
U-235	10	2	7.65	0.516	0.829
	9	3	7.86	0.522	
	7.3	5	8.08	0.526	
	5.2	8	8.03	0.511	
	3.6	15	8.38	0.536	
	3.6 (3.6 liters)	23.2	9.51	0.626	0.938
	3.6 (1 gallon)	any	8.75*	0.60	0.95
U-233	2.8	2	4.97	0.423	0.743
	2.5	3	5.10	0.413	
	2.2	5	5.40	0.414	
	1.8	8	5.63	0.413	
	1.3	15	5.97	0.422	
	1.3 (1.3 liters)	23.1	6.77	0.481	0.866
Pu-239	2.5	2	4.70	0.388	0.659
	2.5	3	5.02	0.385	
	2.5	5	5.56	0.394	
	2.5	8	6.21	0.421	
	2.4	15	7.25	0.485	
	2.4 (2.4 liters)	23.9	8.31	0.553	0.880

* Radium of max. reactivity one gallon cylinder, Sec. 5.5.2.

It may be seen from the results in Table I 5.5-12 that the most reactive unit is the 3.6 kg/3.6 liter sphere of U-235 with k_{eff} = 0.626. This is also the largest unit. Spherical containers are not used in storage, and this maximum unit is best represented by the maximum reactivity one gallon container Type B-4 in Sec. 5.5.2. This container has been demonstrated to be safe when stored in single layer planar arrays under Std. Limit

Type G in Sec. 5.5.7. It has also been established that smaller containers and those of shapes having greater leakage than the cylinder are also safe in the same array. Thus it follows that the smaller containers of limited H/U ratio and the containers of Pu and U-233 listed in Table I 5.5-8 may be stored in the same array and may be mixed in storage. The license limits severly restrict the possession of Pu and U-233, therefore, at most, only a few containers will be on hand for storage at any point in time.

5.6 STANDARD LIMIT FOR PLUTONIUM OR U-233

5.6.1 Standard Limit Type D

Mass limit	4 kg Pu or 1.3 kg U-233
Volume limit	2.4 liters Pu or 1.3 liters U-233
Moderator	H or C to volume limit
Reflector	Full water
Safety factor	2.3 mass, 1.33 volume
Pu	
k_{eff} bare	0.48
k_{eff} reflected	0.87
Interaction allowed. .	Use U-235 value (2.74 steradians)
U-233	
k_{eff} bare	0.55
k_{eff} reflected	0.88
Interaction allowed . .	Use U-235 value (2.74 steradians)

This set of limits is used only for storage of SNM. The limits are the same as the lightest mass limits combined with the volume limits in standard limit Type H in this section. The configurations are safe under all conditions of moderation physically possible within the container volume and with full water reflection, although storage is in rooms that are generally free of water quantities that could cause a reflection problem. The storage containers used are closed.

The individual container of Pu is safe based on a similar argument to that for U-235 in Fig. I 5.4-1. Figure 27 of TID-7028 (Ref. 5.2-2) shows 2.4 kg of Pu-239 is safe in a spherical shape, with a 2.3 safety factor, for all metal-water mixtures above 1.4 kg Pu-239 per liter, and Fig. 28 shows that 2.4 liters is a safe spherical volume, with a safety factor of 75%, for any metal-water mixture below 1.9 kg Pu-239 liter.

Similarly, the U-233 case is individually safe based on the fact that Fig. 34 of TID-7028 shows 1.3 kg of U-233 is safe in a spherical shape, with a safety factor of 2.3, for all metal-water mixtures above 0.96 kg U-233 per liter and Fig. 35 shows that 1.3 liters is a safe spherical volume, with a safety factor of 75%, for any metal-water mixture below 3.9 kg U-233 per liter.

The reactivity for each case is obtained from the analysis shown under Type H. These units may be stored in plane arrays which have jigs or fixtures to assure minimum spacing of 16 in. x 18 in. center-to-center and 8 in. surface-to-surface. For conservatism in the use of this limit, the Pu and U-233 cases have been assigned the same maximum allowable interaction as the more reactive U-235 limit. (See Standard Limit Type B-1.)

5.7 STANDARD LIMIT FOR 20% ENRICHED URANIUM

The standard limits discussed in Section 5.5 are based on a uranium enrichment of 93.5%. The application of these limits to uranium enrichments lower than 93.5% is conservative since this results in an increased safety margin. However, for some fuel operations that involve enrichments of 20% or less, these standard limits were found to be unnecessarily too restrictive. Since some future activities at GA are anticipated to involve the use of uranium enriched to 20% or less, a special standard limit for this enrichment was developed.

5.7.1 Standard Limit Type I

Mass limit	457 g U-235
Volume limit	None
Moderator	H/U or C/U (avg ratio)
Reflector	Full water
Safety factor	2.3
k_{eff} bare	0.675
Interaction allowed	2.2 steradians

This is the basic "always safe' operating limit for 20% enriched uranium. It is safe under all conditions of moderation, reflection, and double batching. The safety of this limit is based on data shown in Fig. 22 of "Critical Dimentions of Systems Containing U-235, Pu-239 and U-233," LA-10860-MS, 1986 Revision. The minimum critical mass at 20% enrichment is about 1,050 g of U-235. If double batching is not possible, the maximum allowable limit is 1,050 x 0.75 = 788 g of U-235. If double batching is possible, the maximum allowable limit is 1,050/2.3 = 457 g of U-235. The reactivity and interaction parameters were calculated with the methods and data base as were usedd for the development of the standard limits discussed in Section 5.5.

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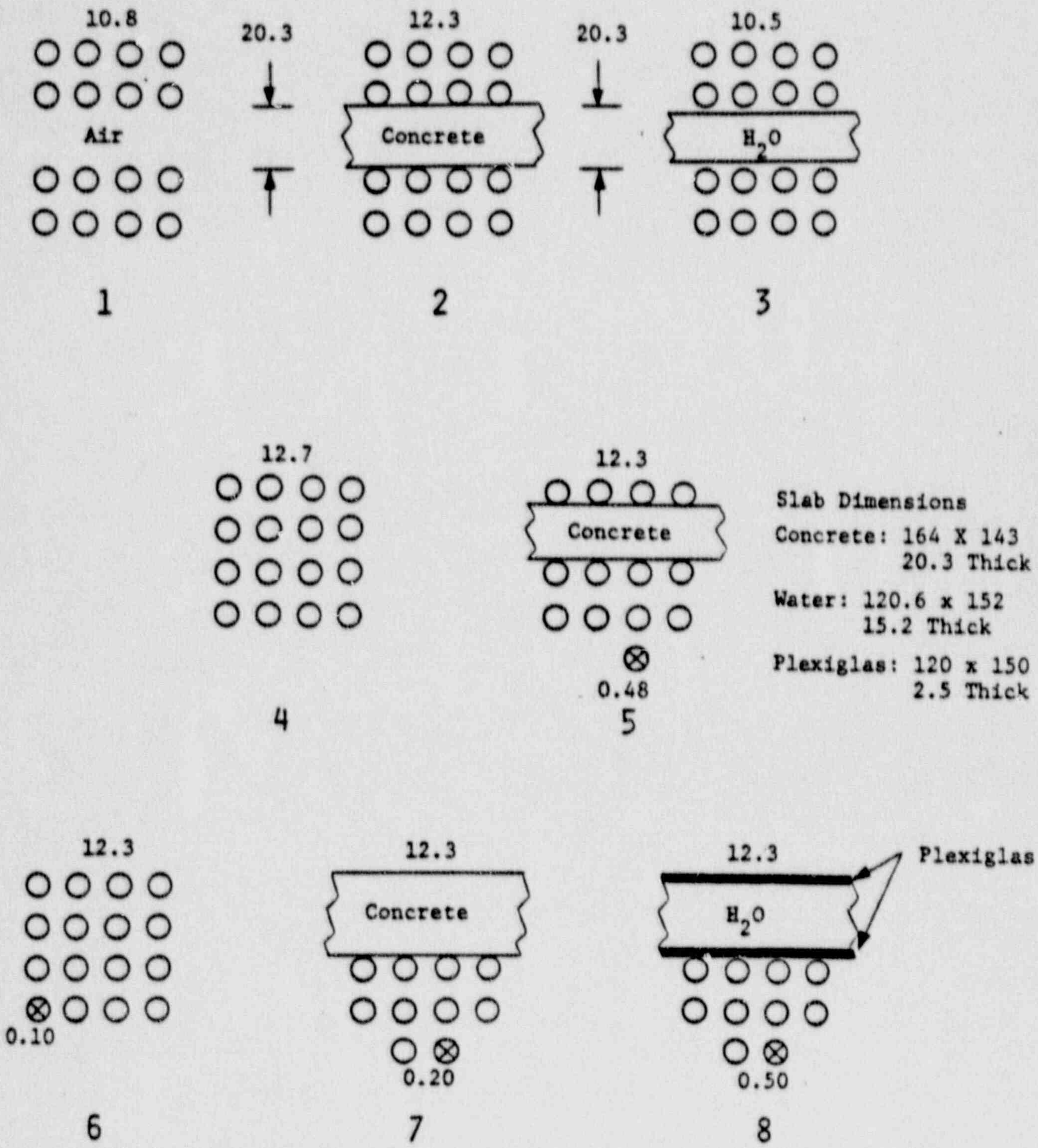

(All dimensions in cm)

(⊗ cylinder filled to indicated fraction of capacity)

Fig. I 5.3-1. Experimental Critical Arrays from TID-7028, Fig. 74.

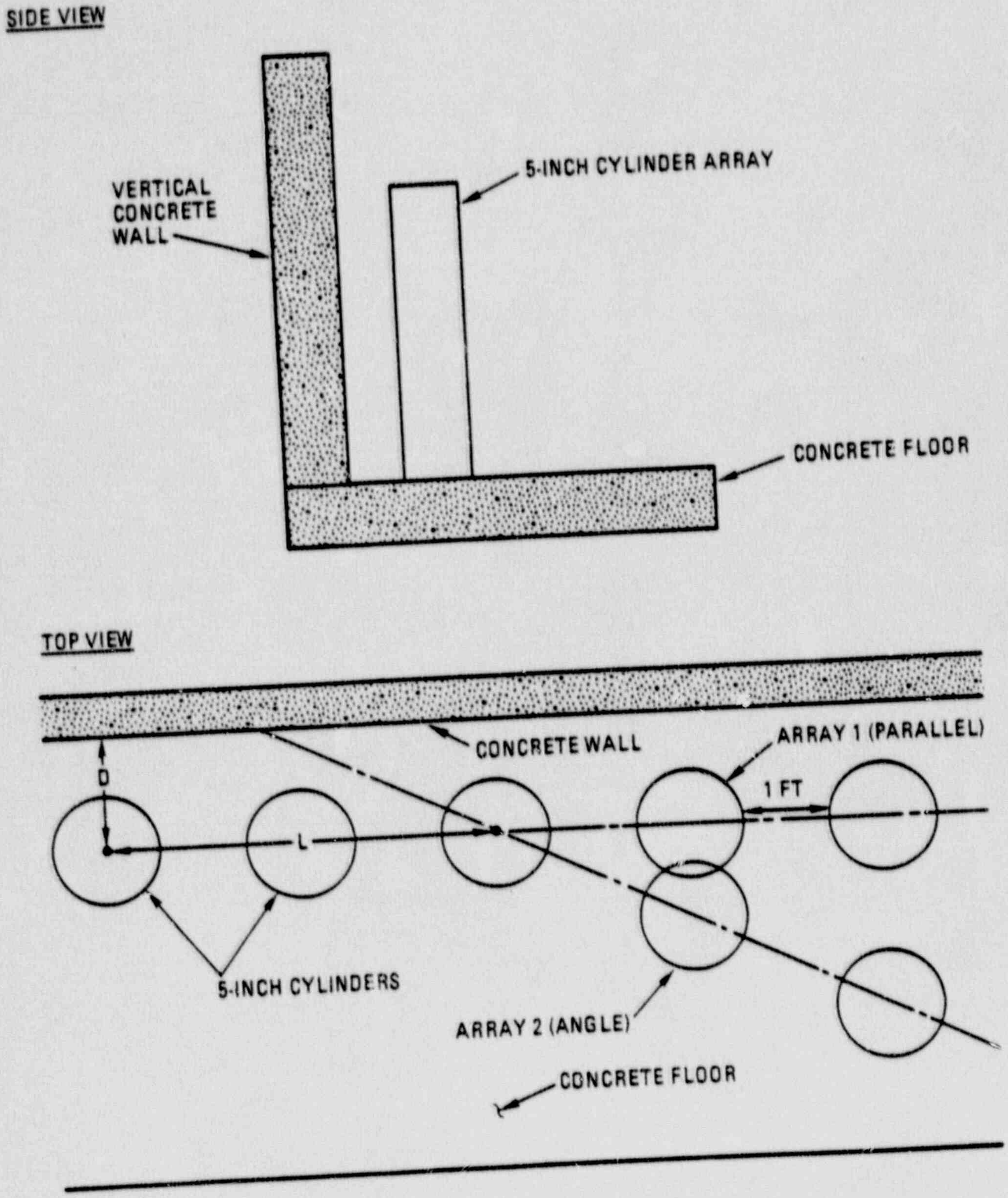

FIG. I 5.3-2 GEOMETRIC MODEL FOR ARRAY OF 5 IN. CYLINDERS ADJACENT TO REFLECTOR WALL AND FLOOR

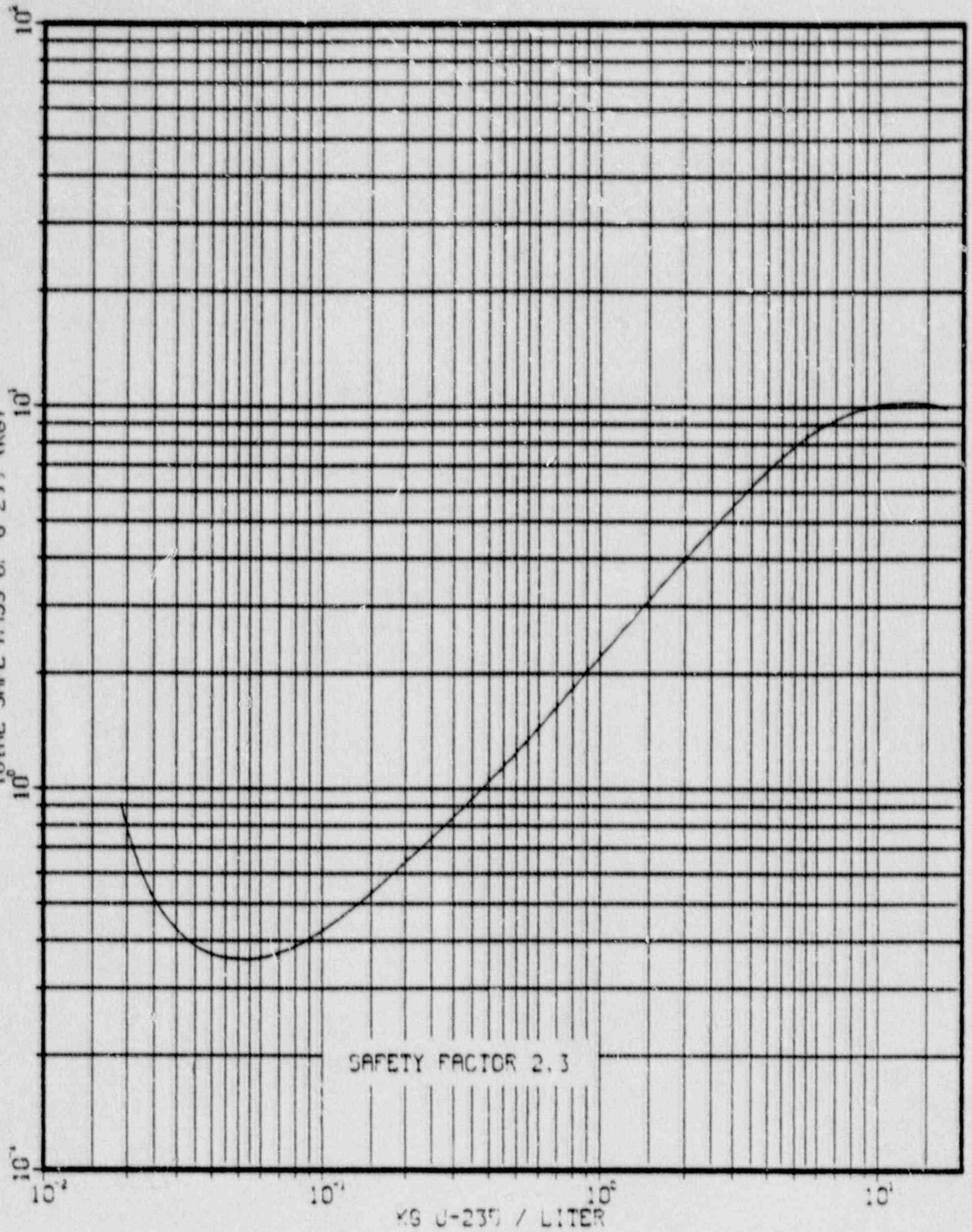

FIG. I 5.4-1 SAFE MASS LIMITS FOR REFLECTED, WATER MODERATED U-235 (93.2%) SPHERES

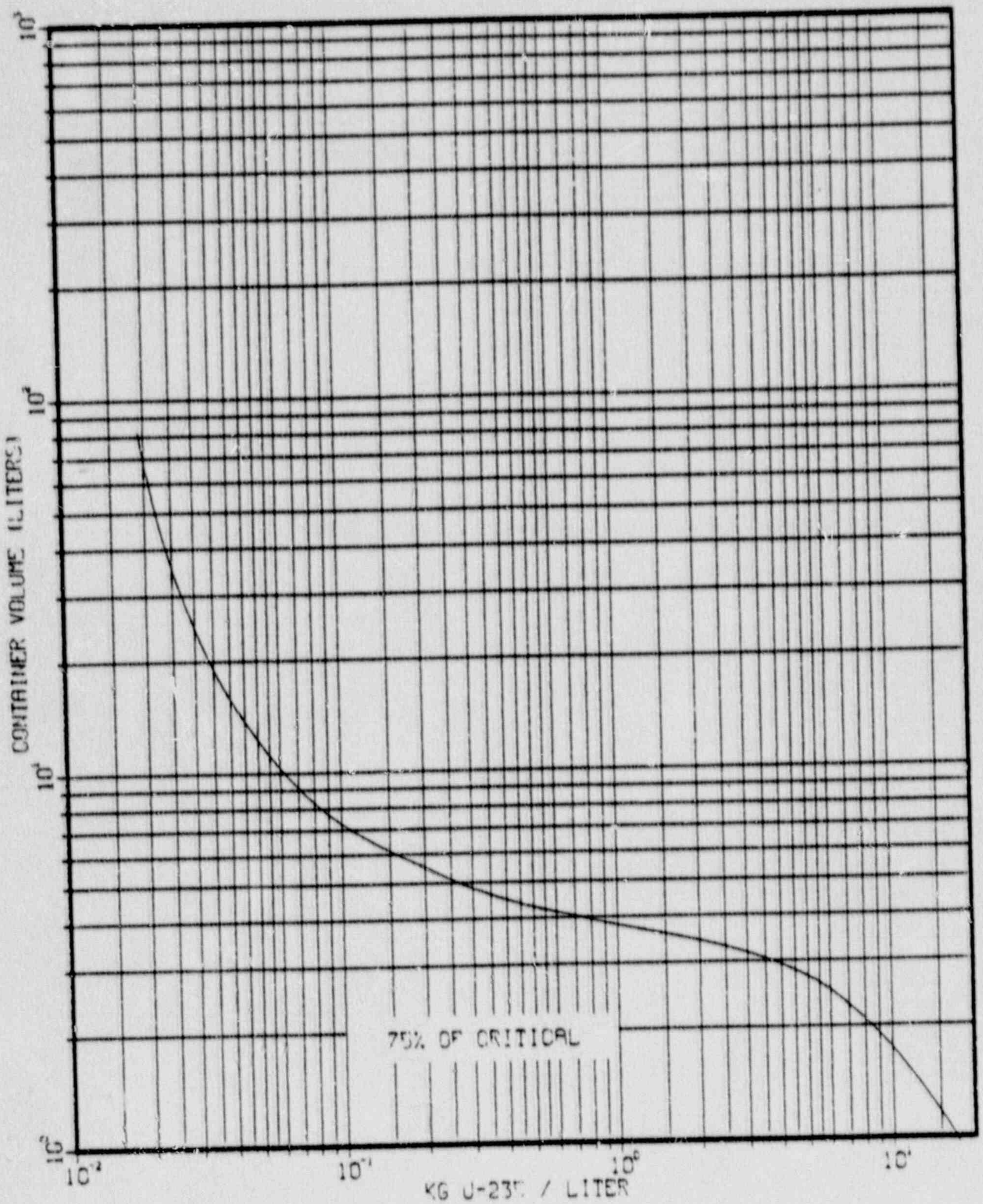

FIG. I 5.4-2 SAFE CONTAINER CAPACITY FOR REFLECTED, WATER MODERATED U-235 (93.2%) SPHERES

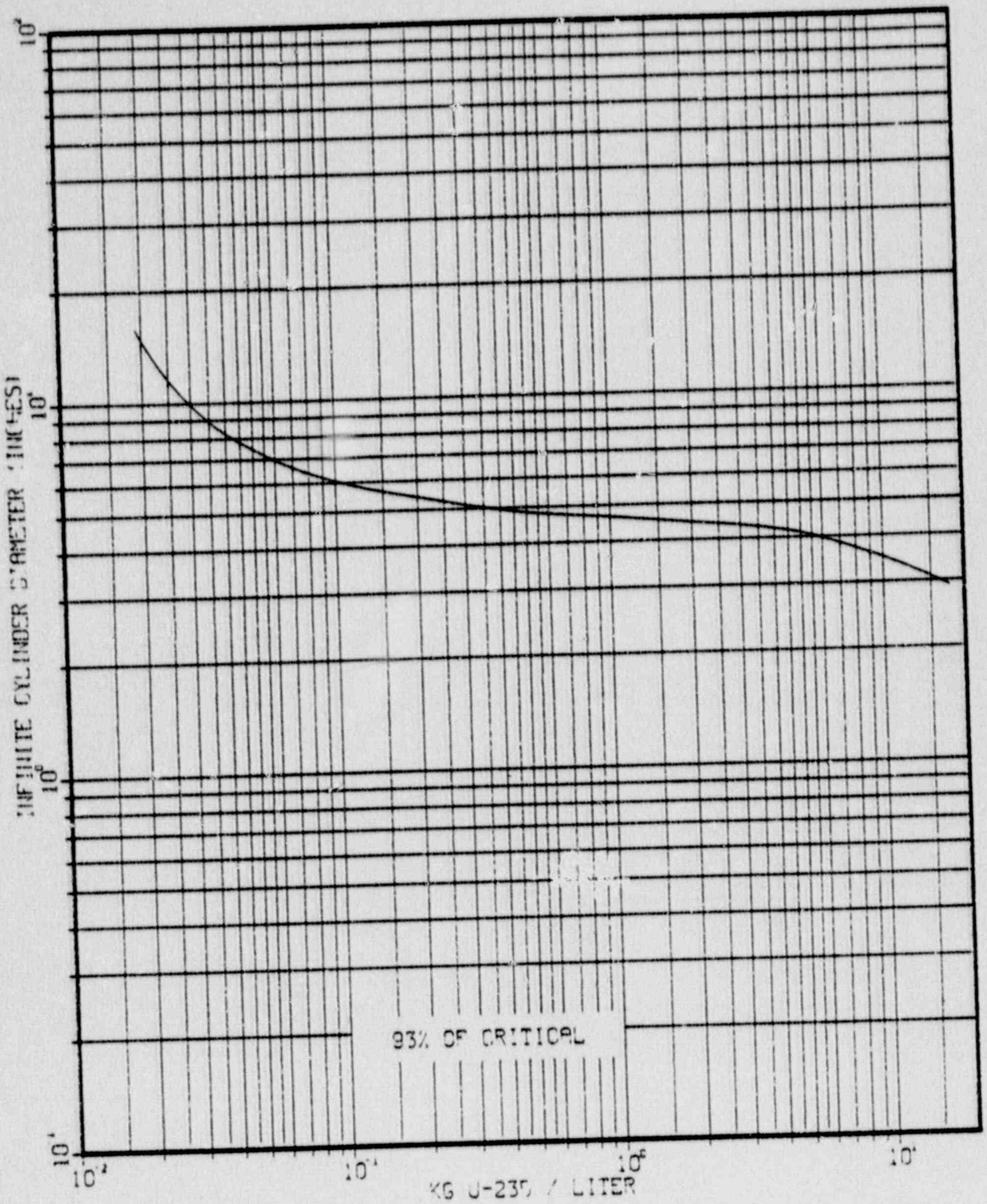

FIG. I 5.4-3 SAFE MASS LIMITS FOR REFLECTED, WATER MODERATED U-235 (93.2%) INFINITE CYLINDERS

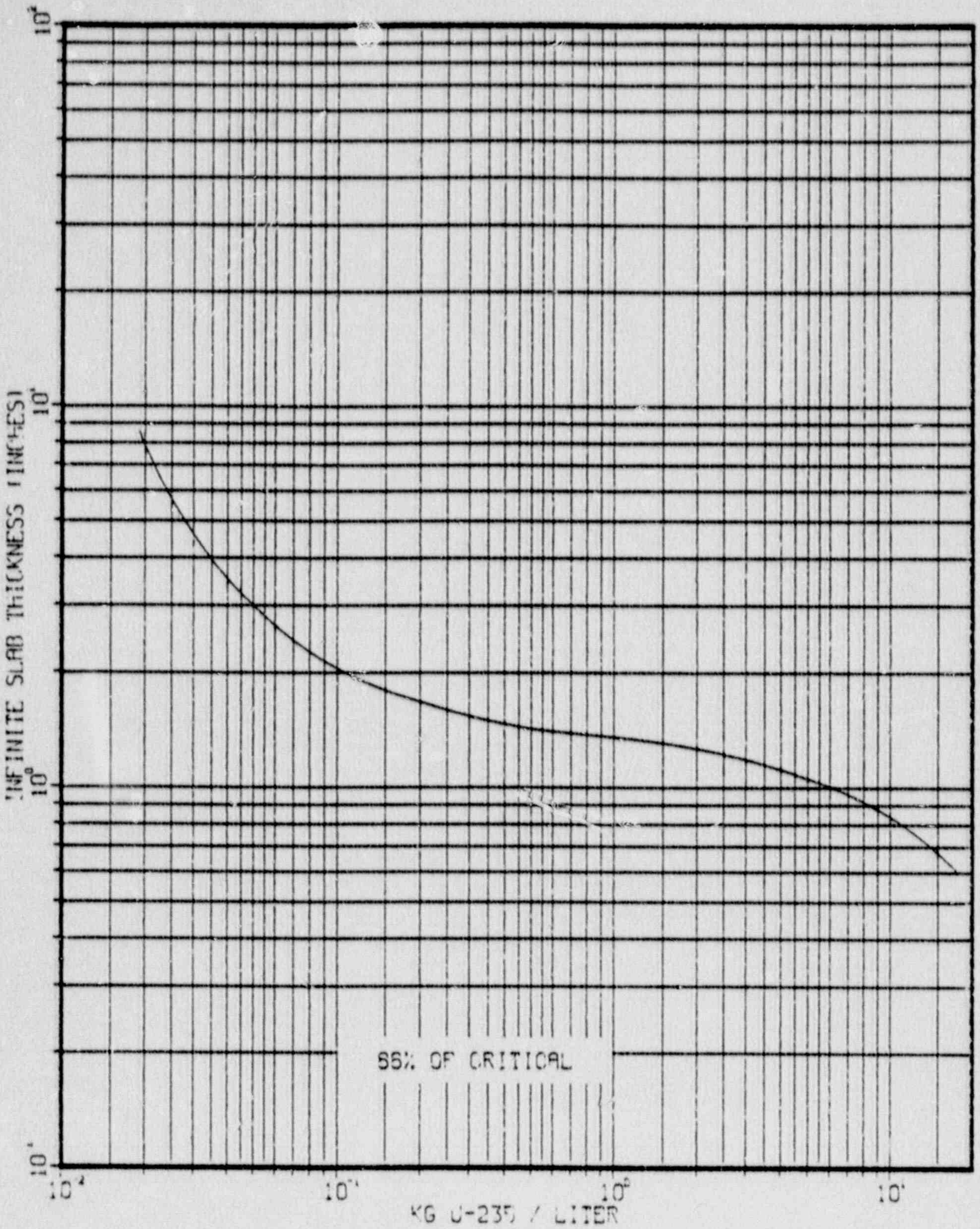

FIG. I 5.4-4 SAFE THICKNESS FOR REFLECTED, WATER MODERATED U-235 (93.2%) INFINITE SLABS

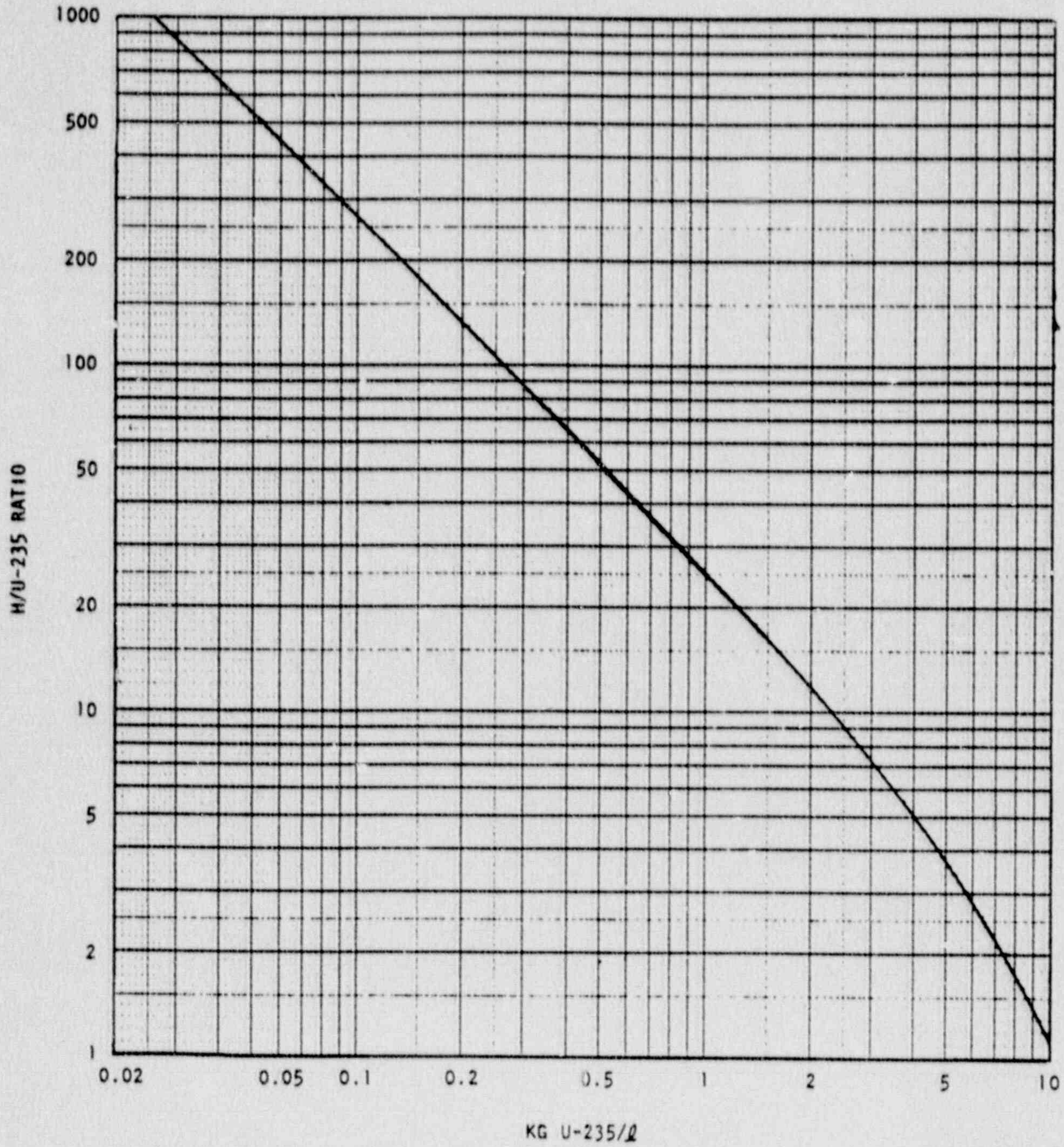

Fig. I 5.4-5 U-235 Density in Metal Water mixture (93.2%)

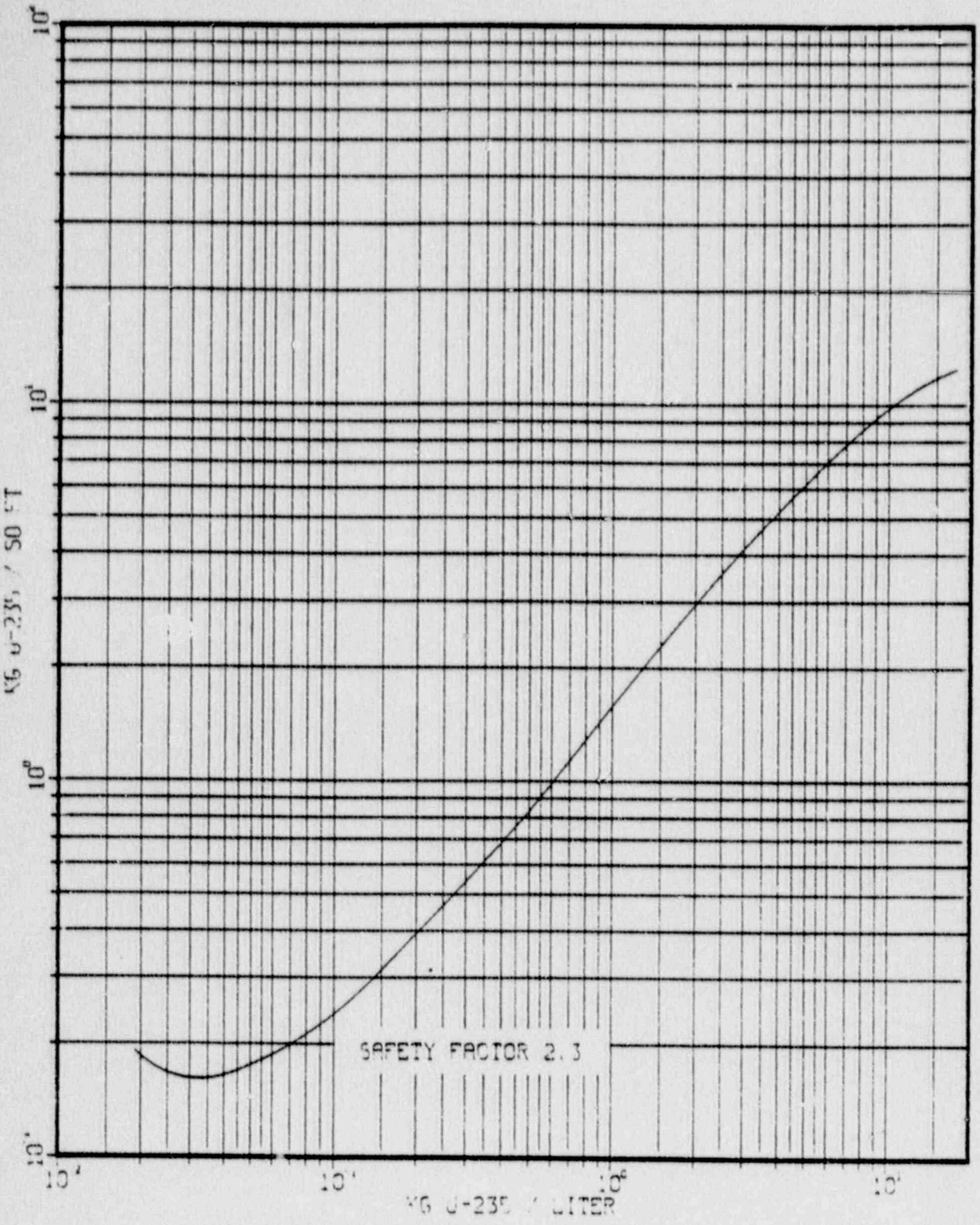

FIG. I 5.4-6 SAFE AREA DENSITY LIMIT FOR REFLECTED, HOMOGENEOUS WATER MODERATED U-235 (93.2%)

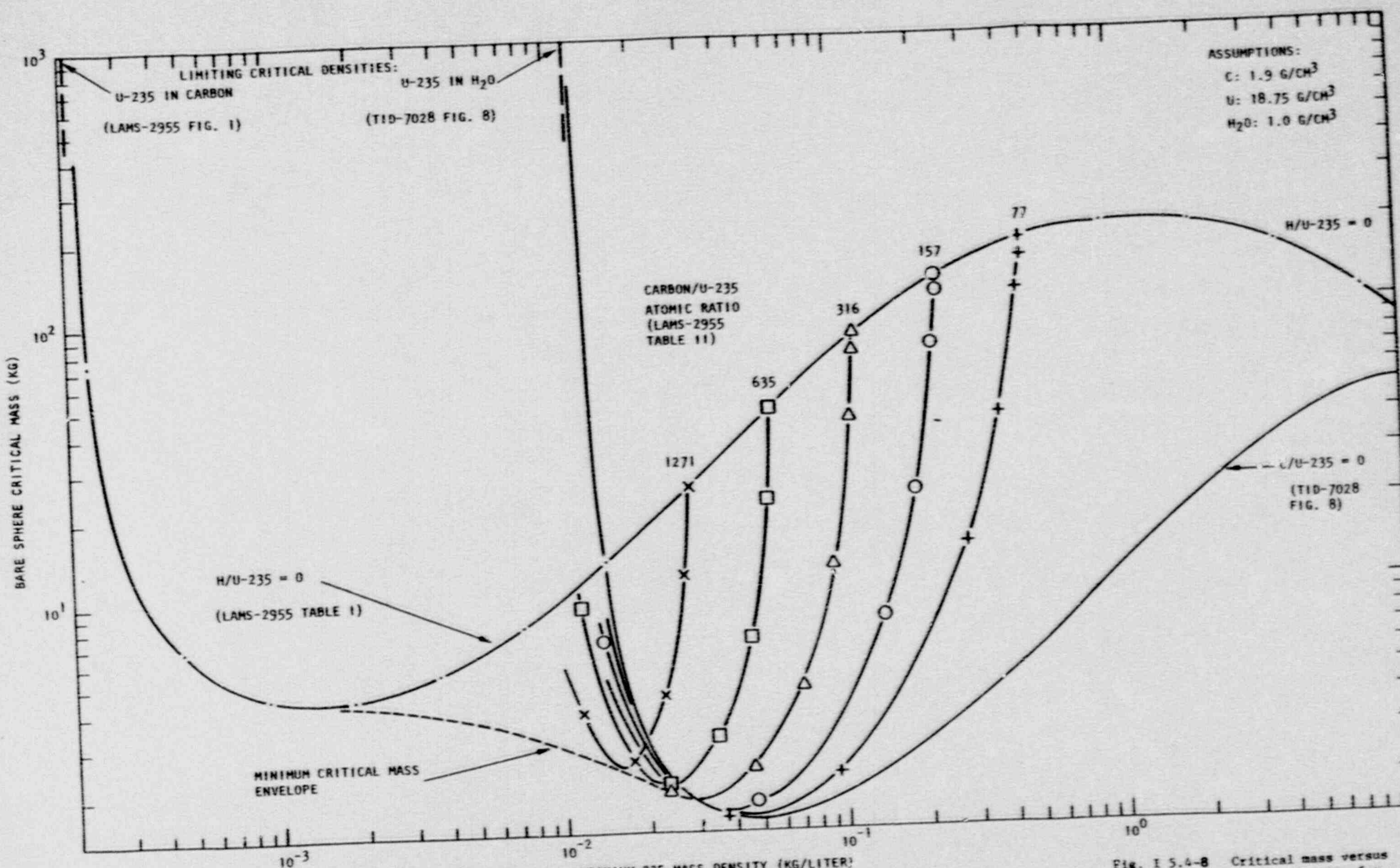

Fig. I 5.4-8 Critical mass versus uranium density for U-235/H_2O/C bare spher

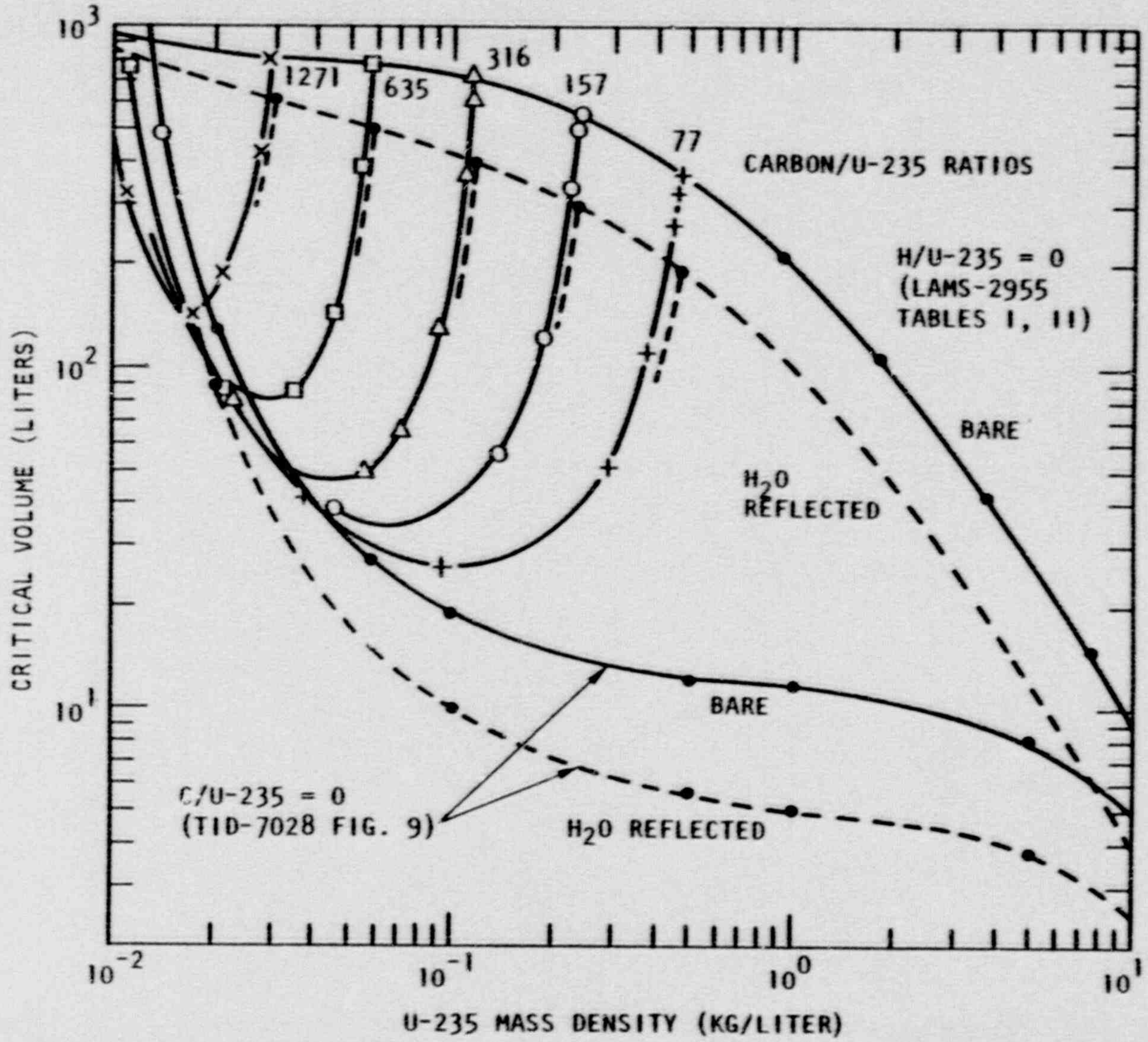

Fig. I 5.4-9 Critical volume versus U-235 density for U-235/H_2O/C spheres

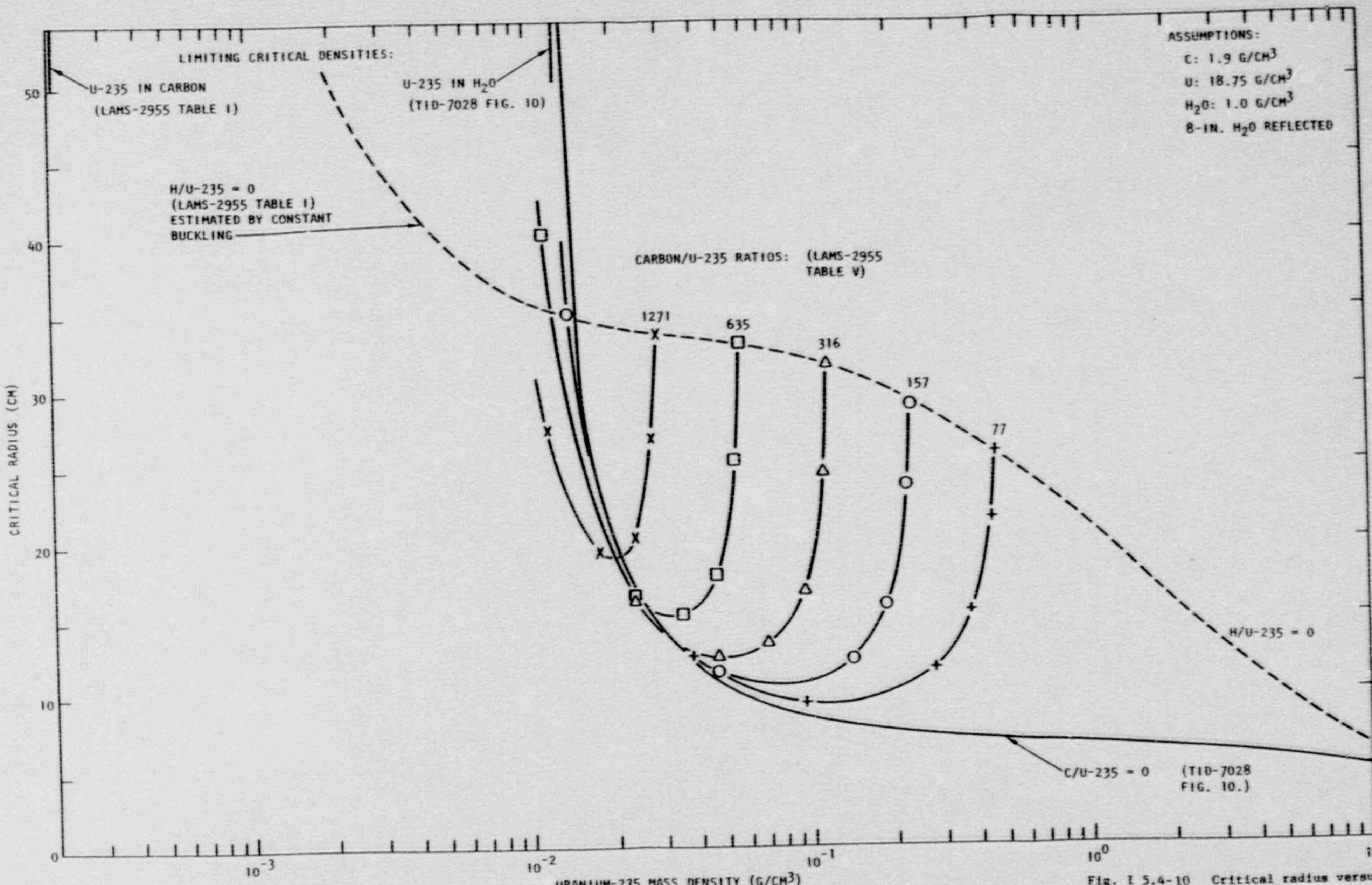

Fig. I 5.4-10 Critical radius versus U-235 density for $U-235/H_2O/C$ cylinders

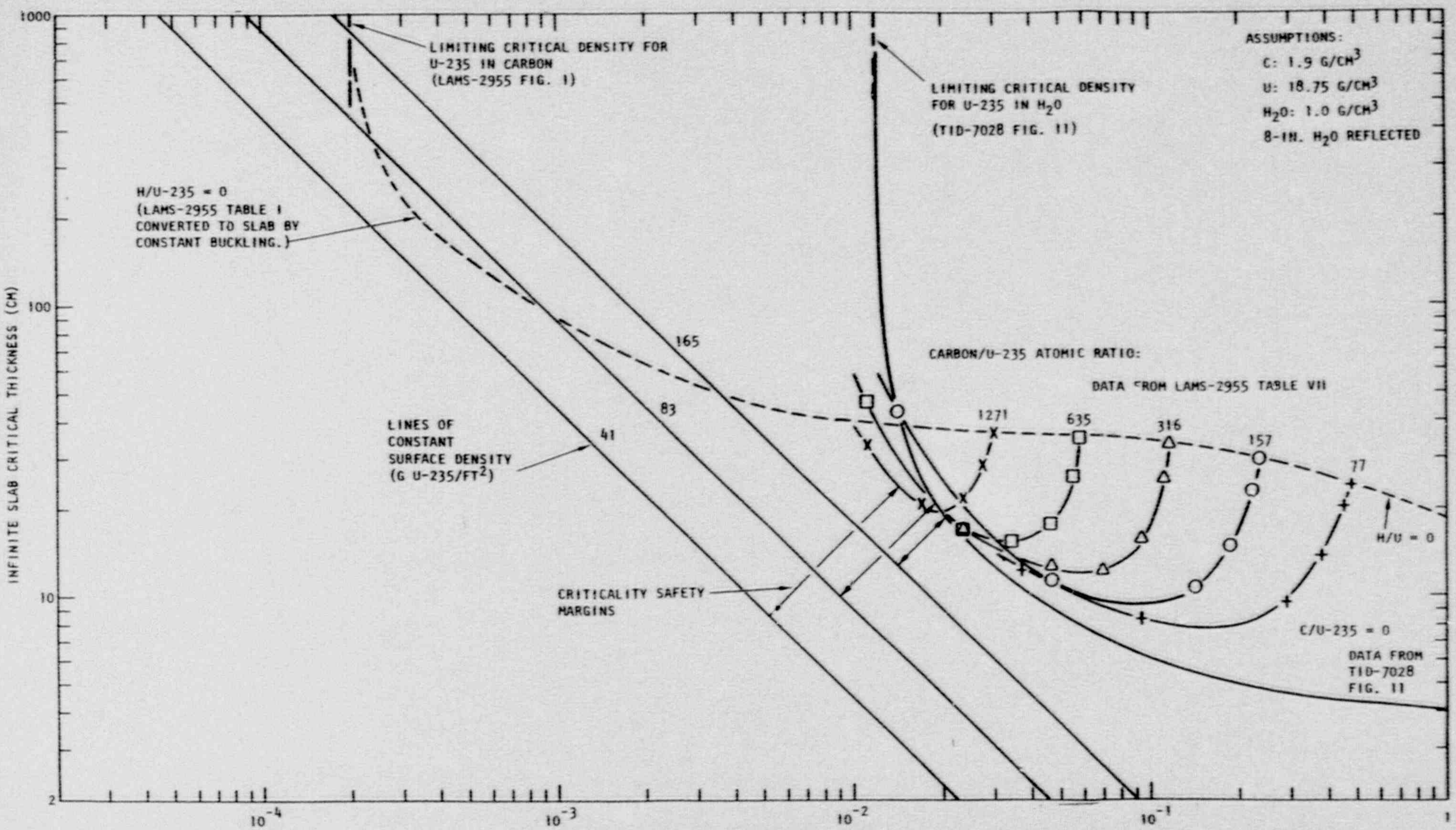

Fig. I 5.4-11 Critical thickness versus uranium density for U-235/H_2O/C systems

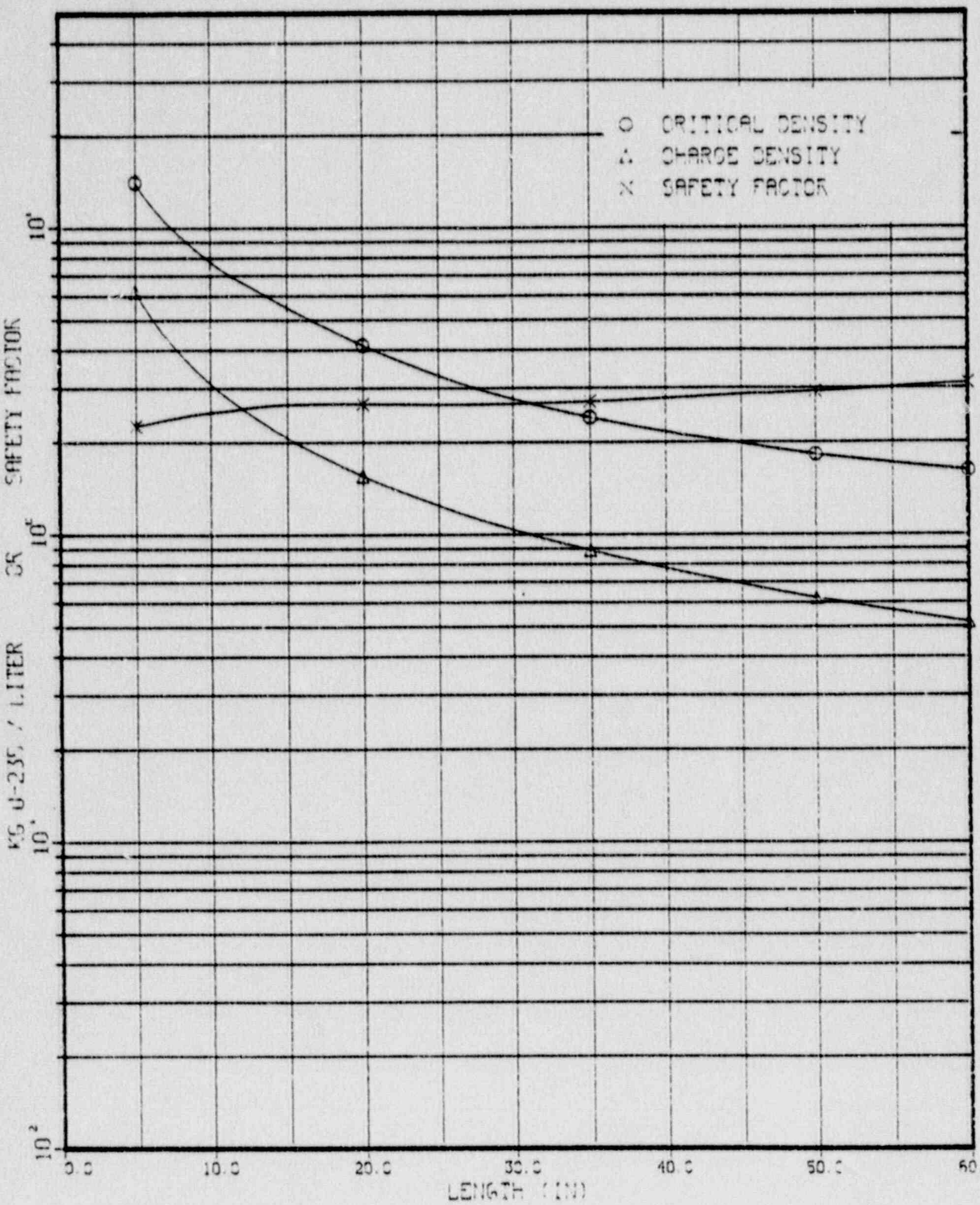

FIG. I 5.4-12 5.0 INCH CYLINDER LOADED WITH 10.0 KG U-235

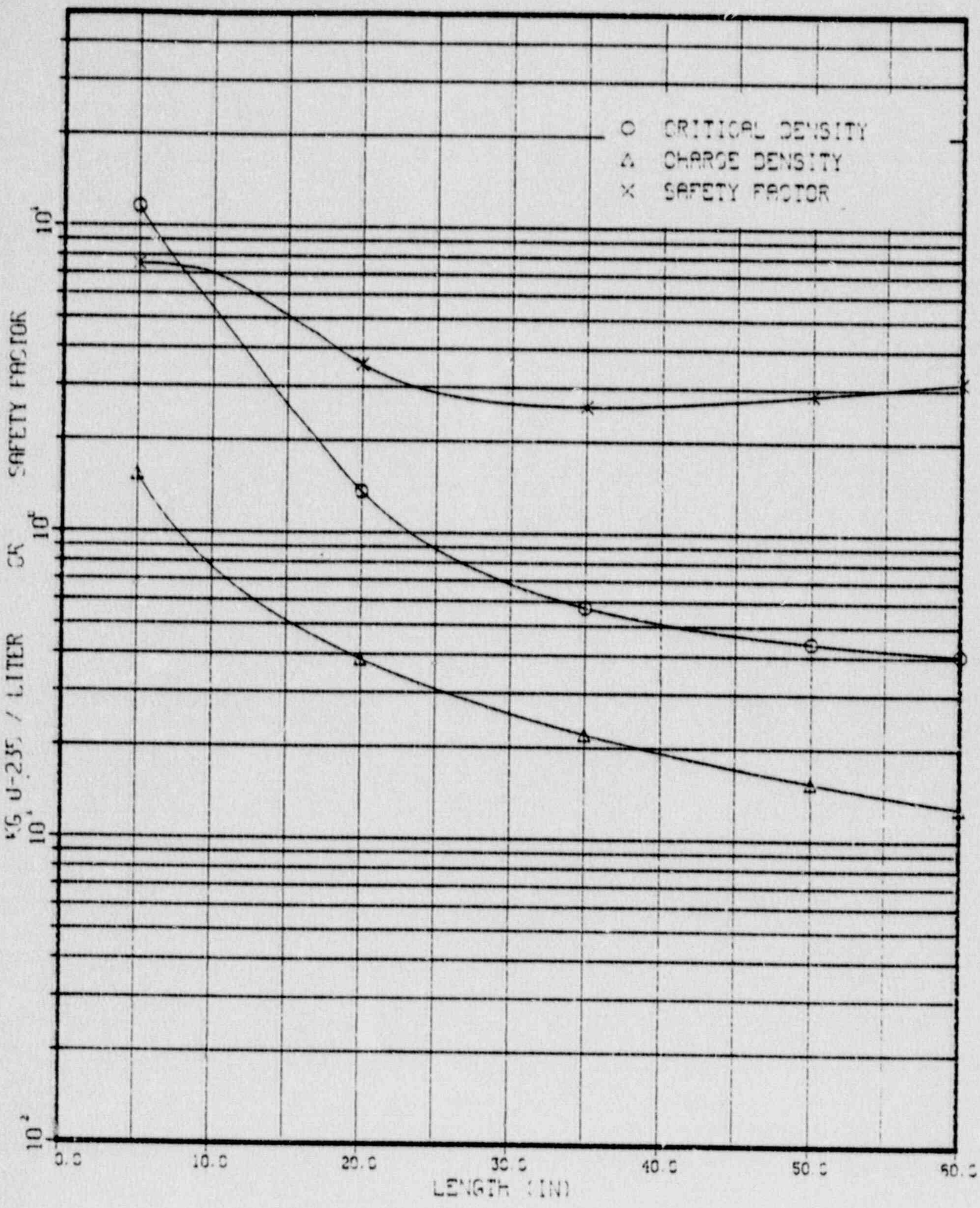

FIG. I 5.4-13 5.5 INCH CYLINDER LOADED WITH 3.0 KG U-235

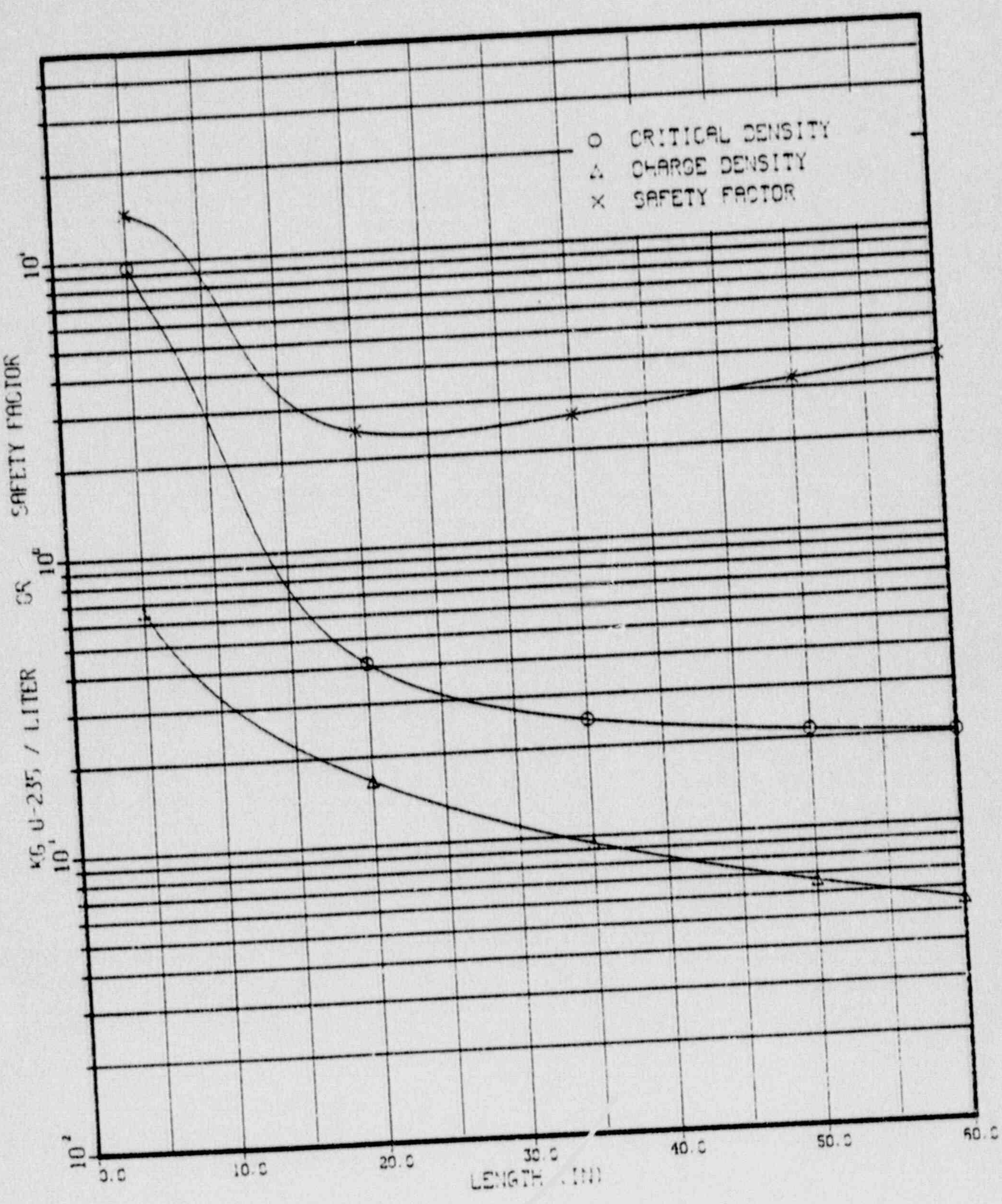

FIG. I 5.4-14 6.0 INCH CYLINDER LOADED WITH 1.53 KG U-235

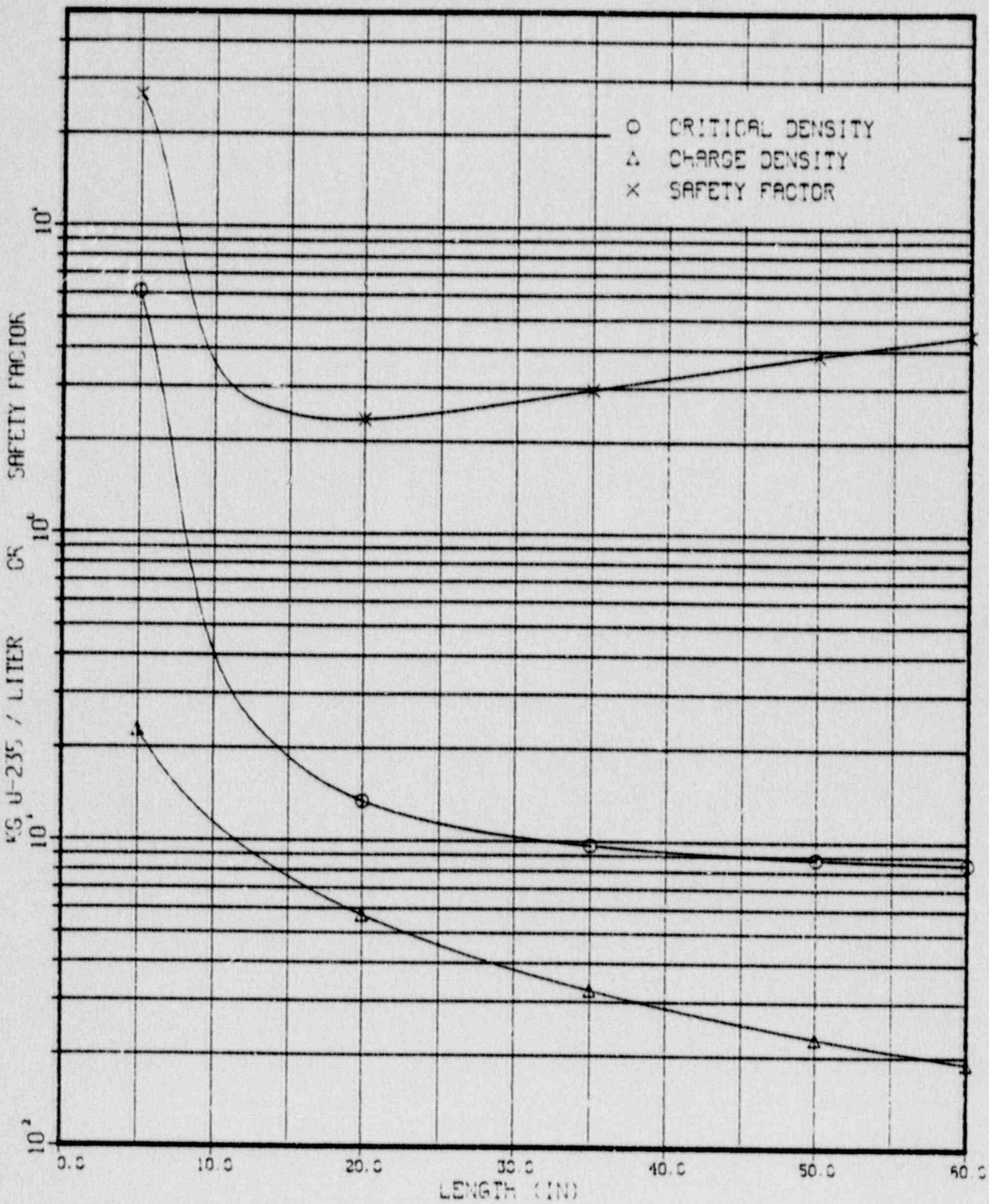

FIG. I 5.4-15 7.0 INCH CYLINDER LOADED WITH 0.72 KG U-235

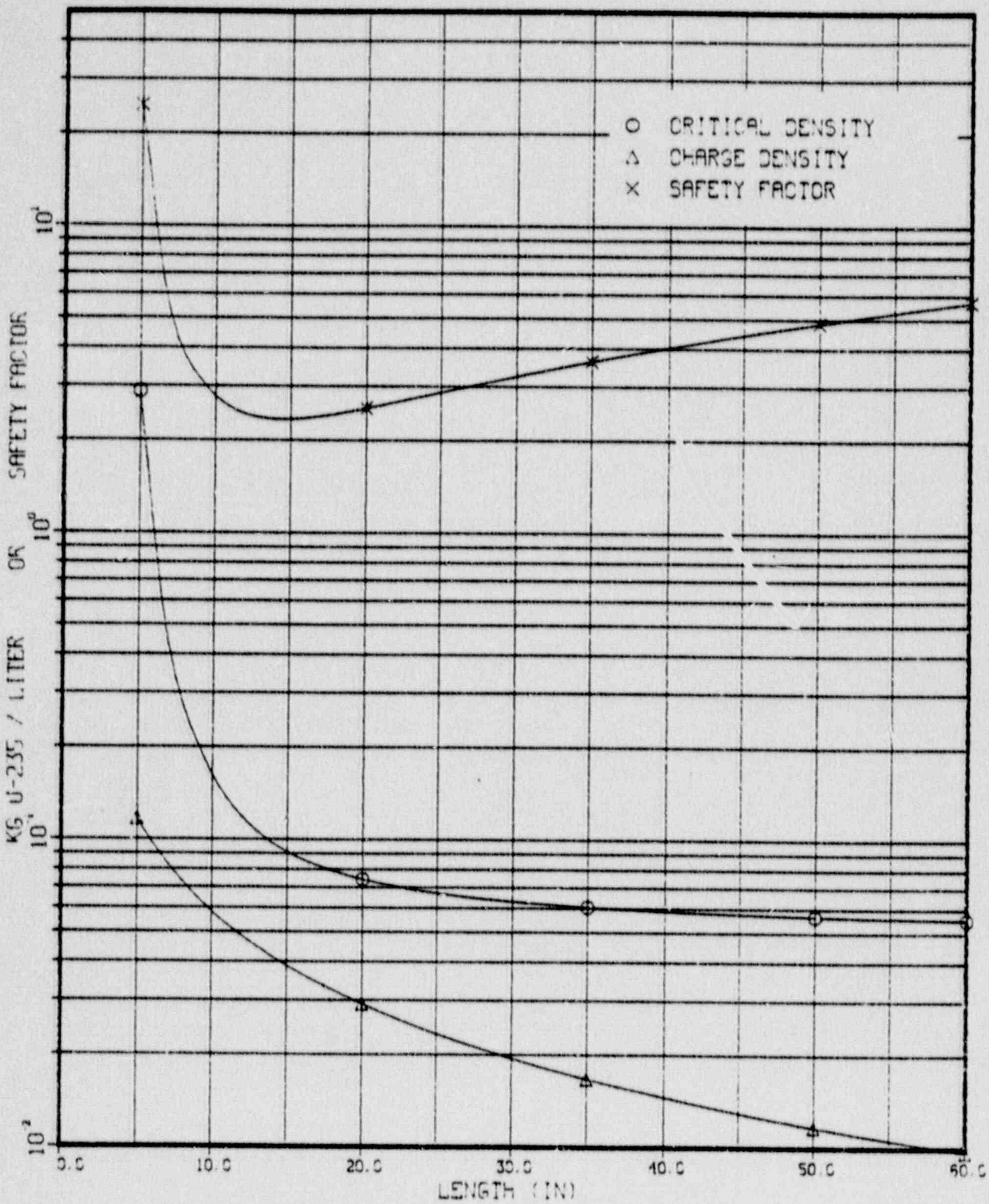

FIG. I 5.4-16 8.0 INCH CYLINDER LOADED WITH 0.48 KG U-235

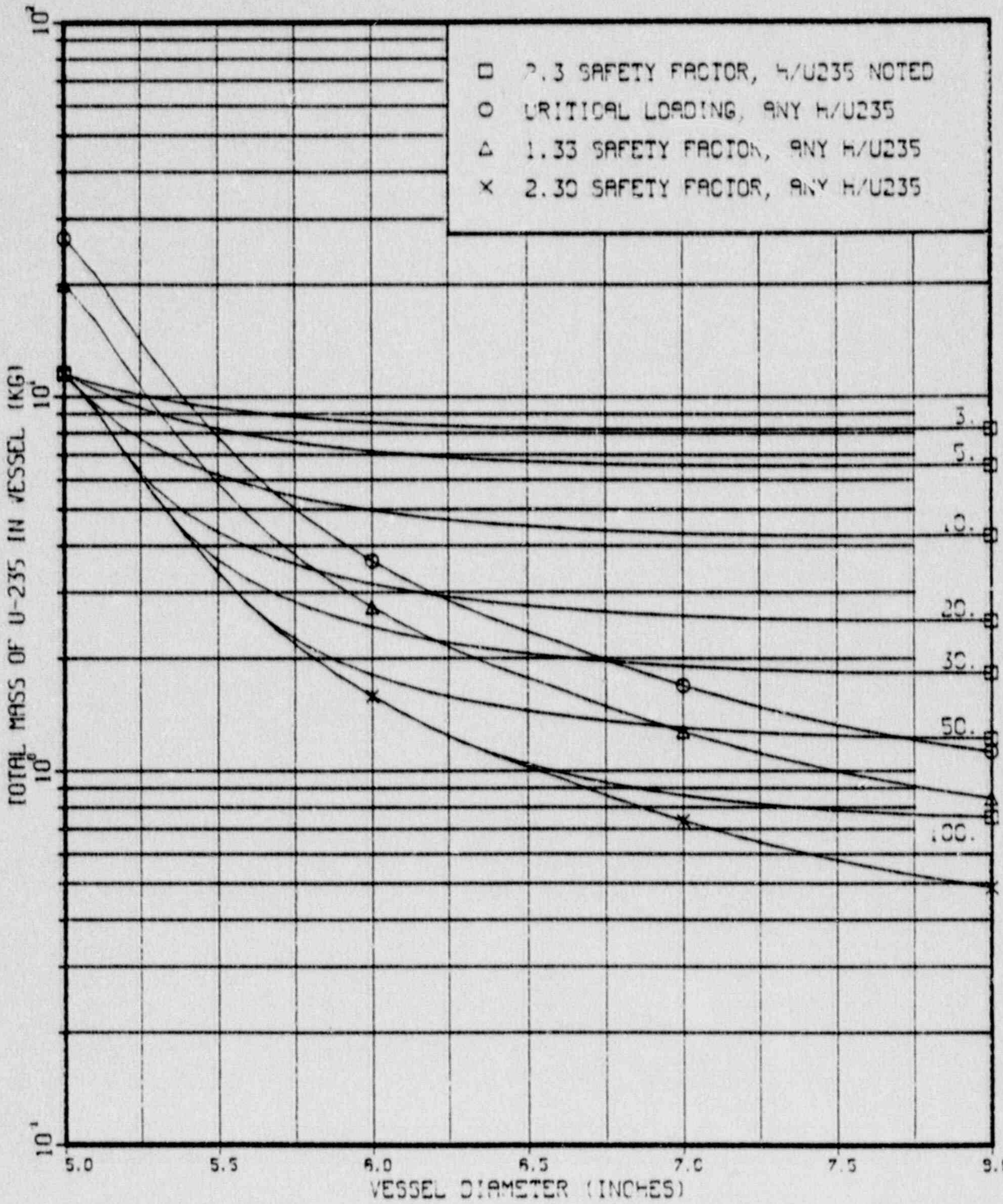

FIG. I 5.4-17 SAFETY OF MASS LIMITED LOADINGS OF U-235 (93.2%) IN REFLECTED CYLINDRICAL VESSELS

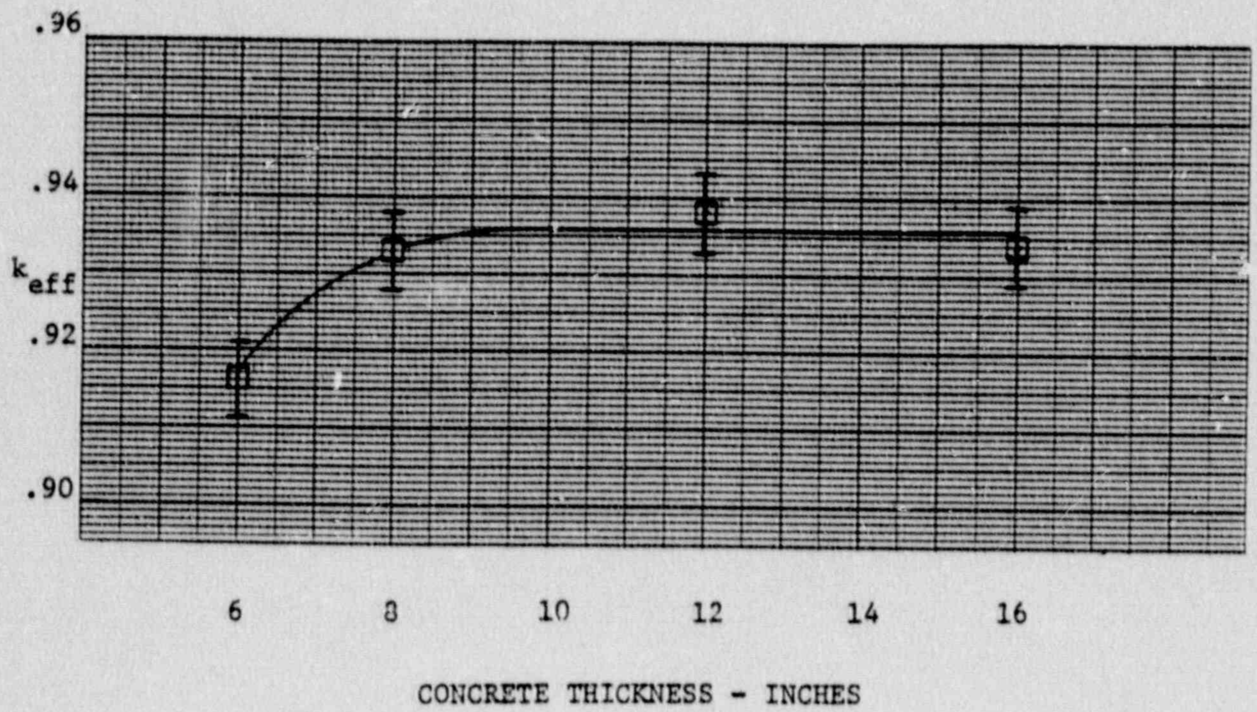

Fig. I 5.5-8 Reactivity of Concrete Reflected Array of One-Gallon/3.6 Kg U-235 Containers

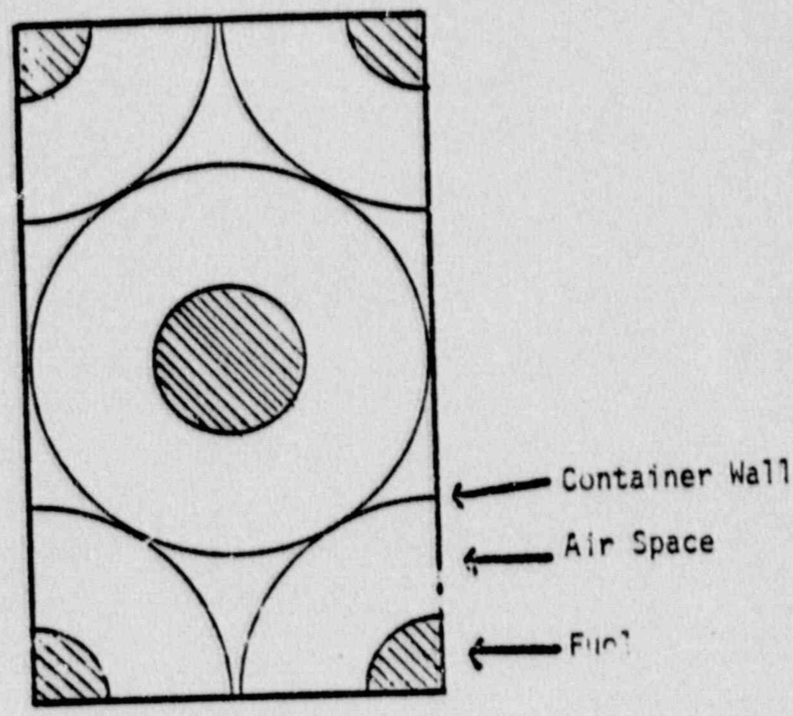

Fig. I 5.5-7 Cross Section of Generalized Geometry Cell.

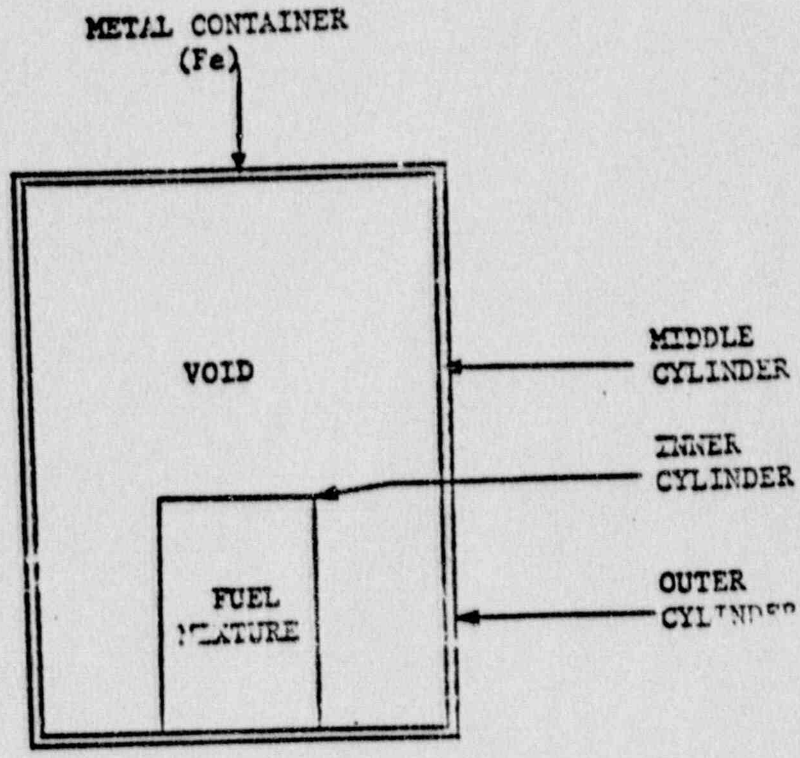

Fig. I 5.5-6 Most Reactive 55-Gallon Barrel

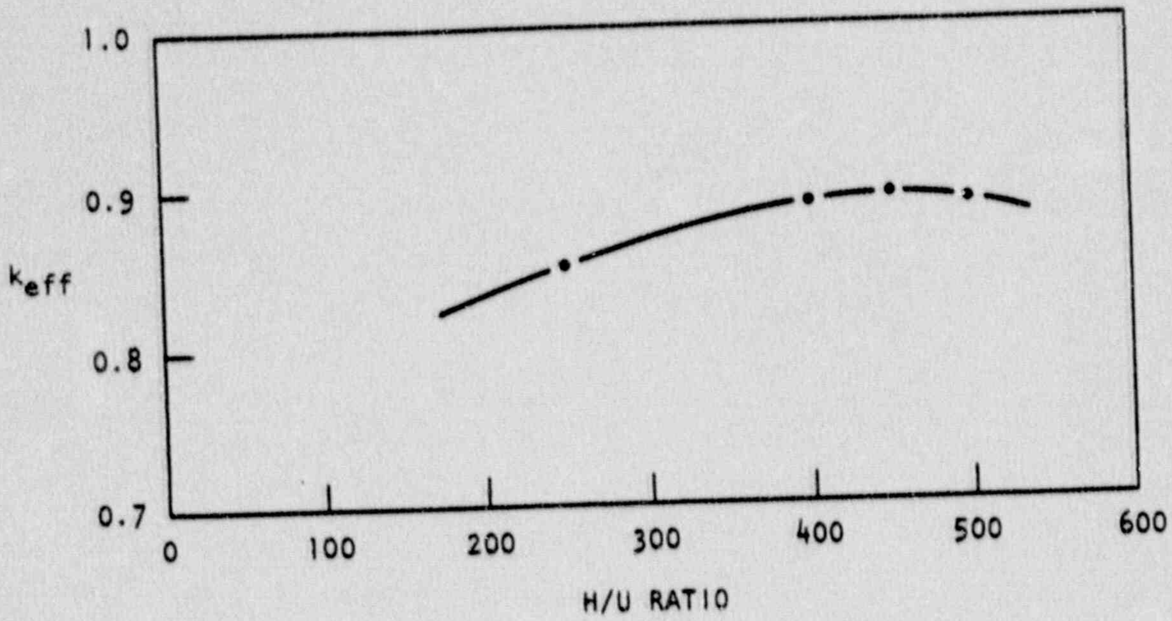

Fig. I 5.5-4. 55-gallon barrel array k_{eff} versus H/U ratio

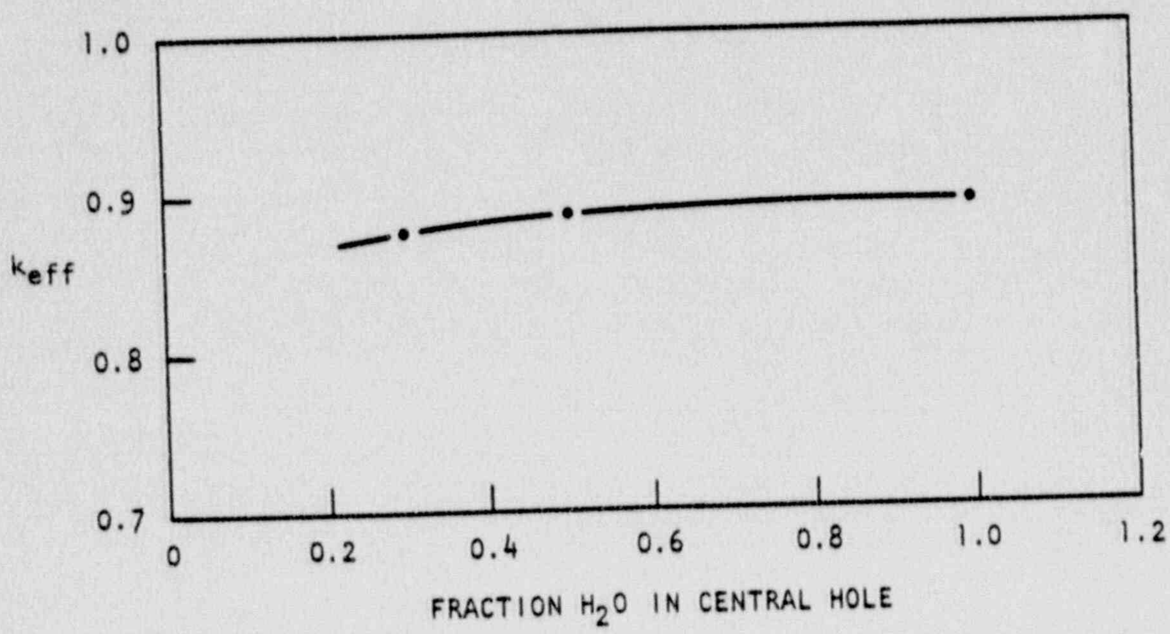

Fig. I 5.5-5. 55-gallon barrel array k_{eff} versus H_2O fraction

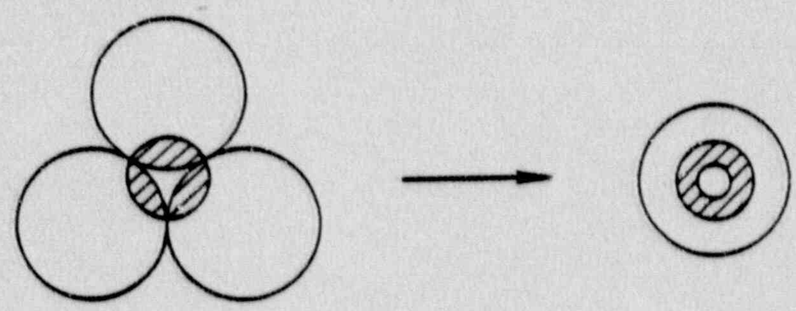

Fig. I 5.5-3. Fuel agglomeration model

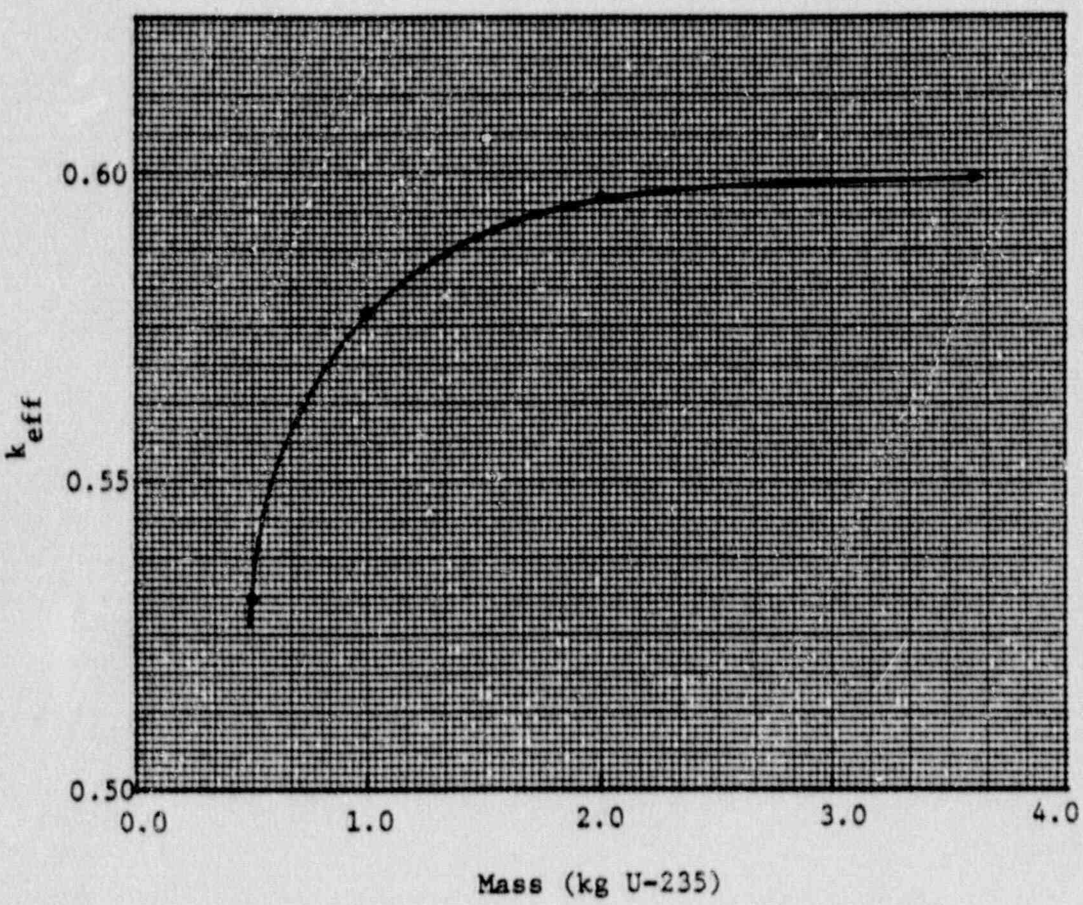

Fig. I 5.5-2. Neutron multiplication factor versus mass

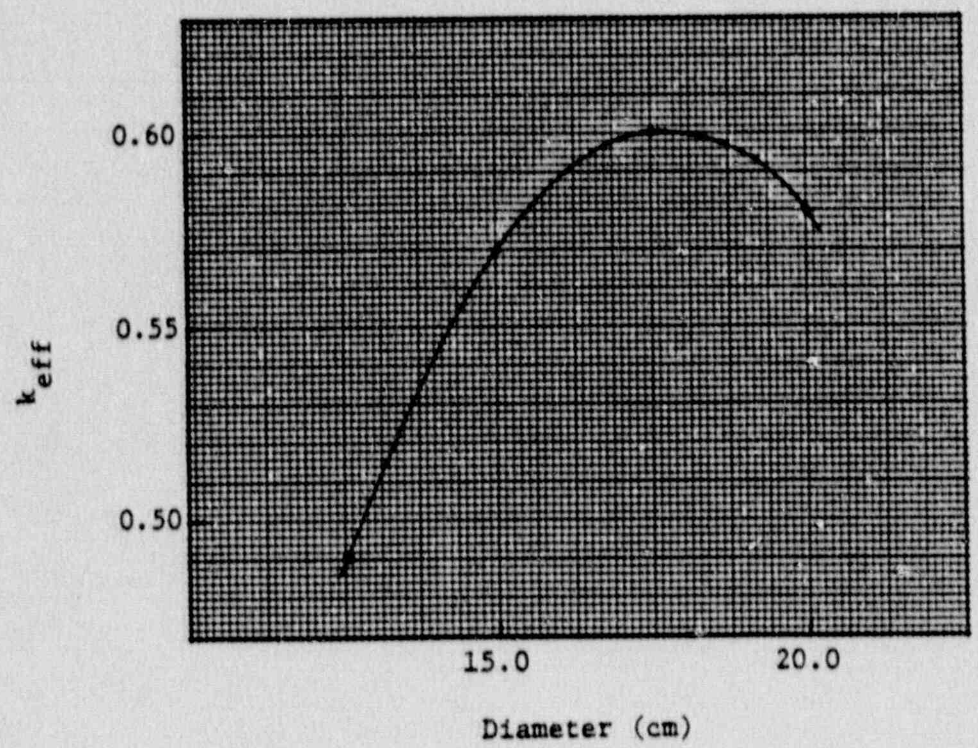

Fig. I 5.5-1 Neutron multiplication factor versus cylinder diameter for a one gallon container with 3.6 kg U-235 in a water mixture (unreflected).

6. ENVIRONMENTAL PROTECTION

6.1 ENVIRONMENTAL MONITORING PROGRAM

The licensee's concept and policy for radiological control is complete containment of radioactive materials and rigid operational controls designed to minimize external radiation levels and the release of radioactive materials to the environment. The operational monitoring program for radiological environmental monitoring is covered below.

The purpose of the Radiological Environmental Monitoring Program is to detect and measure radioactivity in the local environment at or near background levels. From this data, any contamination to the environment can be detected before it becomes significant and corrective measures can be instituted to prevent further release of radioactive materials. Sufficient information is available from this program to evaluate potentially hazardous situations should they occur.

The following radiological environmental monitoring program is currently in effect and shall be continued. This program is currently a license condition under SNM-696.

The program includes (1) air sampling, (2) water (including sewage) sample, and (3) sampling of soil, vegetation, water and external gamma radiation (survey and area radiation).

Current sampling stations are represented in Fig. I 6.1-1. The minimum detectable sensitivities of the above samplings are shown in Table I 6.1-1.

TABLE I 6.1-1

MINIMUM DETECTION SENSITIVITY

Sample Type	Radiation	Sensitivity
Water[1]	alpha	6 pCi/liter
	beta	4 pCi/liter
	gamma	3 pCi/liter
Soil	alpha	10 pCi/g
	beta	2 pCi/g
	gamma	0.1 pCi/g
Vegetation[2]	alpha	15 pCi/g
	beta	2 pCi/g
	gamma	0.5 pCi/g
Air[3]	alpha	0.025 pCi/M^3
	beta	0.010 pCi/M^3
Radiation	gamma	10 mR
	beta	40 mR

[1] Dependent on total solids content.

[2] May vary dependent upon accompanying organic residue.

[3] Seven day sample.

6.1.1 Air Sampling

Air sampling is accomplished at no less than 15 locations on, adjacent to and near the site. The sampler filters are changed weekly. The analysis is performed for long lived alpha and beta radioactivity.

Some air samplers have a dual filter head containing first a membrane filter and then an activated charcoal filter. Air is drawn through the filter by a rotary vane vacuum pump and the total volume of the sample is recorded by a dry gas meter. The average daily sample volume is about 80 cubic meters.

Samples are collected weekly, allowed to decay for a minimum of 72 hours and counted in an automatic alpha/beta counter. The charcoal cartridges are also changed weekly.

The detection sensitivity for I-131 concentration is computed and corrected to the time of removal. The detection sensitivity for I-131 is determined by the interference level from the activity of other nuclides found on the charcoal filter but is about 0.1 pCi/M^3.

Monthly the high, low and average radioactivity in air is calculated for each sample station. This data is compared with current and past data to evaluate trends and to detect any releases of activity into the environmental air.

Air sampling stations are listed in Table I 6.1-2. The station number is for internal identification purposes only. Results of analysis of environmental air samples (and maps showing the locations of the air samplers) for the past five (5) years (1984 through 1988) are provided in Appendix A of this section.

TABLE I 6.1-2

ENVIRONMENTAL AIR SAMPLE LOCATIONS (15 LOCATIONS)

AS OF 1990

Station Site Designation	Location Description
Station 65	City Sewage pump house #65
FONW	Sorrento Valley 'A' Building Fence perimeter northwest
FOSW	Sorrento Valley 'A' Building Fence perimeter southwest
FON	Sorrento Valley 'B' Building Fence perimeter north
FOS	Sorrento Valley 'A' Building Fence perimeter south
FOE	Sorrento Valley 'A' Building Fence perimeter east
Station 64	City Sewage pump house #64
TPI	Torrey Pines Industrial Court
TO-SB	GA Technical Offices Building
GS-2	Guard Station #2
BLDG. 10 -SB	At the site boundary southeast of Building 10
TFF-SB	Southwest of TRIGA Fuel Fabrication Facility, close to the site boundary.
WYSE	East of Building 41, south of SV-A
Jaycor	11011 Torreyana Road
EA-1 Bunker -SB	Behind Building 27-1

6.1.2 Water Sampling

Effluent water is sampled daily. The gross alpha and gross beta concentrations are determined.

Where radioactive materials are authorized for release to the municipal sewage system, such materials are held in a tank until samples have been taken and analyses performed to assure compliance with applicable laws and regulations.

Sewage and water samples are prepared by evaporating to dryness a 200 ml sample and counting the residue for one hour in a low background proportional counter. The minimum sensitivity depends on the amount of residue present but is about 2 pCi/liter for both alpha and beta for an average sample. Monthly the high, low and average concentration of radioactivity in sewage and water is computed for each sampling station. The data is compared with current and past values to determine trends and to evaluate any release of activity into the sewage system.

6.1.3 Survey and Area Radiation

An annual survey is made of samples of typical soil, vegetation, water and external radiation levels. Gross alpha, beta and gamma spectral analyses are routinely performed on each sample. External radiation is measured by gamma scintillation counting. There are no less than 16 onsite/offsite stations in the annual environmental survey.

The survey schedule is changed to a quarterly basis if the air sample results from stations at the site boundary show quarterly average releases equal to or greater than 25% of the unrestricted area MPC identified in 10 CFR 20, Appendix B.

Soil samples are collected by taking the top inch of soil from a square foot area. The samples are taken in a one-quart polyethylene jar and are gamma counted as is. Counting sensitivity is about 2 pCi/gm. Sample results from each site are compared with current and previous data to detect any soil contamination.

Vegetation samples are collected annually at each site. About 500 gm are collected in a polyethylene jar or bag. The sensitivity is about 2.0 pCi/gm. These samples are compared with each other and past samples to detect contamination on the environmental vegetation.

Water samples are collected if water is present. The activity of individual samples is expected to fall in the range of similar samples from the same or similar sites.

Direct measurements are made at each sampling site of the gamma radiation level. Presently, a portable microR meter is being used. The instrument specifically measures very low levels of radiation in the microR/hour levels ranging from 0 to 5000 microR/hr. The instrument is calibrated annually.

Thermoluminescent dosimeters are used at selected air sampling stations to monitor the environmental radiation. These badges are changed quarterly.

Any change in gamma radiation levels above background can be detected and measured by the two methods listed above.

Table I 6.1-3 lists the sampling sites for soil, vegetation and water.

Gamma spectroscopy results of the soil, vegetation and water samples collected during the annual environmental surveys for the past four years including 1989 (1986 through 1989) are provided in Appendix B of this section. In addition, maps showing the locations of the sample sites are also provided.

TABLE I 6.1-3

ANNUAL ENVIRONMENTAL SURVEY SAMPLING SITES (16 SITES)

CURRENT SITES (AS OF 1988)

SITE CODE	DESCRIPTION
C	Stream bed near culvert at Interstate off-ramp and Roselle Street near Sorrento Road. This is storm drainage from entire eastern slope of laboratory facilities.
C2	Northwest corner of service yard for Hot Cell facility behind waste retention tanks where storm drainage enters uncontrolled area.
D	Stream bed near intersection of Dunhill Street and GA Sorrento Valley access road.
D2	At the east end of culvert under Roselle Street at the south side of Fuel Fabrication 'A' Building.
E2	At the east end of culvert under Roselle Street at the northeast side of Fuel Fabrication 'A' Building.
G2	Northwest of entrance to laboratory facility on east side of Torrey Pines Road.
T1	Southern part of Torrey Pines State Preserve at Los Penasquitos Creek; one-half mile from entrance to Torrey Pines State Reserve.

TABLE I 6.1-3 (Continued)

ANNUAL ENVIRONMENTAL SURVEY SAMPLING SITES

SITE CODE	DESCRIPTION
L1	About 350 feet from the mouth of the bottom of the Hot Cell Canyon.
AA	SV-A North in ice plant area - adjacent to storage building (added in 1988).
AC	Scripps - Old Miramar Road; across from Scripps Hospital (replacement of area I which was changed due to new construction in the area; (added in 1988).
AD	Science Laboratories Building drainage - Canyon area below location where L-307 tank was located; (added in 1988).
AE	TRIGA Fuel Fabrication (TFF) Southwest - In close proximity to TFF environmental air sampler (added in 1988).
AF	TRIGA Fuel Fabrication (TFF) Northeast - Outside fences area in drainage area from TRIGA Fuel Fabrication Facility; about 20 feet from the fence (added in 1988).
AG	TRIGA Fuel Fabrication (TFF) Drainage Ditch South of Test Tower about 200 feet upstream from the end of the ditch (added in 1988).

SITE CODE	DESCRIPTION
AH	Hot Cell middle of canyon; about 30 feet below old LINAC 40 meter flight path; at the site boundary. (Added in 1988)
AI	At the site boundary behind EA-1 (Building 27) and TRIGA (Building 22), (added in 1988).

SITES DELETED (FROM 1986 THROUGH 1987)

A2	Next to L-307 Hot Waste Tank (deleted because the tank was removed in 1984; results were within the criteria for release to unrestricted use).
B2	Next to L-540 Hot Waste Tank (deleted because the tank was removed in 1984; (previous results were backgound).
F2	Calbiochem-Behring Corporation (CBC); previous results were backgound.
H	North of Scripps Hospital at IVAC corporation at the extreme NorthWest parking lot (construction around the area; new location picked nearby; previous results were backgound).
H2	Waste Yard - North (WY-N); (1986 and 1987 results were backgound). This Waste Yard has been decommissioned and the area released to unrestricted use; previous results met the criteria for release to unrestricted use.

I2 Southwest of SV-A building on lip of canyon behind Spin Physics company on Torreyana Road; previous results were backgound.

I3 Scripps Hospital (Scripps) -- East of Surgeon's Center, 9900 Genesse Ave. East of fence near drainage grate and west of Scripps Hospital on Scripps property; previous results were backgound.

J1 10110 Sorrento Valley Road at Stream Bed at Southeast corner of Building (JI on results in the appendix); (previous results were backgound).

K2 Northwest of SV-A and SV-B buildings on the lip of canyon behind Hybertech Corporation on Torreyana Blvd; (previous results were backgound).

O2 East of Torrey Pines Industrial Park near the fence line at Entrance to Los Penesquitos Regional Park; (previous results were backgound).

P Entrance to Hot Cell Canyon at fence line off of I-5 on the ramp from Sorrento Valley Road; area was released to unrestricted use; the results were below the release criteria.

Q East of old chemical disposal area and east of GA boundry fence. Part of the Waste Processing area that was decommissioned; the sampe results met the criteria for release to unrestricted use.

R Entrance to TRIGA Canyon; south of site P and of of the on ramp to I-5 from Sorrento Valley; area has been released to unrestricted use during the decommissioning of the former Waste Yard; results met the limits for release to unrestricted use.

S East of Mini Cafe at culvert under I-5 and East of Sorrento Valley Road; previous results were at background levels.

U Below of TRIGA Fuel Element Storage area at the Waste Processing Facility and in the runn-off ditch; Waste Yard was decommissioned; soil sample results were below the release criteria.

W Below the Waste Processing Facility evaporation ponds at the entrance to the Hot Cell Canyon; Waste Yard was decommissioned; soil sample results were below the release criteria.

6.1.4 Sample Counter and Standards

All alpha and beta samples are counted in an automatic low level alpha beta counting system. Backgrounds are typically less than 0.2 counts per minute (cpm) alpha and 2.0 cpm beta. Samples are counted for a minimum time that is consistent with statistical accuracy. Standard NBS traceable reference sources for this instrument are Cs-137 and Am-241.

6.1.5 Location Criteria for Environmental Sampling Stations

Each sampling station is established with consideration for:

a. Type and quantity of material which may be discharged to the environment.

b. Postulated mode of release.

c. Characteristics of the local environment, including local population distribution and land use.

d. Ability of the station to detect the release of radioactive material from the licensed facility.

Sampling stations which show statistically log normal significant results above the natural background levels for the San Diego site will not be deleted unless authorized by the NRC. Any sites deleted are documented.

New sampling stations may be added where meteorology, terrain and population build up indicate their possible necessity. These new locations may be deleted after two years of operation if the sampling results satisfy the above criteria.

6.2 NON-RADIOLOGICAL MONITORING PROGRAMS

6.2.1 Hydrogen Chloride

It is planned to monitor for hydrogen chloride quarterly during HCL furnace operations. The hydrogen chloride collection apparatus at each sampling station will consist of a Greenburg-Smith Standard Impinger or equivalent connected to a sampling pump which in turn is connected to a dry gas meter. Hydrogen chloride can be completely and rapidly absorbed from the air by 0.01 N NaOH solution in any scrubber. The determination of HCl in terms of chlorides in the washing liquid can be effected on the basis of various classical procedures, depending on the amount to be expected.

The method chosen is as follows: hydrogen chloride in ambient air is collected by passing about nine m^3 of air through 100 ml of 0.01 N NaOH solutionin the standard impinger at a rate of approximately 30 liter/min. The sample solution is made up to 100 ml volume, two to four drops of dichlorofluoresscein indicator solution, 0.001 N. At the end point the color of the solution changes sharply to orange and a slight excess of silver nitrate produces a rose color.

6.2.2 Liquid Waste Monitoring Programs

As specified under the Industrial Waste Discharge Permits, the industrial liquid wastes must comply with the city of San Diego's Standards with regard to pH, suspended solids, biochemical oxygen demand (BOD) and ether soluables. The licensee will monitor its industrial waste for the above parameters on a semiannual frequency or as specified in the City Discharge Permit.

6.3 STACK SAMPLING

Stack sampling is conducted at various facilities at GA. These facilities include SV-A (Building 37, HTGR Fuel Fabrication Facility), Building SV-B (Building 39) fuel development area, TRIGA Fuel Fabrication Facility (Building 22), and the Hot Cell facility (Building 23). Results of the stack sampling program is provided in the semiannual effluent reports submitted per 10 CFR 70. Results are also provided in Appendix C of this section for stack samples for the past five years (1984 through 1988). A description of the stack sampling program, the use of the data in the semiannual effluent reports, and a list of sample identifications for each facility is also provided.

Soil, Vegetation and Water sample locations (environmental survey)

Air sample locations (environmental air)

Sewage sample locations

Fig. I 6.1-1 LOCATIONS OF ENVIRONMENTAL SAMPLING SITES

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APPENDIX A

SECTION 6 OF THE DEMONSTRATION VOLUMES

ENVIRONMENTAL AIR SAMPLE RESULTS

FOR THE YEARS 1984 THROUGH 1988

ENVIRONMENTAL AIR SAMPLE INFORMATION

There are currently 15 environmental air sample locations at GA. A few changes were made at the end of 1989 because of GA's new site boundary. The new locations of the air samplers will be effective beginning January 1990. These new locations are provided in section 6 the demonstration volume.

Environmental air samples are located throughout GA's site as well as offsite. Information obtained from environmental air samples from 1984 through 1988 are provided in this appendix (the most recent year is first). Two lists of the air samplers is provided; one for the years 1984, 1985, 1986, and 1987 and another for the year 1988. Maps showing the locations of the air samplers are also provided. Please note that the locations for the years 1984 through 1987 are the same and therefore the maps are the same. There are several new locations in 1988 due to GA's changing of its' site boundary and the release of land to unrestricted use around GA; these locations are the same for 1989 also. In 1990, there will be new changes to the sites due to GA's new site boundary (see demo section for 1990 information).

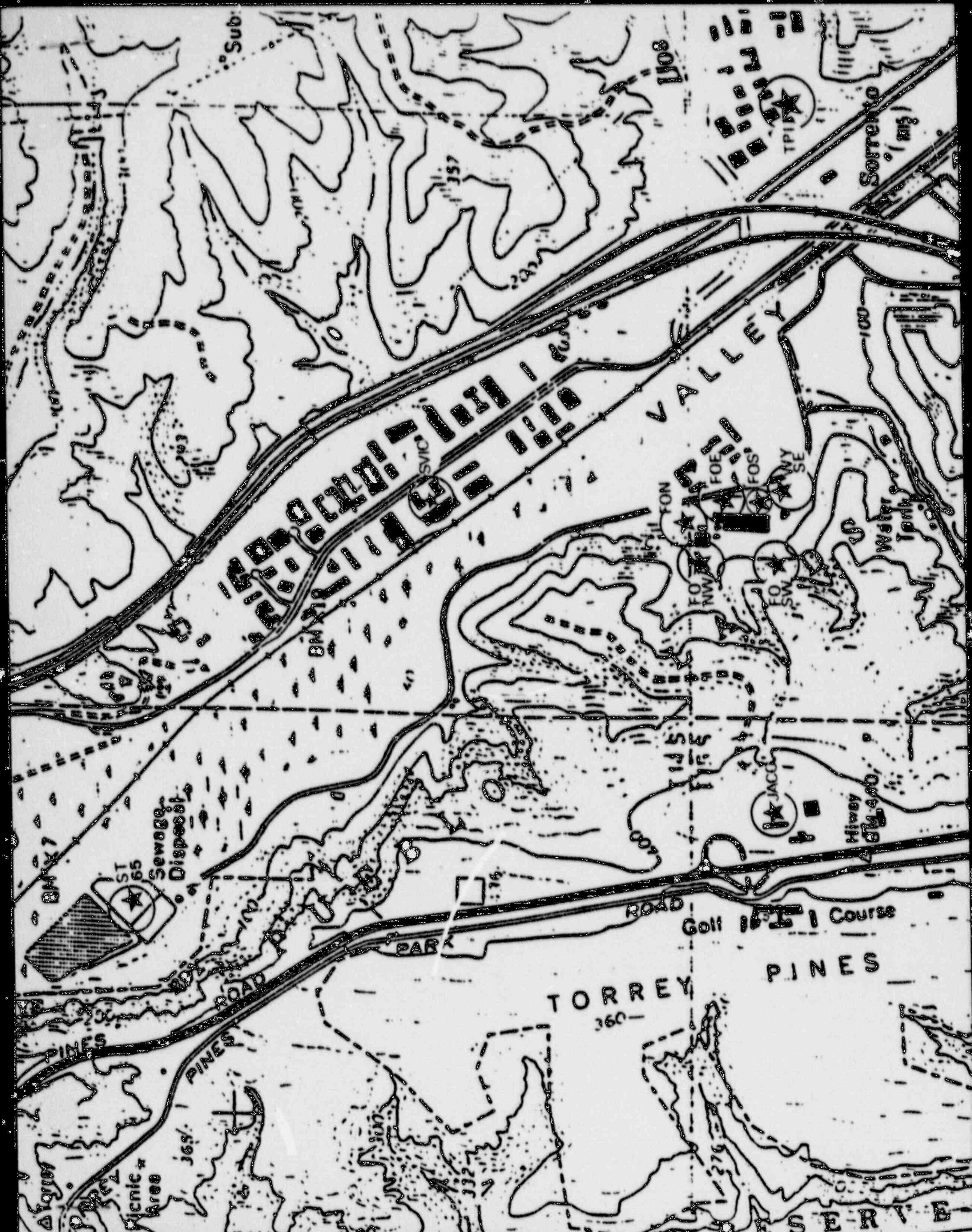
The results provided are gross alpha/beta results. The table provided for each year is in the exact order as the results. The results are provided for each month of the year for each sample loction. A summary sheet (by year) is provided for each group of samples.

ENVIRONMENTAL AIR SAMPLE RESULTS

1988

ENVIRONMENTAL AIR SAMPLES LOCATIONS (15 LOCATIONS)
FOR THE YEAR 1988

Site Code	Location Description
GS2	Guard Station #2
Jaco	11011 Torreyana Road; at Jaycor
Scr	Near Scripps Hospital
Sta 64	City Sewage pump house Station 64
Sta 65	City Sewage pump house Station 65
SVIC	Sorrento Valley Industrial Court
TOB	On the GA site; near the Technical Office Building #15
TPI	Torrey Pines Industrial Court
TPR	Torrey Pines Road (West of GA site) (This station will be replaced by Bldg. 10 - SB in 1/90, this site is near GA's new Site Boundary; due to new construction near GA and new Site Boundary.
TFF-SB	Southwest of TRIGA Fuel Fabrication Facility, close to the site boundary.
WYSE	East of Building 41, south of SV-A
FOE	Sorrento Valley 'A' Building Fence perimeter east
FON	Sorrento Valley 'B' Building Fence perimeter north
FONW	Sorrento Valley 'A' Building Fence perimeter northwest
FOS	Sorrento Valley 'A' Building Fence perimeter south
FOSW	Sorrento Valley 'A' Building Fence perimeter southwest



Sub
VALLEY
Sorrento
TP1
SVIC
FON
FOE
FOS
NY SE
FO NW
FO SW
Water Tank
JACC
Hiwey
Sewage Disposal
ST 65
ROAD
PARK
Golf Course
PINES
TORREY
360
ROAD
PINES
Picnic Area
ESERVE

ENVIRONMENTAL AIR SAMPLE LOCATIONS FOR THE YEAR 1988 (and 1989)

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RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: GS2 GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1988	1.545	23.960	.983	14.874	.720	7.610
FEB	1988	1.360	23.780	1.107	21.398	.840	19.530
MAR	1988	1.120	25.390	.803	19.042	.320	12.200
APR	1988	2.510	28.050	1.085	16.171	.460	4.620
MAY	1988	2.760	18.500	1.179	12.729	.400	8.690
JUN	1988	1.430	28.870	1.042	14.017	.660	4.130
JUL	1988	1.420	15.930	.690	13.052	.210	9.590
AUG	1988	2.200	22.650	1.797	15.805	.370	9.150
SEP	1988	1.890	22.650	1.247	18.301	.700	12.490
OCT	1988	1.650	31.390	.755	21.233	.460	14.660
NOV	1988	1.150	26.110	.946	12.012	.820	8.560
DEC	1988	4.400	36.540	2.279	16.540	.960	4.850
SITE AVERAGE: AVERAGE OF SITE DATA FOR: 12 MONTHS		1.953	25.318	1.126	16.264	.580	9.690
LAST 3 MONTHS ONLY		2.400	31.347	1.327	16.595	.753	9.423

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: JACO GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	1.144	21.970	.722	17.287	.460	13.350
FEB	1988	.810	22.850	.760	20.214	.690	19.030
MAR	1988	1.100	22.450	.608	15.736	.330	.880
APR	1988	.760	16.010	.629	11.451	.490	5.880
MAY	1988	5.110	15.490	1.721	10.164	.340	6.930
JUN	1988	1.660	12.650	.550	8.706	.140	4.300
JUL	1988	1.680	14.400	.731	10.975	.260	7.980
AUG	1988	2.380	34.840	1.348	18.724	.610	10.270
SEP	1988	1.800	22.160	1.081	18.716	.650	12.740
OCT	1988	1.230	28.500	.871	22.041	.600	15.790
NOV	1988	1.230	27.130	.772	14.940	.350	10.140
DEC	1988	1.560	37.540	1.073	24.984	.750	14.100
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.710	22.999	.905	16.163	.472	10.116
LAST 3 MONTHS ONLY		1.347	31.057	.905	20.655	.567	13.343

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: SCR GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1988	1.470	22.690	1.256	17.806	.960	13.080
FEB	1988	2.260	32.160	1.542	27.271	1.240	19.970
MAR	1988	1.840	30.720	1.243	22.746	.590	11.160
APR	1988	1.070	20.190	.686	14.315	.370	3.460
MAY	1988	1.970	26.090	1.480	13.884	.820	8.760
JUN	1988	2.370	14.740	1.295	10.347	.560	6.230
JUL	1988	1.670	21.190	1.039	16.675	.270	7.730
AUG	1988	4.360	31.340	2.424	20.242	1.210	17.230
SEP	1988	4.160	37.000	2.021	27.832	.780	17.350
OCT	1988	2.030	39.810	1.660	30.016	.740	18.430
NOV	1988	10.350	36.880	1.755	19.468	.460	11.360
DEC	1988	13.340	71.290	5.029	35.069	.550	14.490

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	3.909	32.008	1.786	21.308	.712	12.441
LAST 3 MONTHS ONLY	8.573	49.327	2.815	28.191	.583	14.760

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: ST64   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	2.510	23.160	1.352	12.621	.640	6.260
FEB	1988	2.310	37.330	1.820	32.397	.970	12.650
MAR	1988	2.110	35.030	1.603	26.126	.260	.940
APR	1988	1.930	29.410	1.285	16.202	.230	.940
MAY	1988	4.730	24.570	2.914	16.591	.650	11.080
JUN	1988	6.210	30.960	2.209	17.143	.820	6.800
JUL	1988	6.210	38.570	2.863	30.432	1.410	16.960
AUG	1988	8.000	38.570	3.044	31.344	.890	24.080
SEP	1988	8.000	37.100	2.987	24.221	1.450	11.120
OCT	1988	16.400	35.990	6.799	28.075	1.380	20.310
NOV	1988	2.280	23.160	1.508	15.053	.610	7.150
DEC	1988	30.890	35.720	11.967	24.532	.840	13.460

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	7.632	32.466	3.363	22.895	.852	10.981
LAST 3 MONTHS ONLY	16.523	31.623	6.758	22.553	.943	13.640

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: ST65 GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	6.560	64.570	1.808	19.692	.073	5.350
FEB	1988	2.030	22.940	1.367	17.656	.520	12.460
MAR	1988	2.090	17.090	.743	12.215	.040	7.440
APR	1988	.970	19.440	.629	10.360	.330	3.150
MAY	1988	3.760	60.770	1.251	20.445	.250	3.290
JUN	1988	3.520	14.450	.970	7.922	.020	3.990
JUL	1988	3.520	14.450	.945	9.766	.050	6.380
AUG	1988	9.890	32.100	1.837	18.113	.670	11.220
SEP	1988	9.890	32.100	2.567	17.168	.300	3.070
OCT	1988	2.810	24.410	1.310	20.546	.350	12.820
NOV	1988	.910	19.180	.663	9.886	.410	5.900
DEC	1988	1.330	31.670	.970	14.372	.810	2.560

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	3.942	29.431	1.257	14.845	.319	6.469
LAST 3 MONTHS ONLY	1.683	25.087	.981	14.935	.523	7.093

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: SVIC   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1988	1.790	21.080	1.127	18.074	.590	13.030
FEB	1988	2.530	28.110	1.675	25.160	.760	16.930
MAR	1988	1.340	33.060	1.003	21.593	.630	9.190
APR	1988	1.340	33.060	.852	21.848	.320	6.380
MAY	1988	1.070	15.750	.546	12.015	.290	5.820
JUN	1988	2.600	17.710	.982	11.316	.410	5.530
JUL	1988	2.600	23.530	1.500	17.008	.850	12.460
AUG	1988	5.820	33.910	1.568	15.653	.710	7.890
SEP	1988	5.820	33.910	2.390	25.410	1.030	17.440
OCT	1988	2.050	32.100	1.482	26.039	.680	20.640
NOV	1988	1.960	30.570	.919	16.333	.500	11.770
DEC	1988	1.960	30.570	1.146	17.343	.710	.750

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.573	27.780	1.266	18.983	.623	10.652
LAST 3 MONTHS ONLY	1.990	31.080	1.182	19.905	.630	11.053

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: TOB   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1988	2.130	32.590	1.599	23.037	1.107	20.040
FEB	1988	1.340	32.300	.957	26.824	.750	21.370
MAR	1988	1.290	28.720	.963	22.993	.560	11.240
APR	1988	1.230	68.200	.761	26.541	.350	8.030
MAY	1988	1.440	17.140	.833	14.283	.570	9.470
JUN	1988	4.960	20.300	1.881	13.656	.460	5.850
JUL	1988	4.960	21.460	2.018	15.120	.980	10.340
AUG	1988	2.750	26.490	1.472	19.582	.990	14.630
SEP	1988	2.750	26.760	1.567	21.780	.340	8.110
OCT	1988	1.510	39.920	1.142	25.205	.340	8.110
NOV	1988	2.000	42.310	1.190	20.701	.750	14.560
DEC	1988	3.290	69.080	2.650	50.087	2.000	37.710
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.474	35.439	1.419	23.317	.768	14.122
LAST 3 MONTHS ONLY		2.267	50.437	1.661	31.998	1.030	20.127

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TPI GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1988	1.990	22.690	1.440	16.828	1.090	6.730
FEB	1988	1.950	25.290	1.344	22.862	.570	19.520
MAR	1988	2.240	25.770	.990	19.686	.510	10.940
APR	1988	1.940	31.860	.896	15.296	.290	4.950
MAY	1988	.940	22.030	.619	12.123	.340	6.940
JUN	1988	2.790	15.370	1.285	11.161	.410	6.690
JUL	1988	2.190	17.090	1.142	14.797	.660	10.830
AUG	1988	2.260	24.360	1.467	17.711	.640	11.800
SEP	1988	1.930	27.920	1.596	23.015	1.030	20.300
OCT	1988	2.390	32.970	1.779	28.834	.900	23.640
NOV	1988	1.120	26.080	1.017	15.545	.900	9.700
DEC	1988	1.670	43.200	.996	23.678	.520	13.590

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.952	26.219	1.214	18.463	.655	12.136
LAST 3 MONTHS ONLY	1.727	34.083	1.264	22.686	.773	15.643

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TPR   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	8.405	19.030	1.594	14.072	.305	9.720
FEB	1988	1.740	23.270	1.223	20.547	.860	18.290
MAR	1988	.840	21.300	.644	15.498	.500	7.480
APR	1988	.730	14.120	.545	8.641	.340	.580
MAY	1988	1.970	26.090	1.024	12.084	.380	5.460
JUN	1988	2.460	11.200	1.112	7.929	.390	3.810
JUL	1988	1.660	13.370	1.123	11.249	.840	9.250
AUG	1988	2.160	22.310	1.548	17.662	.840	10.500
SEP	1988	2.290	22.690	1.928	18.874	1.350	13.330
OCT	1988	1.830	26.880	1.531	20.914	1.210	13.300
NOV	1988	1.470	25.480	.773	10.999	.390	5.120
DEC	1988	2.760	52.460	1.294	30.850	.520	12.150
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.360	23.183	1.195	15.775	.660	9.064
LAST 3 MONTHS ONLY		2.020	34.940	1.199	20.921	.707	10.190

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE:TFF-SB GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	1.012	16.620	.765	11.692	.481	7.610
FEB	1988	8.290	146.000	2.782	50.703	.790	13.610
MAR	1988	2.590	34.550	.707	15.812	.450	8.010
APR	1988	2.590	34.550	.675	9.666	.240	3.800
MAY	1988	1.540	15.790	.793	6.789	.020	.280
JUN	1988	4.370	36.370	1.340	12.954	.300	2.680
JUL	1988	.810	10.560	.638	9.099	.470	6.450
AUG	1988	2.390	30.450	1.247	15.847	.530	7.790
SEP	1988	1.700	16.290	.982	12.733	.530	10.980
OCT	1988	1.740	21.140	.870	17.621	.340	9.870
NOV	1988	3.060	21.130	1.098	8.604	.340	3.760
DEC	1988	1.370	32.390	.873	21.992	.310	11.050

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.623	34.653	1.064	16.126	.400	7.157
LAST 3 MONTHS ONLY	2.063	24.887	.947	16.072	.330	8.227

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WYSE   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1988	1.927	27.950	1.606	21.230	1.179	13.810
FEB	1988	1.960	31.930	1.553	27.846	1.220	21.570
MAR	1988	2.100	32.100	1.154	24.206	.540	13.930
APR	1988	1.280	25.150	.878	17.858	.550	8.760
MAY	1988	1.020	18.360	.658	12.918	.370	9.500
JUN	1988	3.960	20.470	1.454	12.357	.370	6.910
JUL	1988	3.980	20.470	1.217	15.586	.560	12.800
AUG	1988	29.820	42.030	8.182	20.130	.560	11.960
SEP	1988	7.290	42.030	2.540	29.116	.670	19.850
OCT	1988	3.310	40.620	1.692	32.966	.870	25.180
NOV	1988	1.120	35.060	1.000	22.060	.780	13.730
DEC	1988	2.800	53.590	1.457	30.216	.780	19.390

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	5.049	32.482	1.949	22.257	.721	14.762
LAST 3 MONTHS ONLY	2.410	43.097	1.383	28.421	.810	19.433

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 01

SITE CODE	BEGIN MO	BEGIN YR	END MO	END YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
GS2	01	88	12	88	12	1.953	25.318	1.126	16.264	.580	9.690
JACO	01	88	12	88	12	1.710	22.999	.905	16.103	.472	10.116
SCR	01	88	12	88	12	3.909	32.008	1.786	21.308	.712	12.441
ST64	01	88	12	88	12	7.632	32.466	3.363	22.895	.852	10.981
ST65	01	88	12	88	12	3.942	29.431	1.257	14.845	.319	6.469
SVIC	01	88	12	88	12	2.573	27.780	1.266	18.963	.623	10.652
TOD	01	88	12	88	12	2.474	35.439	1.419	23.317	.768	14.122
TPI	01	88	12	88	12	1.952	26.219	1.214	16.463	.655	12.136
TPR	01	88	12	88	12	2.360	23.183	1.195	15.775	.600	9.084
WYN	01	88	12	88	12	2.623	34.653	1.064	16.126	.400	7.157
WYSE	01	88	12	88	12	5.049	32.482	1.949	22.257	.721	14.782
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:											
12 MONTHS						3.269	29.271	1.504	18.763	.615	10.694
LAST 3 MONTHS ONLY						3.909	35.178	1.857	22.065	.695	12.994

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOE GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	2.547	89.850	1.422	34.789	.590	13.030
FEB	1988	3.710	39.380	1.874	27.885	.530	16.760
MAR	1988	1.900	32.870	1.445	25.560	1.040	12.700
APR	1988	1.780	27.780	1.000	16.571	.220	5.940
MAY	1988	.760	13.040	.606	9.780	.220	7.510
JUN	1988	1.850	16.610	.636	9.851	.160	6.080
JUL	1988	1.850	16.630	.962	13.480	.430	9.260
AUG	1988	5.910	34.610	1.323	16.702	.870	12.040
SEP	1988	5.910	34.610	2.150	24.160	.930	17.910
OCT	1988	1.970	32.050	1.288	26.021	.800	19.890
NOV	1988	1.690	26.230	1.091	17.590	.690	9.690
DEC	1988	2.020	41.040	1.457	24.384	1.030	13.110
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.658	33.725	1.271	20.566	.626	11.993
LAST 3 MONTHS ONLY		1.893	33.107	1.279	22.665	.840	14.230

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FON GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1988	3.644	27.760	2.847	22.047	1.560	19.410
FEB	1988	3.460	46.810	1.888	28.143	1.070	20.380
MAR	1988	2.000	25.450	1.110	20.074	.440	12.700
APR	1988	2.000	22.610	1.115	15.437	.780	8.310
MAY	1988	1.480	13.810	.976	10.967	.650	10.220
JUN	1988	3.340	19.060	1.460	12.082	.880	6.650
JUL	1988	3.340	19.400	1.450	15.065	.890	7.950
AUG	1988	11.370	84.150	4.875	46.173	1.340	12.750
SEP	1988	5.150	31.720	1.960	20.355	.740	12.340
OCT	1988	2.330	29.490	1.368	21.537	.750	12.940
NOV	1988	1.260	24.940	.916	16.434	.460	11.310
DEC	1988	2.320	42.990	1.215	26.819	.620	16.280

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	3.476	32.349	1.765	21.261	.850	12.603
LAST 3 MONTHS ONLY	1.977	32.473	1.166	21.597	.610	13.510

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FONW GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	2.026	23.760	1.546	18.715	.950	15.900
FEB	1988	3.030	35.470	2.070	23.537	1.280	14.090
MAR	1988	6.830	22.690	2.329	17.528	.910	8.050
APR	1988	1.770	18.660	.964	12.905	.420	5.920
MAY	1988	.920	10.650	.791	8.243	.420	5.300
JUN	1988	3.900	14.940	1.864	9.628	.320	5.330
JUL	1988	2.610	14.940	.999	11.443	.560	7.010
AUG	1988	4.970	24.350	1.596	15.065	.620	11.240
SEP	1988	4.970	24.350	2.800	18.873	1.250	10.660
OCT	1988	2.110	26.670	1.574	21.824	1.080	15.850
NOV	1988	1.910	27.360	1.646	15.298	1.320	11.570
DEC	1988	3.570	40.520	1.873	25.670	.830	10.720
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		3.218	23.700	1.671	16.562	.830	10.137
LAST 3 MONTHS ONLY		2.530	31.523	1.698	20.931	1.077	12.713

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOS GROUP I.D. C2

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	2.170	22.340	1.492	18.242	.276	3.060
FEB	1988	2.940	36.910	2.365	32.503	1.850	22.340
MAR	1988	2.860	30.820	1.460	24.264	.300	11.130
APR	1988	2.190	24.660	.994	15.968	.440	5.750
MAY	1988	2.130	21.430	1.157	14.717	.440	9.520
JUN	1988	3.410	19.580	1.167	12.797	.450	10.830
JUL	1988	3.410	19.580	1.193	15.033	.640	12.350
AUG	1988	9.420	41.700	2.019	21.420	.760	14.310
SEP	1988	9.420	41.700	3.104	27.044	.880	20.020
OCT	1988	4.200	40.200	2.332	34.925	1.150	26.790
NOV	1988	3.120	32.920	1.737	19.095	1.330	11.150
DEC	1988	5.070	47.300	3.393	28.897	2.830	14.680

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	4.195	31.595	1.868	22.060	.945	13.494
LAST 3 MONTHS ONLY	4.130	40.140	2.487	27.639	1.770	17.540

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOSW   GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1988	3.120	27.960	2.376	23.135	1.730	16.570
FEB	1988	2.700	34.550	1.900	27.211	1.160	18.420
MAR	1988	2.240	30.220	1.517	24.765	1.180	20.750
APR	1988	3.740	44.840	2.347	28.258	1.360	16.340
MAY	1988	1.820	31.830	.647	10.116	.290	5.820
JUN	1988	4.350	15.390	1.875	8.435	.730	5.040
JUL	1988	2.440	15.390	1.070	10.929	.630	8.630
AUG	1988	25.710	157.900	11.526	49.527	.910	10.780
SEP	1988	14.180	40.350	8.704	20.452	3.030	10.880
OCT	1988	8.250	23.800	5.176	18.893	1.630	13.600
NOV	1988	12.830	37.510	8.369	20.121	4.000	12.000
DEC	1988	5.340	52.620	2.826	27.314	1.040	15.000
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		7.227	42.697	4.028	22.430	1.474	12.836
LAST 3 MONTHS ONLY		8.807	37.977	5.458	22.109	2.223	13.533

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 02

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FOE	01 88	12 88	12	2.658	33.725	1.271	20.566	.626	11.993
FON	01 88	12 88	12	3.476	32.349	1.765	21.261	.850	12.603
FONW	01 88	12 88	12	3.218	23.700	1.671	16.562	.830	10.137
FOS	01 88	12 88	12	4.195	31.595	1.868	22.080	.945	13.494
FOSW	01 88	12 88	12	7.227	42.697	4.028	22.430	1.474	12.836
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				4.155	32.813	2.121	20.580	.945	12.213
LAST 3 MONTHS ONLY				3.867	35.044	2.418	22.968	1.304	14.305

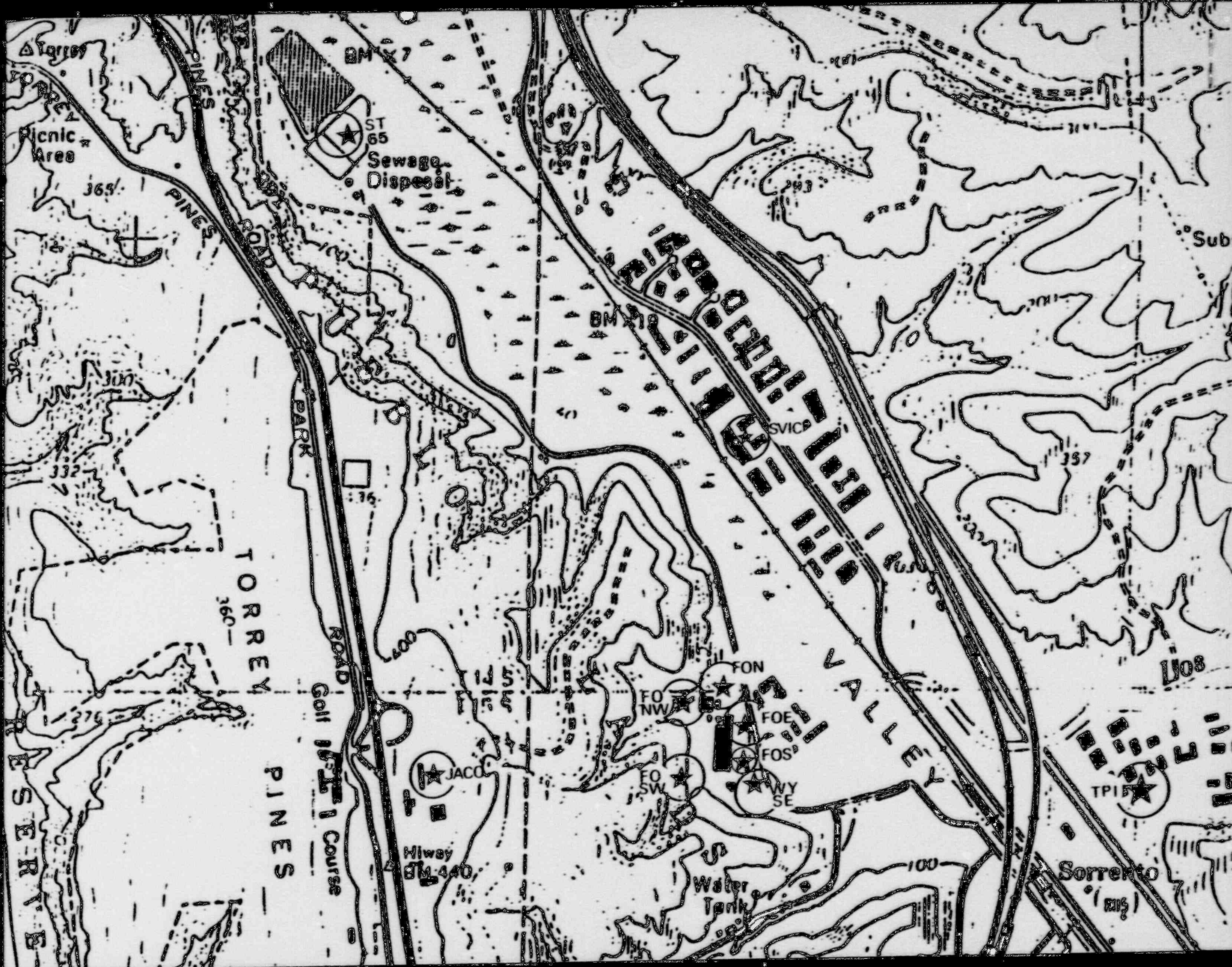
** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

ENVIRONMENTAL AIR SAMPLE RESULTS

1987

ENVIRONMENTAL AIR SAMPLES LOCATIONS (15 LOCATIONS)
FOR THE YEARS 1984, 1985, 1986 AND 1987

Site Code	Location Description
GS2	Guard Station #2
Jaco	11011 Torreyana Road; at Jaycor
Scr	Near Scripps Hospital
Sta 64	City Sewage pump house Station 64
Sta 65	City Sewage pump house Station 65
SVIC	Sorrento Valley Industrial Court
TOB	On the GA site; near the Technical Office Building #15
TPI	Torrey Pines Industrial Court
TPR	Torrey Pines Road (West of GA site) (This station will be replaced by Bldg. 10 - SB in 1/90, this site is near GA's new Site Boundary; due to new construction near GA and new Site Boundary.
WYN	Waste Yard North (In the former Waste Processing Facility; site deleted 1/88; Air sampler moved southwest of TRIGA Fuel Fabrication near GA's new site boundary and identified as TFF-SB.
WYS	Waste Yard South (In the former Waste Processing Facility; site deleted 7/87; Waste Processing Facility relocated and a new air sampler (WYSE) was in the new location in 1984.
WYSE	East of Building 41, south of SV-A; at the new Waste Processing Facility.
FOE	Sorrento Valley 'A' Building Fence perimeter east
FON	Sorrento Valley 'B' Building Fence perimeter north
FONW	Sorrento Valley 'A' Building Fence perimeter northwest
FOS	Sorrento Valley 'A' Building Fence perimeter south
FOSW	Sorrento Valley 'A' Building Fence perimeter southwest



Torrey
Picnic Area
365
PINES
PINES ROAD
ST 65
Sewage Disposal
Sub
SVIC
357
332
TORREY
PINES
360
PARK
ROAD
Golf Course
400
FON
FO NW
FOE
FOS
FO SW
WY SE
JACO
TPI
VALLEY
Hiway BM 440
Water Tank
Sorrento
100

ENVIRONMENTAL AIR SAMPLES LOCATIONS 1984, 1985, 1986 and 1987

SI
APERTURE
CARD
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Aperture Card

8908210116-06

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: GS2   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	2.150	30.890	1.263	21.980	.440	14.790
FEB	1987	1.400	25.160	.868	15.236	.440	5.700
MAR	1987	1.400	24.810	1.005	16.281	.610	6.960
APR	1987	1.890	33.820	1.069	20.748	.360	10.270
MAY	1987	1.890	23.070	1.222	18.969	.560	15.680
JUN	1987	1.590	15.680	.877	12.545	.630	8.970
JUL	1987	1.360	13.320	.761	9.246	.510	4.070
AUG	1987	1.470	22.400	.493	14.358	.200	8.550
SEP	1987	1.470	38.110	.935	15.769	.520	.040
OCT	1987	1.110	42.070	.909	31.308	.600	18.280
NOV	1987	1.470	27.980	.851	22.800	.520	16.350
DEC	1987	1.984	25.540	1.560	24.233	1.118	23.250
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.609	26.904	.984	18.623	.544	11.326
LAST 3 MONTHS ONLY		1.521	31.863	1.107	26.114	.746	19.293

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: JACO   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1987	1.320	25.710	.888	20.126	.310	11.700
FEB	1987	.750	21.550	.605	14.616	.310	8.050
MAR	1987	1.210	20.830	.822	13.419	.200	3.270
APR	1987	.960	25.560	.745	16.264	.560	10.720
MAY	1987	.800	22.320	.591	14.968	.280	11.530
JUN	1987	.900	12.360	.568	9.638	.230	7.460
JUL	1987	1.000	9.870	.427	6.810	.200	4.140
AUG	1987	1.300	21.400	.675	13.373	.320	7.590
SEP	1987	1.300	37.000	.919	22.102	.530	13.600
OCT	1987	1.290	37.430	.863	27.426	.670	14.740
NOV	1987	1.040	25.660	.802	17.702	.560	10.040
DEC	1987	1.760	20.310	1.119	16.364	.692	11.730
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.137	23.333	.752	16.067	.405	9.547
LAST 3 MONTHS ONLY		1.370	27.800	.928	20.497	.641	12.170

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: SCR   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	1.310	31.470	1.183	22.575	1.040	14.440
FEB	1987	1.810	36.220	1.076	19.436	.750	5.670
MAR	1987	2.560	34.310	1.512	21.449	.540	5.600
APR	1987	1.800	26.720	1.490	19.811	.810	8.130
MAY	1987	1.320	20.390	1.069	16.977	.660	13.050
JUN	1987	1.320	15.540	.715	11.599	.560	10.610
JUL	1987	.870	15.540	.635	10.143	.370	5.610
AUG	1987	1.300	24.250	.851	17.289	.540	14.000
SEP	1987	2.300	59.770	1.409	27.110	.900	22.900
OCT	1987	1.950	59.770	1.100	37.688	.070	20.930
NOV	1987	1.770	35.060	1.170	28.555	.910	21.840
DEC	1987	1.944	28.120	1.474	19.922	1.205	9.445

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.669	32.430	1.140	21.046	.696	12.665
LAST 3 MONTHS ONLY	1.888	40.983	1.248	28.722	.728	17.405

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: ST64   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	2.540	41.770	1.467	26.805	.770	13.740
FEB	1987	1.290	32.470	.959	20.973	.300	13.100
MAR	1987	2.060	38.040	1.312	22.332	.400	12.500
APR	1987	1.860	30.540	1.050	23.773	.750	17.490
MAY	1987	1.120	26.410	.955	18.887	.750	10.000
JUN	1987	1.540	19.510	1.140	16.980	.550	14.370
JUL	1987	1.010	20.100	.594	15.195	.019	4.600
AUG	1987	1.780	51.860	1.058	29.475	.540	19.500
SEP	1987	4.420	77.130	1.444	33.833	.810	1.590
OCT	1987	4.420	77.130	1.442	44.576	.580	17.360
NOV	1987	9.270	198.900	3.388	66.880	.660	15.710
DEC	1987	2.510	37.800	1.713	23.346	.729	14.350

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	2.818	54.305	1.377	28.568	.571	12.859
LAST 3 MONTHS ONLY	5.400	104.610	2.181	44.934	.656	15.807

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: ST65   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	2.060	35.460	1.224	18.690	.750	8.290
FEB	1987	1.030	16.260	.827	10.733	.500	7.010
MAR	1987	1.140	20.040	.796	13.815	.330	4.690
APR	1987	1.560	30.390	.932	15.817	.370	6.760
MAY	1987	1.360	23.710	1.090	16.801	.720	12.490
JUN	1987	1.300	43.650	.777	17.537	.670	8.030
JUL	1987	1.200	43.650	.636	15.099	.290	7.330
AUG	1987	2.860	20.550	1.138	15.106	.570	11.650
SEP	1987	2.860	41.230	1.360	25.844	.910	16.570
OCT	1987	2.150	41.230	1.326	29.649	.510	14.970
NOV	1987	2.130	33.730	1.529	23.018	.510	14.970
DEC	1987	6.560	64.570	2.612	31.820	.321	3.490

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.166	34.541	1.229	19.498	.538	9.667
LAST 3 MONTHS ONLY	3.613	46.510	1.822	28.162	.447	11.143

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: SVIC GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	1.430	31.720	1.101	23.716	.400	16.380
FEB	1987	1.370	21.690	.976	15.073	.780	10.030
MAR	1987	1.170	22.520	.818	15.477	.430	7.030
APR	1987	.970	27.690	.806	18.395	.670	14.720
MAY	1987	1.580	27.690	.938	17.171	.610	11.330
JUN	1987	1.580	19.150	.722	11.365	.400	7.240
JUL	1987	.650	13.370	.468	6.546	.170	.030
AUG	1987	1.640	22.180	.838	15.560	.570	10.580
SEP	1987	2.400	41.350	1.649	27.417	.760	14.240
OCT	1987	1.840	66.150	1.187	33.955	.790	17.620
NOV	1987	1.090	22.200	.778	15.988	.500	11.710
DEC	1987	1.651	21.080	1.555	18.448	1.453	15.010

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	1.448	28.066	.986	18.259	.628	11.327
LAST 3 MONTHS ONLY	1.527	36.477	1.173	22.797	.914	14.780

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TOB GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	2.070	44.520	1.158	27.892	.610	14.130
FEB	1987	1.800	21.970	1.032	15.164	.610	10.850
MAR	1987	1.280	30.960	.921	17.343	.340	6.970
APR	1987	.980	21.870	.641	16.603	.200	10.980
MAY	1987	1.910	21.170	1.062	15.406	.720	9.560
JUN	1987	1.910	17.890	.718	11.715	.460	6.900
JUL	1987	1.150	20.750	.731	10.457	.210	4.390
AUG	1987	2.580	28.880	.553	13.758	.390	9.080
SEP	1987	2.580	45.960	1.663	25.803	1.220	18.400
OCT	1987	2.260	141.500	1.419	56.212	.530	11.880
NOV	1987	15.420	33.940	4.628	25.430	.520	11.880
DEC	1987	2.804	35.670	1.823	30.297	.848	21.250

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	3.062	38.757	1.362	22.173	.555	11.356
LAST 3 MONTHS ONLY	6.828	70.370	2.623	37.313	.633	15.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: TP1 GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	1.230	21.990	.982	16.750	.800	10.340
FEB	1987	1.270	20.570	1.048	14.998	.650	10.130
MAR	1987	1.100	17.670	.579	12.672	.310	3.860
APR	1987	1.100	22.220	.842	15.415	.390	8.610
MAY	1987	1.100	18.670	.749	11.586	.500	7.750
JUN	1987	1.070	9.740	.554	8.175	.210	6.980
JUL	1987	.890	12.870	.671	7.466	.430	5.620
AUG	1987	1.290	24.560	.859	16.553	.560	11.660
SEP	1987	2.130	42.870	1.525	24.521	.660	16.400
OCT	1987	1.370	47.980	.849	30.469	.360	12.790
NOV	1987	1.260	29.760	.877	19.473	.610	10.880
DEC	1987	1.350	25.360	1.092	19.944	.905	12.790

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.263	24.522	.886	16.502	.532	9.834
LAST 3 MONTHS ONLY	1.327	34.367	.939	23.295	.625	12.153

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: TPR   GROUP I.D. C1

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.870	21.830	.604	14.951	.430	8.250
FEB	1987	.910	16.440	.548	9.694	.260	5.670
MAR	1987	1.310	18.300	.886	13.416	.600	7.980
APR	1987	1.190	26.110	.925	16.162	.680	9.160
MAY	1987	1.290	23.560	.792	15.255	.340	8.200
JUN	1987	1.290	18.640	.417	7.132	.210	5.210
JUL	1987	.600	11.540	.300	6.951	.009	4.970
AUG	1987	1.290	25.510	.718	15.506	[illegible]	9.350
SEP	1987	1.290	38.190	1.109	23.255	.700	20.800
OCT	1987	1.030	38.190	.688	27.345	.370	17.460
NOV	1987	.990	28.230	.807	18.946	.370	14.400
DEC	1987	8.405	17.130	3.483	13.604	.521	8.748
SITE AVERAGE: AVERAGE OF SITE DATA FOR: 12 MONTHS		1.705	23.639	.940	15.165	.397	10.016
LAST 3 MONTHS ONLY		3.475	27.850	1.659	19.965	.420	13.536

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WYN   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	.950	68.040	.719	28.749	.390	9.320
FEB	1987	.970	18.070	.572	11.968	.340	6.140
MAR	1987	1.570	17.050	1.029	13.277	.230	2.400
APR	1987	.760	15.440	.588	11.851	.370	7.540
MAY	1987	1.390	15.210	.862	12.329	.460	7.540
JUN	1987	.870	13.280	.573	8.005	.250	4.250
JUL	1987	.810	8.870	.504	5.950	.310	2.470
AUG	1987	1.460	21.310	.843	13.035	.410	8.650
SEP	1987	1.050	30.340	.541	15.668	.330	12.200
OCT	1987	2.260	36.380	1.108	25.143	.330	11.880
NOV	1987	1.360	26.530	.835	18.524	.330	11.880
DEC	1987	1.510	20.320	1.082	15.308	.431	7.232

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.247	24.237	.773	14.984	.348	7.625
LAST 3 MONTHS ONLY	1.710	27.743	1.008	19.658	.364	10.331

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WYS GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	2.070	32.500	1.229	22.781	.510	14.720
FEB	1987	3.030	26.260	1.434	16.691	.370	9.930
MAR	1987	1.590	24.650	1.193	16.738	.400	6.160
APR	1987	2.190	22.540	1.321	18.058	.660	13.800
MAY	1987	1.700	25.650	1.053	18.579	.690	11.890
JUN	1987	1.700	25.650	.701	12.000	.570	7.530
JUL	1987	1.630	14.310	.946	7.383	.020	.040
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
7 MONTHS		1.967	24.509	1.125	16.033	.460	9.153
LAST 3 MONTHS ONLY		1.677	21.870	.900	12.654	.427	6.487

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: WYSE   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	2.250	29.970	1.429	20.195	.670	14.300
FEB	1987	1.440	25.490	.795	16.038	.500	10.600
MAR	1987	1.590	24.430	.872	16.907	.430	6.580
APR	1987	1.590	21.400	1.147	18.431	.770	11.860
MAY	1987	1.320	19.900	.912	15.377	.780	11.000
JUN	1987	1.030	17.560	.869	13.743	.570	10.190
JUL	1987	1.020	18.260	.725	9.493	.570	4.960
AUG	1987	2.970	31.770	1.155	22.007	.550	17.350
SEP	1987	2.970	54.670	2.100	34.661	1.480	29.740
OCT	1987	2.720	55.430	1.537	42.531	.590	24.090
NOV	1987	1.970	39.260	1.438	30.064	.590	22.820
DEC	1987	4.712	74.720	2.871	43.452	1.689	19.270
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.132	34.409	1.321	23.575	.766	15.247
LAST 3 MONTHS ONLY		3.134	56.470	1.949	38.682	.956	22.060

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 01

SITE CODE	BEGIN MO	BEGIN YR	END MO	END YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
GS2	01	87	12	87	12	1.609	26.904	.984	18.623	.544	11.326
JACO	01	87	12	87	12	1.137	23.333	.752	16.067	.405	9.547
SCR	01	87	12	87	12	1.689	32.430	1.140	21.046	.696	12.685
ST54	01	87	12	87	12	2.818	54.305	1.377	28.588	.571	12.859
ST65	01	87	12	87	12	2.166	34.541	1.229	19.498	.536	9.687
SVIC	01	87	12	87	12	1.448	28.066	.986	18.259	.628	11.327
TOB	01	87	12	87	12	3.062	38.757	1.362	22.173	.555	11.356
TPI	01	87	12	87	12	1.263	24.522	.886	16.502	.532	9.834
TPR	01	87	12	87	12	1.705	23.639	.940	15.185	.397	10.016
WYN	01	87	12	87	12	1.247	24.237	.773	14.984	.348	7.625
WYS	01	87	07	87	7	1.967	24.509	1.125	16.033	.400	9.153
WYSE	01	87	12	87	12	2.132	34.409	1.321	23.575	.766	15.247
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR: 12 MONTHS						1.657	30.804	1.073	19.211	.537	10.889
LAST 3 MONTHS ONLY						2.769	43.909	1.462	26.899	.630	14.161

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOE   GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	3.240	44.900	1.339	25.477	.460	11.360
FEB	1987	1.590	32.970	1.057	17.926	.640	11.190
MAR	1987	1.560	32.300	.936	16.502	.330	4.640
APR	1987	1.650	22.480	1.279	17.901	.920	13.370
MAY	1987	1.040	20.880	.747	14.682	.500	8.960
JUN	1987	1.110	13.340	.922	10.976	.730	6.760
JUL	1987	1.500	12.260	.884	8.588	.290	4.560
AUG	1987	2.810	26.640	.824	16.638	.450	10.530
SEP	1987	2.810	44.920	1.720	24.768	1.070	11.510
OCT	1987	1.720	44.920	1.019	30.252	.070	17.930
NOV	1987	1.550	36.760	1.215	27.626	.710	17.930
DEC	1987	1.890	24.940	1.327	17.613	.702	9.864

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.872	29.776	1.106	19.079	.573	10.719
LAST 3 MONTHS ONLY	1.720	35.540	1.187	25.164	.494	15.248

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FON GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	3.700	40.360	1.798	27.858	.400	10.370
FEB	1987	1.540	37.960	1.071	19.479	.400	10.370
MAR	1987	1.320	29.030	.803	17.902	.320	7.070
APR	1987	2.200	24.350	1.371	21.581	.850	17.570
MAY	1987	1.360	24.490	1.021	18.628	.810	14.160
JUN	1987	1.360	15.740	.834	11.964	.390	9.420
JUL	1987	1.070	14.230	.578	7.176	.310	.031
AUG	1987	2.600	28.690	1.110	22.604	.560	11.210
SEP	1987	2.600	45.760	1.921	29.572	1.150	25.660
OCT	1987	2.830	45.760	1.498	40.864	.830	29.810
NOV	1987	1.990	34.080	1.391	26.146	.720	10.910
DEC	1987	3.644	27.890	2.568	25.797	1.509	22.050

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.184	30.697	1.330	22.469	.687	14.053
LAST 3 MONTHS ONLY	2.821	35.910	1.819	30.936	1.020	20.923

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FONW   GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	2.220	24.570	1.398	19.479	1.070	14.430
FEB	1987	1.360	21.900	.952	13.945	.410	9.510
MAR	1987	1.480	20.200	.888	15.320	.350	7.600
APR	1987	1.290	20.440	1.070	15.594	.780	9.580
MAY	1987	1.510	17.630	1.055	12.056	.850	8.720
JUN	1987	1.510	9.870	.692	8.454	.450	6.880
JUL	1987	.880	23.030	.632	11.424	.450	4.580
AUG	1987	1.880	23.040	.978	17.350	.650	11.740
SEP	1987	2.360	43.340	1.579	17.010	.460	.030
OCT	1987	1.950	43.340	1.318	25.305	.460	12.310
NOV	1987	2.390	28.630	1.639	23.034	1.080	12.310
DEC	1987	2.930	24.430	1.584	21.592	.708	16.790

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	1.815	25.035	1.149	16.714	.643	9.540
LAST 3 MONTHS ONLY	2.423	32.133	1.514	23.310	.749	13.803

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOS   GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	2.600	27.930	1.672	20.665	.960	14.370
FEB	1987	1.600	24.950	1.183	17.372	.740	11.960
MAR	1987	1.560	27.140	1.023	17.892	.500	7.230
APR	1987	1.700	26.470	1.315	20.284	.800	13.550
MAY	1987	2.100	22.490	1.647	20.098	1.050	15.360
JUN	1987	1.410	21.910	1.187	12.353	1.030	6.820
JUL	1987	1.410	13.760	1.056	8.873	.770	5.710
AUG	1987	2.740	29.280	1.250	18.446	.680	12.380
SEP	1987	3.200	49.420	2.013	29.584	1.070	25.760
OCT	1987	3.000	54.520	2.199	38.076	1.470	23.330
NOV	1987	1.970	36.080	1.594	26.040	1.180	21.310
DEC	1987	2.190	25.180	1.066	14.208	.000	.000

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.123	29.927	1.434	20.324	.854	13.150
LAST 3 MONTHS ONLY	2.387	38.593	1.620	26.108	.883	14.880

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOSW   GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	2.610	33.900	1.890	24.117	1.150	11.780
FEB	1987	1.800	25.300	1.196	17.623	.380	10.930
MAR	1987	1.730	22.680	1.165	16.352	.380	8.490
APR	1987	2.560	31.430	1.588	22.278	.900	14.010
MAY	1987	1.600	26.470	1.230	16.129	.920	8.520
JUN	1987	6.870	26.470	1.643	16.193	.770	11.540
JUL	1987	6.870	66.870	2.047	21.735	.790	.990
AUG	1987	2.930	30.250	1.227	20.010	.790	10.710
SEP	1987	2.930	38.220	2.018	24.054	1.390	16.570
OCT	1987	2.220	39.180	1.618	29.816	1.030	21.020
NOV	1987	1.930	34.130	1.546	24.437	1.090	12.990
DEC	1987	3.550	33.240	1.995	23.649	.759	16.320
SITE AVERAGE: AVERAGE OF SITE DATA FOR: 12 MONTHS		3.138	34.012	1.597	21.366	.862	11.969
LAST 3 MONTHS ONLY		2.567	35.517	1.720	25.967	.960	16.777

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. C2

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FOE	01 87	12 87	12	1.672	29.776	1.106	19.079	.573	10.719
FON	01 87	12 87	12	2.164	30.697	1.330	22.469	.667	14.053
FONW	01 87	12 87	12	1.815	25.035	1.149	16.714	.643	9.540
FOS	01 87	12 87	12	2.123	29.927	1.434	20.324	.854	13.150
FOSW	01 87	12 87	12	3.138	34.012	1.597	21.366	.862	11.969

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	2.227	29.869	1.323	19.990	.724	11.890
LAST 3 MONTHS ONLY	2.364	35.539	1.572	26.[illegible]97	.821	16.326

* PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

ENVIRONMENTAL AIR SAMPLE RESULTS

1986

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: GS2   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.960	29.250	.830	23.474	.670	13.010
FEB	1986	1.750	19.730	.743	12.681	.290	6.690
MAR	1986	.890	19.050	.573	10.897	.340	4.130
APR	1986	1.860	16.770	1.110	10.308	.430	.020
MAY	1986	6.260	708.300	1.797	223.662	.180	13.630
JUN	1986	2.030	43.860	.840	21.813	.520	7.970
JUL	1986	2.030	14.090	1.303	9.840	.700	7.680
AUG	1986	1.800	22.110	1.058	18.010	.310	14.090
SEP	1986	1.500	28.770	1.119	17.066	.640	11.190
OCT	1986	1.600	36.820	1.037	29.203	.670	12.870
NOV	1986	2.220	34.260	1.411	25.914	.760	14.310
DEC	1986	1.460	24.200	1.197	20.539	.620	17.890

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.033	83.101	1.085	35.284	.511	10.290
LAST 3 MONTHS ONLY	1.760	31.760	1.215	25.219	.683	15.023

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: JACO   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.810	22.150	.542	15.329	.310	8.210
FEB	1986	.650	14.270	.369	8.183	.220	5.860
MAR	1986	.810	17.000	.424	10.069	.210	2.490
APR	1986	.820	12.780	.534	10.256	.270	6.910
MAY	1986	1.360	219.200	.802	129.030	.230	6.910
JUN	1986	1.180	51.590	.529	17.426	.330	7.430
JUL	1986	.970	12.050	.769	8.008	.410	5.510
AUG	1986	1.190	13.680	.835	11.705	.490	10.690
SEP	1986	1.040	16.860	.771	13.141	.390	7.300
OCT	1986	1.250	32.370	.929	24.458	.580	13.120
NOV	1986	2.410	35.480	1.302	22.046	.300	13.920
DEC	1986	1.320	25.250	1.169	23.658	1.000	15.250

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.151	39.392	.748	24.442	.395	8.633
LAST 3 MONTHS ONLY	1.660	31.033	1.133	23.387	.627	14.097

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: SCR GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	2.440	29.000	1.239	24.224	.470	18.680
FEB	1986	.940	18.660	.685	13.310	.430	10.910
MAR	1986	1.360	26.730	1.046	17.968	.650	11.600
APR	1986	2.590	28.740	1.717	16.762	1.160	12.740
MAY	1986	1.840	267.300	.993	170.366	.460	15.030
JUN	1986	1.530	69.180	.891	23.234	.390	7.150
JUL	1986	1.860	17.450	1.321	13.503	.660	7.150
AUG	1986	1.440	21.150	1.058	18.488	.009	16.010
SEP	1986	2.150	24.600	1.650	17.491	.009	12.200
OCT	1986	2.780	52.290	1.838	39.345	.910	24.600
NOV	1986	2.390	36.600	1.351	24.925	.630	16.200
DEC	1986	1.400	28.400	1.011	21.147	.530	14.440

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.893	51.677	1.233	33.565	.527	13.892
LAST 3 MONTHS ONLY	2.190	39.097	1.400	28.472	.690	18.413

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: ST64   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	1.140	24.080	.806	21.493	.590	18.450
FEB	1986	1.140	19.400	.821	12.548	.520	7.920
MAR	1986	.960	19.930	.557	13.195	.270	5.010
APR	1986	1.620	19.740	.978	14.579	.390	9.170
MAY	1986	1.260	238.000	.812	157.658	.400	18.180
JUN	1986	1.800	66.840	.873	24.029	.370	8.710
JUL	1986	2.570	16.600	1.205	12.652	.670	9.730
AUG	1986	2.570	19.960	1.520	16.012	1.120	13.070
SEP	1986	2.480	25.970	1.507	19.527	.860	15.520
OCT	1986	2.560	50.120	2.115	41.069	1.420	25.970
NOV	1986	2.460	39.250	1.659	29.028	.700	17.270
DEC	1986	1.810	33.510	1.417	30.751	1.110	23.500

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	1.867	47.783	1.169	32.712	.702	14.375
LAST 3 MONTHS ONLY	2.263	40.960	1.730	33.616	1.077	22.247

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: ST65 GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.960	21.470	.547	17.477	.082	12.010
FEB	1986	1.510	34.390	.680	13.058	.300	7.980
MAR	1986	1.510	34.390	.619	11.621	.350	5.650
APR	1986	2.060	19.270	1.083	11.760	.460	7.170
MAY	1986	.750	228.900	.613	128.953	.480	8.130
JUN	1986	1.820	48.530	.652	17.179	.390	8.230
JUL	1986	1.820	21.640	1.222	12.353	.880	7.390
AUG	1986	1.460	14.890	1.078	12.016	.610	10.440
SEP	1986	1.630	16.340	1.030	11.666	.240	1.450
OCT	1986	2.360	40.070	1.463	27.774	.730	15.930
NOV	1986	3.370	38.670	1.766	22.750	.710	9.810
DEC	1986	1.720	27.390	1.362	17.325	.710	7.650
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.747	45.496	1.010	25.328	.497	8.487
LAST 3 MONTHS ONLY		2.483	35.377	1.530	22.616	.717	11.130

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: SVIC   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	1.120	42.380	.994	27.283	.730	15.380
FEB	1986	1.080	15.900	.576	9.739	.390	6.440
MAR	1986	.660	18.210	.512	10.409	.300	3.080
APR	1986	1.470	19.950	.825	14.252	.300	9.290
MAY	1986	1.090	245.500	.788	161.773	.340	9.290
JUN	1986	1.300	52.540	.606	23.074	.340	8.740
JUL	1986	2.050	19.170	1.106	9.958	.470	5.850
AUG	1986	2.050	19.170	1.067	15.019	.640	13.180
SEP	1986	1.740	19.220	1.257	15.195	.650	10.010
OCT	1986	1.510	38.300	1.173	28.602	.660	15.070
NOV	1986	2.180	35.370	1.209	25.048	.600	15.660
DEC	1986	1.620	37.820	1.115	25.396	.660	16.380
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.469	46.961	.936	30.479	.507	10.697
LAST 3 MONTHS ONLY		1.770	37.163	1.166	26.349	.640	15.703

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TOB   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.910	35.020	.566	21.409	.420	10.290
FEB	1986	.430	12.400	.320	10.129	.260	7.600
MAR	1986	.590	16.270	.436	10.153	.230	3.400
APR	1986	1.100	13.130	.678	10.166	.290	7.050
MAY	1986	.960	204.800	.590	129.587	.240	7.050
JUN	1986	.770	54.280	.555	17.957	.340	7.410
JUL	1986	1.140	12.250	.738	7.891	.240	5.160
AUG	1986	4.640	27.920	1.442	15.271	.380	9.750
SEP	1986	4.640	27.920	1.491	13.128	.750	8.120
OCT	1986	1.740	40.920	1.296	30.170	.890	15.280
NOV	1986	2.050	43.300	1.169	28.803	.610	13.400
DEC	1986	2.070	44.520	1.615	35.600	.690	24.670
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.753	44.394	.908	27.522	.445	9.932
LAST 3 MONTHS ONLY		1.953	42.913	1.361	31.524	.730	17.783

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: TPI   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.960	24.590	.814	18.908	.630	10.620
FEB	1986	.850	15.850	.594	9.970	.490	7.470
MAR	1986	.920	16.060	.491	10.597	.240	3.540
APR	1986	1.710	18.240	1.162	12.700	.730	8.020
MAY	1986	1.040	271.100	.830	163.178	.450	9.480
JUN	1986	1.530	59.670	.867	20.077	.450	7.320
JUL	1986	2.010	19.170	1.147	11.518	.600	7.700
AUG	1986	2.010	19.170	1.012	15.535	.570	12.710
SEP	1986	1.310	19.860	.860	15.541	.370	10.720
OCT	1986	2.070	42.690	1.431	32.845	.910	19.860
NOV	1986	2.940	35.970	1.396	24.057	.750	12.280
DEC	1986	1.180	40.460	.953	21.729	.750	11.480

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.546	48.569	.963	29.721	.578	10.100
LAST 3 MONTHS ONLY	2.063	39.707	1.260	26.210	.803	14.540

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TPR GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	1.530	18.530	.764	15.104	.380	7.320
FEB	1986	1.530	7.930	.440	7.069	.300	6.080
MAR	1986	.790	14.360	.530	9.725	.230	4.990
APR	1986	.890	12.830	.593	9.840	.260	5.770
MAY	1986	3.130	817.200	1.366	166.431	.600	8.600
JUN	1986	1.110	44.920	.637	20.020	.390	9.390
JUL	1986	1.360	12.860	.979	8.706	.250	6.340
AUG	1986	1.230	16.250	.741	13.498	.510	11.410
SEP	1986	1.240	35.860	.877	18.542	.610	10.230
OCT	1986	1.650	39.570	1.241	30.415	.640	18.780
NOV	1986	2.290	32.290	1.168	20.921	.500	11.040
DEC	1986	1.440	39.280	.875	18.577	.670	9.700
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.516	90.996	.851	[illegible]9.908	.445	9.137
LAST 3 MONTHS ONLY		1.793	37.047	1.095	23.304	.603	13.173

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: WYN   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	1.240	26.540	.723	20.984	.440	10.420
FEB	1986	.650	12.390	.403	8.111	.190	4.520
MAR	1986	.900	16.600	.503	9.671	.230	1.800
APR	1986	1.090	15.670	.702	11.254	.410	6.980
MAY	1986	1.220	221.700	.811	143.446	.270	8.840
JUN	1986	1.220	53.130	.613	20.255	.330	9.830
JUL	1986	1.360	[illegible]5.950	.974	10.639	.430	7.500
AUG	1986	1.370	23.550	.924	17.994	.540	13.540
SEP	1986	1.340	42.050	1.095	21.467	.670	9.660
OCT	1986	1.460	38.550	1.091	28.263	.670	14.350
NOV	1986	3.130	78.740	1.289	34.181	.620	9.300
DEC	1986	1.170	46.710	.866	27.520	.610	11.640

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	1.346	49.467	.833	29.482	.451	9.032
LAST 3 MONTHS ONLY	1.920	54.667	1.082	29.988	.633	11.763

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: WYS GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	1.130	26.910	.972	19.924	.810	12.780
JUL	1986	1.890	10.100	1.442	8.427	.720	7.390
AUG	1986	1.320	18.150	1.029	10.707	.610	7.460
SEP	1986	1.420	20.910	.889	15.992	.340	7.460
OCT	1986	2.440	29.720	1.415	23.606	.870	16.270
NOV	1986	2.750	30.620	1.411	21.909	.800	12.480
DEC	1986	2.130	44.400	1.553	30.672	.800	16.240
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
7 MONTHS		1.869	25.830	1.244	18.748	.707	11.440
LAST 3 MONTHS ONLY		2.440	34.913	1.460	25.396	.823	14.997

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WYSE GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1986	1.440	26.040	.986	21.673	.680	17.870
FEB	1986	1.440	21.150	.692	12.556	.210	8.420
MAR	1986	1.060	21.150	.745	14.131	.310	5.690
APR	1986	2.660	24.290	1.437	15.964	.660	6.110
MAY	1986	1.590	359.500	.952	197.468	.620	10.850
JUN	1986	1.640	77.040	.916	28.279	.450	8.950
JUL	1986	1.930	17.230	1.209	13.468	.610	9.720
AUG	1986	2.720	19.960	1.842	16.919	1.400	14.940
SEP	1986	2.560	22.280	1.410	18.252	.810	13.790
OCT	1986	1.660	39.590	1.437	30.695	.810	18.620
NOV	1986	2.670	39.320	1.938	25.593	.880	14.000
DEC	1986	2.620	37.580	1.750	25.141	.860	17.840

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.004	53.761	1.276	35.012	.693	12.250
LAST 3 MONTHS ONLY	2.323	38.830	1.708	27.143	.857	16.687

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 01

SITE CODE	BEGIN MO	BEGIN YR	END MO	END YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
GS2	01	86	12	86	12	2.033	63.101	1.085	35.284	.511	10.290
JACO	01	86	12	86	12	1.151	39.392	.748	24.442	.395	8.633
SCR	01	86	12	86	12	1.693	51.677	1.233	33.565	.527	13.892
ST64	01	86	12	86	12	1.867	47.783	1.169	32.712	.702	14.375
ST65	01	86	12	86	12	1.747	45.496	1.010	25.328	.497	8.487
SVIC	01	86	12	86	12	1.409	46.961	.936	30.479	.507	10.697
TOB	01	86	12	86	12	1.753	44.394	.908	27.522	.445	9.932
TPI	01	86	12	86	12	1.546	48.569	.963	29.721	.578	10.100
TPR	01	86	12	86	12	1.516	90.996	.851	29.908	.445	9.137
WYN	01	86	12	86	12	1.346	49.467	.833	29.462	.451	9.032
WYS	01	86	12	86	7	1.869	25.830	1.244	18.748	.707	11.440
WYSE	01	86	12	86	12	2.004	58.761	1.276	35.012	.693	12.250
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:											
12 MONTHS						1.665	52.702	1.023	29.350	.536	10.689
LAST 3 MONTHS ONLY						2.053	38.622	1.345	26.935	.740	15.460

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FOE   GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	1.390	26.750	1.143	23.054	1.000	19.160
FEB	1986	1.020	27.550	.843	12.077	.740	.760
MAR	1986	.900	27.550	.714	14.516	.490	4.570
APR	1986	2.230	21.440	1.340	15.237	.400	9.520
MAY	1986	1.420	369.500	1.067	168.177	.820	14.380
JUN	1986	1.890	74.350	.875	26.092	.330	10.370
JUL	1986	1.850	15.580	1.311	11.461	.660	8.700
AUG	1986	1.710	18.940	1.139	16.013	.790	13.660
SEP	1986	1.710	19.270	1.194	16.507	.950	12.840
OCT	1986	2.050	42.820	1.453	32.496	.950	16.800
NOV	1986	2.360	37.290	1.552	26.395	1.080	15.990
DEC	1986	3.240	44.900	1.863	33.046	1.100	20.840
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.816	60.495	1.209	34.569	.777	12.299
LAST 3 MONTHS ONLY		2.557	41.670	1.629	30.646	1.043	17.877

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FON   GROUP I.D. C2

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1986	1.340	50.320	.992	30.518	.730	18.220
FEB	1986	1.390	18.980	.841	13.037	.320	8.050
MAR	1986	1.030	24.190	.812	16.815	.370	4.260
APR	1986	3.540	20.040	1.402	13.543	.500	10.980
MAY	1986	1.690	315.900	.991	187.736	.560	11.870
JUN	1986	1.850	89.120	1.214	39.552	.430	12.010
JUL	1986	2.600	20.960	1.575	14.774	.610	9.940
AUG	1986	2.180	21.410	1.329	19.237	.880	16.400
SEP	1986	2.070	29.990	1.509	22.314	1.110	17.680
OCT	1986	2.820	63.860	2.334	50.245	1.790	23.110
NOV	1986	2.650	60.370	2.231	39.691	1.860	23.040
DEC	1986	3.700	72.580	2.750	47.521	1.270	32.390
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.238	65.643	1.498	41.249	.871	15.662
LAST 3 MONTHS ONLY		3.057	65.603	2.438	45.819	1.640	26.180

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FONW   GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1986	.960	23.670	.806	19.594	.490	13.790
FEB	1986	.960	13.790	.668	10.391	.560	8.440
MAR	1986	1.050	14.910	.839	11.788	.460	6.020
APR	1986	1.460	19.390	1.083	13.020	.630	9.400
MAY	1986	1.040	362.800	.974	168.875	.870	11.810
JUN	1986	1.530	79.930	.531	24.327	.300	11.530
JUL	1986	1.640	14.100	1.336	12.327	.570	9.880
AUG	1986	1.590	13.990	.864	12.444	.580	11.270
SEP	1986	1.420	18.730	.976	14.411	.610	8.930
OCT	1986	2.270	35.400	1.537	27.658	.670	16.610
NOV	1986	1.630	30.830	1.109	24.011	.670	12.300
DEC	1986	2.220	32.120	1.623	23.866	.820	19.710

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.484	54.972	1.029	30.226	.602	11.641
LAST 3 MONTHS ONLY	2.040	32.783	1.423	25.178	.720	16.207

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FOS GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1986	2.010	28.330	1.500	26.406	1.120	22.760
FEB	1986	1.630	22.980	1.164	16.747	.750	13.340
MAR	1986	1.360	22.980	.834	15.716	.520	6.920
APR	1986	2.790	27.110	1.732	18.877	.620	11.260
MAY	1986	2.440	335.600	1.149	174.897	.420	11.260
JUN	1986	2.570	76.270	1.139	33.734	.420	12.960
JUL	1986	2.060	20.540	1.244	14.365	.810	10.870
AUG	1986	2.060	20.540	1.232	16.531	.560	14.580
SEP	1986	2.030	23.650	1.507	16.593	1.100	12.000
OCT	1986	3.350	46.350	2.042	33.533	1.100	19.140
NOV	1986	2.610	39.060	1.830	28.922	.830	14.970
DEC	1986	2.600	25.490	2.243	21.773	1.660	16.480
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.292	57.408	1.468	34.841	.627	13.878
LAST 3 MONTHS ONLY		2.853	36.967	2.038	28.076	1.203	16.863

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOSW   GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	1.730	35.850	1.229	26.544	.730	14.930
FEB	1986	.990	14.930	.688	10.238	.360	8.230
MAR	1986	.890	21.960	.695	11.137	.360	2.660
APR	1986	2.440	21.980	1.359	16.264	.390	11.480
MAY	1986	1.050	266.000	.743	151.329	.290	11.480
JUN	1986	1.580	69.830	.767	23.933	.280	10.160
JUL	1986	2.060	16.030	1.363	13.402	.650	9.780
AUG	1986	1.590	15.810	.977	14.314	.460	12.070
SEP	1986	1.690	19.970	1.429	17.012	1.050	14.230
OCT	1986	4.660	39.700	2.461	31.416	1.430	18.390
NOV	1986	2.450	35.180	1.395	26.027	.520	13.680
DEC	1986	2.610	43.160	1.922	32.699	1.100	22.540

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.960	50.035	1.254	31.193	.637	12.471
LAST 3 MONTHS ONLY	3.240	39.347	1.926	30.047	1.017	18.203

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 02

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FOE	01 86	12 86	12	1.816	60.495	1.209	34.569	.777	12.299
FON	01 86	12 86	12	2.238	65.643	1.498	41.249	.871	15.662
FONW	01 86	12 86	12	1.484	54.972	1.029	30.226	.602	11.641
FOS	01 86	12 86	12	2.292	57.408	1.468	34.841	.827	13.878
FOSW	01 86	12 86	12	1.980	50.035	1.254	31.193	.637	12.471

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	1.962	57.711	1.292	34.420	.743	13.190
LAST 3 MONTHS ONLY	2.749	43.274	1.891	31.953	1.125	19.066

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

ENVIRONMENTAL AIR SAMPLE RESULTS

1985

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: GS2   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	2.720	34.310	1.278	20.854	.460	11.340
FEB	1985	2.090	26.250	1.341	18.013	.460	11.340
MAR	1985	.870	21.660	.664	14.172	.440	6.470
APR	1985	1.070	18.520	.784	14.010	.340	6.060
MAY	1985	2.760	42.150	1.306	18.465	.520	7.630
JUN	1985	.930	16.080	.686	13.834	.310	7.560
JUL	1985	3.200	31.780	1.673	21.959	.210	13.420
AUG	1985	1.600	22.430	1.039	15.846	.670	12.680
SEP	1985	1.420	51.190	.945	17.435	.420	9.060
OCT	1985	4.870	51.190	1.900	27.886	.720	15.770
NOV	1985	.900	37.120	.721	16.323	.360	7.000
DEC	1985	2.550	30.180	1.301	23.049	.360	7.000

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.083	31.905	1.136	18.467	.439	9.611
LAST 3 MONTHS ONLY	2.773	39.497	1.307	22.419	.480	9.923

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: JACO   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1985	2.490	27.260	1.074	16.317	.230	8.880
FEB	1985	1.130	17,750	.662	13.052	.230	8.880
MAR	1985	1.040	18.220	.635	12.508	.330	6.100
APR	1985	.970	14.870	.533	10.934	.220	6.200
MAY	1985	.950	15.040	.698	9.020	.470	4.310
JUN	1985	1.010	16.680	.754	14.133	.430	9.060
JUL	1985	4.910	25.570	1.849	14.187	.770	.790
AUG	1985	1.790	18.320	.951	13.924	.380	9.670
SEP	1985	7.660	29.930	1.267	13.635	.840	6.170
OCT	1985	7.660	47.240	2.187	21.130	.270	13.630
NOV	1985	.960	47.240	.745	17.681	.220	5.050
DEC	1985	1.730	21.280	1.037	16.426	.220	5.050

SITE AVERAGE: AVERAGE OF SITE DATA FOR:	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	2.692	24.950	1.033	14.412	.364	6.982
LAST 3 MONTHS ONLY	3.450	38.587	1.323	18.412	.237	7.910

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: SCR GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	1.800	33.400	1.170	20.372	.540	12.260
FEB	1985	.860	20.610	.696	17.422	.540	12.260
MAR	1985	.850	20.630	.630	14.995	.400	7.820
APR	1985	1.040	17.890	.648	12.547	.180	6.490
MAY	1985	1.950	30.130	.943	15.683	.420	7.950
JUN	1985	1.430	19.470	1.069	17.047	.690	9.760
JUL	1985	2.460	31.020	1.260	20.781	.210	11.810
AUG	1985	1.230	20.850	.776	15.891	.460	12.270
SEP	1985	1.610	39.730	.962	18.301	.860	11.120
OCT	1985	1.770	42.930	1.407	27.873	1.090	19.550
NOV	1985	1.500	42.930	1.048	21.967	.680	10.030
DEC	1985	2.440	38.460	1.324	24.859	.710	10.030

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.578	29.837	.994	18.978	.565	10.946
LAST 3 MONTHS ONLY	1.903	41.440	1.260	24.900	.827	13.203

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: ST64   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
FEB	1985	.860	19.070	.675	16.096	.510	10.300
MAR	1985	.800	18.960	.673	13.454	.440	7.040
APR	1985	.970	14.720	.766	11.345	.440	5.720
MAY	1985	1.470	31.690	.808	19.913	.550	7.850
JUN	1985	1.360	17.790	.753	12.244	.530	7.820
JUL	1985	4.890	45.640	1.850	21.036	.500	11.180
AUG	1985	1.260	21.760	.951	15.920	.500	11.180
SEP	1985	.960	31.230	.618	15.893	.280	11.990
OCT	1985	2.650	31.230	1.288	23.457	.690	19.050
NOV	1985	2.650	38.160	1.156	23.063	.430	8.570
DEC	1985	3.610	51.160	1.510	24.852	.430	8.570
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
11 MONTHS		1.960	29.221	1.004	17.936	.462	9.934
LAST 3 MONTHS ONLY		2.970	40.183	1.318	23.797	.517	12.063

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: ST65   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	1.970	27.190	.955	18.646	.400	9.050
FEB	1985	2.360	49.520	1.030	23.315	.380	8.820
MAR	1985	1.160	27.140	.871	15.035	.390	7.220
APR	1985	.940	18.360	.843	11.680	.660	4.360
MAY	1985	.920	13.100	.673	10.193	.280	6.570
JUN	1985	2.270	16.410	1.253	11.436	.400	6.570
JUL	1985	2.610	31.320	1.423	19.257	.870	13.070
AUG	1985	2.610	31.320	1.091	15.004	.510	10.170
SEP	1985	2.320	26.200	1.057	9.130	.510	1.500
OCT	1985	1.830	33.060	1.073	22.843	.560	17.910
NOV	1985	1.110	33.060	.561	10.332	.350	5.260
DEC	1985	2.060	35.450	.986	17.817	.090	5.260
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.848	28.511	.985	15.391	.452	7.982
LAST 3 MONTHS ONLY		1.673	33.857	.873	16.997	.333	9.477

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: SVIC   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1985	2.890	34.030	1.310	21.847	.700	10.730
FEB	1985	.950	21.220	.566	15.821	.420	10.730
MAR	1985	.920	20.190	.604	13.439	.270	7.470
APR	1985	1.150	16.230	.817	13.196	.270	7.470
MAY	1985	.740	15.180	.549	11.349	.300	7.020
JUN	1985	1.120	15.850	.846	12.739	.400	7.020
JUL	1985	2.160	19.580	1.273	16.392	.210	12.880
AUG	1985	1.510	21.490	1.015	15.305	.640	12.540
SEP	1985	1.210	31.220	.646	15.036	.370	10.33[illegible]
OCT	1985	1.570	31.220	1.261	23.315	.670	17.580
NOV	1985	1.180	28.330	.827	15.325	.670	5.450
DEC	1985	4.290	69.020	1.990	32.847	.730	5.450
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.641	26.963	.985	17.216	.471	9.556
LAST 3 MONTHS ONLY		2.347	42.857	1.359	23.829	.690	9.493

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: TOB GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1985	2.250	36.480	1.039	22.607	.480	10.730
FEB	1985	1.250	23.720	.975	18.675	.480	10.730
MAR	1985	1.150	21.610	.675	15.360	.480	8.060
APR	1985	1.310	19.480	1.000	13.950	.590	4.530
MAY	1985	1.240	21.900	.845	12.971	.540	7.430
JUN	1985	1.470	15.520	.909	12.409	.350	7.440
JUL	1985	1.530	21.350	.891	12.422	.390	.850
AUG	1985	1.670	13.930	.930	11.642	.360	8.340
SEP	1985	2.690	27.990	1.199	14.242	.500	9.460
OCT	1985	1.200	34.100	.793	21.218	.390	15.020
NOV	1985	1.100	34.100	.887	15.096	.630	5.910
DEC	1985	1.510	24.770	1.150	17.580	.500	5.910

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.531	24.579	.941	15.681	.474	7.867
LAST 3 MONTHS ONLY	1.270	30.990	.943	17.965	.507	8.947

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: TPI GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	2.540	20.360	1.010	16.443	.520	8.340
FEB	1985	1.140	19.560	.681	13.959	.360	8.340
MAR	1985	1.220	19.320	.761	13.064	.580	7.220
APR	1985	1.030	16.520	.724	11.805	.460	6.940
MAY	1985	1.040	16.860	.696	11.501	.450	7.040
JUN	1985	1.190	16.800	.747	13.703	.540	7.040
JUL	1985	2.000	19.660	1.280	12.367	.400	.750
AUG	1985	.960	18.530	.728	13.838	.550	8.510
SEP	1985	1.250	29.410	.537	10.253	.300	1.990
OCT	1985	1.560	30.950	1.231	22.330	.660	16.550
NOV	1985	1.560	30.950	.986	15.704	.620	10.530
DEC	1985	1.590	50.440	.900	27.503	.230	10.530
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.425	24.113	.857	15.206	.472	7.815
LAST 3 MONTHS ONLY		1.570	37.447	1.039	21.846	.503	12.537

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: TPR GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	1.600	25.000	.793	15.748	.320	9.600
FEB	1985	.910	16.990	.699	13.633	.510	9.600
MAR	1985	.910	16.990	.614	12.079	.360	6.300
APR	1985	1.170	14.780	.766	11.513	.440	7.210
MAY	1985	.870	11.960	.760	9.644	.660	6.860
JUN	1985	1.050	13.560	.682	11.587	.290	6.860
JUL	1985	1.660	24.180	.926	17.654	.250	10.030
AUG	1985	1.420	20.890	.847	14.774	.480	10.030
SEP	1985	.940	23.600	.553	11.304	.520	8.350
OCT	1985	1.330	25.580	.705	17.278	.510	12.200
NOV	1985	1.330	25.980	.620	12.828	.380	5.520
DEC	1985	2.390	19.810	1.233	14.698	.240	5.520

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	1.303	19.943	.775	13.562	.413	8.173
LAST 3 MONTHS ONLY	1.683	23.790	.853	14.935	.377	7.747

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WYN GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1985	2.420	31.240	1.302	17.355	.530	6.650
FEB	1985	.970	18.540	.687	13.645	.320	7.650
MAR	1985	1.270	17.450	.630	11.418	.300	6.720
APR	1985	1.770	21.300	1.114	15.624	.370	8.120
MAY	1985	.560	15.490	.474	9.854	.370	4.860
JUN	1985	1.110	17.260	.698	13.364	.340	6.540
JUL	1985	1.480	20.530	.889	13.671	.290	.940
AUG	1985	1.260	31.590	.806	17.579	.360	11.260
SEP	1985	1.030	31.590	.616	15.072	.430	8.860
OCT	1985	1.510	44.640	.944	21.723	.550	14.400
NOV	1985	1.510	44.640	1.066	17.829	.560	6.130
DEC	1985	1.650	22.880	1.221	18.835	.440	6.130
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		1.380	26.432	.871	15.497	.405	7.355
LAST 3 MONTHS ONLY		1.557	37.387	1.077	19.462	.517	8.887

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WYS GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1965	3.320	32.880	1.463	19.408	.300	8.200
FEB	1985	1.710	22.680	1.050	15.948	.300	8.200
SEP	1935	1.100	34.570	.886	-32.398	.450	10.830
OCT	1985	1.060	28.930	.865	20.065	.540	16.390
NOV	1985	1.010	28.930	.774	16.742	.590	13.290
DEC	1985	2.390	33.800	1.545	22.951	.390	9.040
SITE AVERAGE: AVERAGE OF SITE DATA FOR: 6 MONTHS		1.768	30.298	1.097	10.453	.428	10.992
LAST 3 MONTHS ONLY		1.493	30.553	1.061	19.919	.507	12.907

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WYSE   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	1.870	34.490	1.042	22.803	.590	13.920
FEB	1985	1.460	23.700	.984	19.067	.570	15.700
MAR	1985	.700	24.780	.605	16.083	.480	6.480
APR	1985	1.230	17.920	.793	12.261	.540	5.060
MAY	1985	3.540	20.860	1.196	15.604	.410	11.060
JUN	1985	3.540	18.970	1.325	15.425	.520	10.750
JUL	1985	1.920	25.860	1.293	19.438	.200	14.500
AUG	1985	1.040	21.290	.735	16.923	.540	14.500
SEP	1985	4.540	29.600	1.949	17.709	.500	11.750
OCT	1985	2.860	35.820	1.639	25.214	.980	21.270
NOV	1985	1.900	48.270	1.334	20.204	.910	.860
DEC	1985	3.160	38.500	2.024	24.905	.800	5.800

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	2.315	28.340	1.243	18.803	.587	10.971
LAST 3 MONTHS ONLY	2.640	40.863	1.666	23.441	.897	9.310

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 01

SITE CODE	BEGIN MO	BEGIN YR	END MO	END YR	# MO	AVERAGE HIGHEST VALUE ALPHA	AVERAGE HIGHEST VALUE ** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	AVERAGE WEIGHTED AVERAGE ** BETA	AVERAGE LOWEST VALUE ALPHA	AVERAGE LOWEST VALUE ** BETA
GS2	01	85	12	85	12	2.063	31.905	1.136	18.487	.439	9.611
JACO	01	85	12	85	12	2.692	24.950	1.033	14.412	.384	6.982
SCR	01	85	12	85	12	1.578	29.837	.994	18.978	.565	10.946
ST54	02	85	12	85	11	1.960	29.221	1.004	17.936	.482	9.934
ST65	01	85	12	85	12	1.848	28.511	.985	15.391	.452	7.982
SVIC	01	85	12	85	12	1.641	26.963	.985	17.218	.471	9.556
TOB	01	85	12	85	12	1.531	24.579	.941	15.681	.474	7.867
TPI	01	85	12	85	12	1.425	24.113	.857	15.206	.472	7.815
TPR	01	85	12	85	12	1.303	19.943	.775	13.562	.413	8.173
WYN	01	85	12	85	12	1.380	26.432	.871	15.497	.405	7.355
WYS	01	85	12	85	6	1.768	30.298	1.097	10.453	.428	10.992
WYSE	01	85	12	85	12	2.315	28.340	1.243	18.803	.587	10.971

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
12 MONTHS	1.794	27.091	.993	15.969	.464	9.015
LAST 3 MONTHS ONLY	2.111	36.454	1.173	20.660	.532	10.200

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOE GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1985	1.560	34.960	1.122	21.982	.720	8.410
FEB	1985	1.690	20.540	1.186	17.798	.720	12.010
MAR	1985	1.290	23.640	.934	17.416	.710	10.330
APR	1985	1.280	16.250	1.001	14.517	.550	10.330
MAY	1985	1.350	17.720	1.047	14.306	.580	11.530
JUN	1985	1.640	15.380	1.455	13.863	1.150	10.640
JUL	1985	3.790	48.680	1.338	26.321	.200	12.850
AUG	1985	1.200	24.600	.940	17.146	.680	12.750
SEP	1985	1.240	29.880	1.018	16.485	.840	13.170
OCT	1985	2.590	35.720	1.315	25.457	.710	19.310
NOV	1985	8.670	35.720	2.716	15.745	.280	8.900
DEC	1985	2.020	34.410	1.411	25.964	.550	8.900

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.362	28.125	1.290	18.917	.641	11.594
LAST 3 MONTHS ONLY	4.427	35.283	1.814	22.389	.513	12.370

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FON GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	3.000	29.010	1.004	18.453	.740	11.610
FEB	1985	1.070	19.600	.742	14.339	.410	11.460
MAR	1985	.770	19.200	.519	12.053	.320	5.580
APR	1985	1.360	14.700	.936	12.674	.430	5.580
MAY	1985	1.250	14.150	.795	9.192	.360	5.160
JUN	1985	1.740	17.700	.994	12.850	.460	8.410
JUL	1985	2.620	27.500	1.463	17.426	.270	.880
AUG	1985	.950	22.540	.703	15.649	.290	11.550
SEP	1985	2.250	38.720	1.083	17.325	.680	10.830
OCT	1985	2.810	77.970	2.060	33.805	1.490	21.350
NOV	1985	2.040	77.970	1.463	25.631	.750	9.250
DEC	1985	3.030	50.320	1.720	27.428	.550	9.250

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	1.907	34.115	1.123	18.069	.562	9.242
LAST 3 MONTHS ONLY	2.627	68.753	1.748	28.955	.930	13.283

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FONW   GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA **	BETA	WEIGHTED AVERAGE ALPHA **	BETA	LOWEST VALUE ALPHA **	BETA
JAN	1985	.950	24.680	.758	16.762	.360	7.870
FEB	1985	1.300	20.700	1.044	17.334	.600	13.710
MAR	1985	1.300	25.190	.824	15.638	.460	8.480
APR	1985	1.220	19.110	1.131	12.664	.480	6.200
MAY	1985	1.390	18.620	.980	14.425	.530	10.720
JUN	1985	2.110	20.390	1.265	14.897	.500	11.640
JUL	1985	2.200	29.750	1.318	14.964	.240	.740
AUG	1985	1.060	19.910	.943	15.642	.810	12.330
SEP	1985	17.200	123.400	4.928	43.106	.410	9.520
OCT	1985	1.400	48.560	1.085	28.838	.720	17.760
NOV	1985	1.510	31.490	1.146	20.312	.880	9.220
DEC	1985	2.080	32.190	1.375	22.925	.490	9.220

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.817	34.501	1.400	19.794	.543	9.764
LAST 3 MONTHS ONLY	1.663	37.420	1.202	24.025	.697	12.067

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOS   GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	2.120	34.710	1.199	21.747	.740	9.900
FEB	1985	1.620	22.780	1.266	18.702	.740	11.000
MAR	1985	1.290	28.400	.959	18.195	.730	9.660
APR	1985	2.190	23.080	1.531	17.219	.930	10.600
MAY	1985	3.300	21.750	1.394	16.491	.770	10.560
JUN	1985	3.970	18.790	2.217	14.889	.670	10.560
JUL	1985	9.810	45.760	2.901	21.278	.780	7.650
AUG	1985	2.190	23.430	1.533	19.130	.960	15.060
SEP	1985	2.200	34.880	1.248	19.201	.790	12.360
OCT	1985	2.870	42.270	2.005	33.327	1.070	26.970
NOV	1985	2.510	25.150	1.937	19.227	.990	11.480
DEC	1985	2.790	37.890	2.164	31.792	1.120	11.480

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	3.072	29.907	1.696	20.933	.857	12.273
LAST 3 MONTHS ONLY	2.723	35.103	2.035	28.115	1.060	16.643

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOSW GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1985	2.870	35.690	1.172	22.418	.760	14.380
FEB	1985	1.620	64.810	1.322	31.856	.940	14.380
MAR	1985	1.150	31.960	.888	20.146	.680	10.600
APR	1985	1.560	20.210	1.013	14.486	.610	6.130
MAY	1985	.960	18.390	.810	13.883	.670	10.310
JUN	1985	1.750	16.990	1.174	13.936	.720	10.740
JUL	1985	3.660	22.610	1.448	14.986	.560	3.640
AUG	1985	1.050	16.560	.702	14.574	.450	12.550
SEP	1985	1.000	24.680	.651	12.103	.260	8.120
OCT	1985	3.500	33.540	1.785	24.283	.930	11.700
NOV	1985	2.010	31.160	1.468	19.958	1.140	13.340
DEC	1985	1.910	35.850	1.314	23.103	.710	13.340

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	1.925	29.372	1.146	18.811	.702	10.769
LAST 3 MONTHS ONLY	2.473	33.523	1.522	22.448	.927	12.793

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 02

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FOE	01 85	12 85	12	2.362	28.125	1.790	18.917	.641	11.594
FON	01 85	12 85	12	1.907	34.115	1.123	18.069	.562	9.242
FONW	01 85	12 85	12	2.817	34.501	1.400	19.794	.543	9.784
FOS	01 85	12 85	12	3.072	29.907	1.696	20.933	.857	12.273
FOSW	01 85	12 85	12	1.925	29.372	1.146	18.811	.702	10.769

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	2.416	31.204	1.331	19.305	.661	10.733
LAST 3 MONTHS ONLY	2.783	42.017	1.664	25.186	.825	13.431

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

ENVIRONMENTAL AIR SAMPLE RESULTS

1984

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: GS2   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	2.810	25.130	2.354	20.489	.900	10.740
FEB	1984	2.190	30.720	1.708	17.501	1.260	9.050
MAR	1984	2.010	12.310	1.352	7.875	.970	5.180
APR	1984	2.650	9.120	1.252	6.862	.670	4.760
MAY	1984	2.560	9.500	1.606	7.904	.930	4.760
JUN	1984	2.560	10.060	1.409	7.920	.780	6.240
JUL	1984	2.050	9.750	1.221	7.947	.770	6.410
AUG	1984	1.310	16.500	1.038	10.121	.770	5.980
SEP	1984	2.410	18.120	1.650	13.551	1.060	5.980
OCT	1984	2.420	24.530	2.064	16.521	1.230	10.630
NOV	1984	5.560	16.800	2.866	13.061	1.720	8.010
DEC	1984	2.190	18.620	1.732	13.377	1.000	6.770

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.563	16.763	1.689	11.927	1.005	7.042
LAST 3 MONTHS ONLY	3.390	19.983	2.227	14.320	1.317	8.470

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: JACO   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	2.550	20.070	1.922	17.518	.500	7.910
FEB	1984	1.760	18.950	1.593	12.826	1.290	7.780
MAR	1984	1.960	17.950	1.303	9.863	.810	6.010
APR	1984	1.120	8.490	.851	7.386	.690	4.790
MAY	1984	1.540	8.610	1.216	7.481	.920	4.920
JUN	1984	1.520	9.110	.996	6.993	.710	5.330
JUL	1984	1.560	13.140	1.469	9.665	1.200	6.330
AUG	1984	1.500	15.140	1.005	11.006	.520	7.260
SEP	1984	2.600	17.760	1.915	14.009	1.410	9.290
OCT	1984	3.840	18.020	2.449	14.905	1.560	11.860
NOV	1984	7.760	16.200	3.103	12.221	1.280	6.310
DEC	1984	2.580	12.950	1.832	10.147	1.370	7.750

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.524	14.699	1.638	11.168	1.022	7.128
LAST 3 MONTHS ONLY	4.727	15.723	2.461	12.424	1.403	8.640

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: SCR   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA **	BETA	WEIGHTED AVERAGE ALPHA **	BETA	LOWEST VALUE ALPHA **	BETA
JAN	1984	2.590	22.520	2.066	19.249	1.090	8.490
FEB	1984	2.560	22.820	1.861	17.489	.870	11.160
MAR	1984	3.140	21.030	1.956	13.369	1.270	6.540
APR	1984	1.800	10.040	1.335	7.930	.780	4.390
MAY	1984	2.100	10.040	1.362	8.211	1.040	4.390
JUN	1984	2.100	9.980	1.109	7.442	.710	4.400
JUL	1984	1.920	11.180	1.554	9.391	.710	7.650
AUG	1984	2.290	14.260	1.520	10.225	.920	6.860
SEP	1984	2.450	18.340	1.833	12.780	.920	6.860
OCT	1984	2.990	20.620	2.044	15.944	1.450	13.990
NOV	1984	2.990	20.620	1.497	12.158	.870	8.150
DEC	1984	1.920	19.710	1.487	13.492	.860	6.210
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.404	16.763	1.635	12.307	.957	7.424
LAST 3 MONTHS ONLY		2.633	20.317	1.676	13.865	1.060	9.450

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: ST64 GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	2.330	19.790	1.601	16.379	.960	10.160
FEB	1984	1.950	19.970	1.473	15.655	.810	9.470
MAR	1984	2.170	19.830	1.628	12.532	1.090	5.670
APR	1984	2.260	9.590	1.305	7.920	.800	5.490
MAY	1984	2.760	10.640	1.652	9.178	1.120	5.490
JUN	1984	1.700	10.650	1.176	8.200	.750	5.480
JUL	1984	2.320	13.180	1.829	10.961	.750	7.910
AUG	1984	2.060	13.630	1.294	10.270	.810	7.360
SEP	1984	2.260	18.520	1.658	14.267	1.250	8.400
OCT	1984	2.910	18.520	2.417	16.039	1.610	11.430
NOV	1984	2.030	17.290	1.663	12.497	1.170	6.620
DEC	1984	1.770	14.730	1.398	11.535	1.080	6.680
DEC	1984	1.770	14.730	1.383	11.560	1.080	6.680

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
13 MONTHS	2.178	15.467	1.575	12.076	1.022	7.451
LAST 3 MONTHS ONLY	1.857	15.583	1.481	11.864	1.110	6.660

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 84

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
GS2	01 84	12 84	12	2.563	16.763	1.689	11.927	1.005	7.042
JACO	01 84	12 84	12	2.524	14.699	1.638	11.168	1.022	7.128
SCR	01 84	12 84	12	2.404	16.763	1.635	12.307	.957	7.424
ST54	01 84	12 84	13	2.178	15.467	1.575	12.076	1.022	7.451
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
13 MONTHS				2.417	15.923	1.634	11.870	1.001	7.261
LAST 3 MONTHS ONLY				3.152	17.902	1.961	13.118	1.222	8.305

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: ST65   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	2.100	20.790	1.837	18.161	1.240	8.770
FEB	1984	3.560	18.980	1.440	14.616	1.030	8.300
MAR	1984	3.580	18.980	1.716	10.797	.980	4.860
APR	1984	1.690	8.890	.927	5.857	.080	1.690
MAY	1984	2.800	10.770	1.919	8.995	1.690	7.020
JUN	1984	2.800	10.770	1.122	7.576	.850	5.380
JUL	1984	1.630	11.960	1.258	8.990	.800	7.030
AUG	1984	4.090	14.160	1.747	10.501	.300	8.920
SEP	1984	3.060	17.300	2.076	14.595	.910	9.590
OCT	1984	3.160	17.400	2.206	13.057	1.350	7.590
NOV	1984	2.220	14.970	1.729	10.198	1.130	4.850
DEC	1984	4.740	16.270	2.678	12.470	1.010	9.510
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.954	15.103	1.721	11.318	.947	6.959
LAST 3 MONTHS ONLY		3.373	16.213	2.204	11.908	1.163	7.317

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: SVIC   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	2.610	23.200	1.815	18.973	.720	8.850
FEB	1984	2.140	23.200	1.795	16.054	1.550	9.740
MAR	1984	1.690	19.810	1.433	12.761	1.250	7.810
APR	1984	2.140	10.230	1.641	9.012	1.170	6.610
MAY	1984	3.930	10.260	2.198	8.568	1.140	6.610
JUN	1984	2.700	8.640	1.523	7.956	1.000	6.560
JUL	1984	2.000	10.000	1.201	8.735	.860	6.560
AUG	1984	2.000	14.480	1.151	9.771	.750	5.260
SEP	1984	4.070	18.510	2.472	13.841	.750	6.520
OCT	1984	3.760	22.740	2.232	16.058	.920	10.370
NOV	1984	2.660	15.790	1.673	11.439	1.000	7.000
DEC	1984	1.870	13.620	1.329	10.911	.700	8.630

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.632	15.873	1.705	12.007	.984	7.543
LAST 3 MONTHS ONLY	2.770	17.383	1.745	12.803	.873	8.667

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TOB GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1984	3.250	21.100	2.548	19.135	1.680	10.710
FEB	1984	2.040	18.560	1.904	13.772	1.790	8.570
MAR	1984	2.150	20.500	1.439	11.202	.860	5.460
APR	1984	2.070	9.920	1.727	7.758	.940	4.660
MAY	1984	6.900	11.130	1.688	8.078	.940	4.660
JUN	1984	6.900	11.140	1.478	7.475	.710	4.630
JUL	1984	1.440	12.120	1.140	9.893	.760	7.390
AUG	1984	1.280	14.860	1.030	10.053	.850	8.130
SEP	1984	4.890	22.550	3.092	17.404	.940	8.130
OCT	1984	4.340	23.650	1.931	16.010	.000	.000
NOV	1984	5.830	23.650	3.596	14.652	1.750	10.720
DEC	1984	4.810	20.430	2.200	15.436	1.420	7.300

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	3.825	17.472	1.981	12.572	1.053	6.697
LAST 3 MONTHS ONLY	4.993	22.577	2.576	15.366	1.057	6.007

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: TPI GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	1.740	22.560	1.570	19.319	1.290	14.770
FEB	1984	2.800	21.810	1.970	15.895	1.630	9.090
MAR	1984	2.800	18.610	1.745	12.112	.850	6.420
APR	1984	2.540	10.560	1.588	8.417	.850	5.790
MAY	1984	10.460	11.130	2.431	9.275	.880	5.790
JUN	1984	10.460	14.440	2.338	8.771	.890	5.520
JUL	1984	1.250	11.460	.969	9.879	.840	8.190
AUG	1984	1.170	16.140	1.063	11.599	.920	8.300
SEP	1984	3.910	18.970	2.325	14.619	1.170	9.300
OCT	1984	3.480	18.970	2.086	14.534	1.230	9.140
NOV	1984	3.480	17.150	1.841	12.368	.880	6.930
DEC	1984	3.640	17.150	1.879	12.132	.820	7.410
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		3.977	16.581	1.819	12.410	1.021	8.054
LAST 3 MONTHS ONLY		3.533	17.757	1.935	13.011	.977	7.827

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: TPR   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA **	BETA	WEIGHTED AVERAGE ALPHA **	BETA	LOWEST VALUE ALPHA **	BETA
JAN	1984	3.020	20.060	1.704	15.566	.790	8.900
FEB	1984	1.600	20.060	1.366	12.824	1.000	7.380
MAR	1984	3.760	17.220	1.671	10.401	.840	6.320
APR	1984	1.730	8.500	1.417	7.269	.840	4.220
MAY	1984	2.090	8.860	1.290	7.728	.840	4.220
JUN	1984	2.090	10.350	1.315	7.408	.810	5.000
JUL	1984	1.160	10.180	1.025	8.765	.880	6.610
AUG	1984	2.270	14.280	1.496	9.997	.800	6.880
SEP	1984	1.960	18.300	1.666	12.974	.880	6.880
OCT	1984	2.560	18.300	1.780	13.456	1.340	10.180
NOV	1984	2.560	13.290	1.530	8.555	1.030	6.330
DEC	1984	2.830	14.080	1.765	10.482	.930	4.880

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.304	14.457	1.504	10.452	.915	6.483
LAST 3 MONTHS ONLY	2.650	15.223	1.692	10.831	1.100	7.130

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: WYN GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1984	1.990	23.350	1.722	20.329	1.360	18.760
FEB	1984	3.200	21.030	1.748	15.935	.940	10.480
APR	1984	1.170	6.100	.908	4.831	.710	2.880
MAY	1984	2.020	19.160	1.291	11.000	.710	3.280
MAY	1984	1.220	6.860	.846	5.301	.500	2.860
JUN	1984	1.420	8.530	1.128	6.288	.920	3.580
JUL	1984	1.790	11.370	1.323	9.241	.960	6.630
AUG	1984	1.790	17.820	1.325	12.056	.860	7.580
SEP	1984	3.610	22.300	2.655	15.072	1.270	8.130
OCT	1984	7.660	30.160	2.356	18.555	.810	10.190
NOV	1984	7.660	29.990	4.427	14.028	2.250	7.290
DEC	1984	4.390	13.370	2.224	8.991	.970	6.650
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		3.160	17.503	1.829	11.802	1.023	7.362
LAST 3 MONTHS ONLY		6.570	24.507	3.002	13.858	1.343	8.043

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: WYS   GROUP I.D. 01

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	2.590	23.640	1.675	20.306	1.200	10.050
FEB	1984	2.590	22.660	1.567	15.955	.790	7.680
MAR	1984	1.930	20.970	1.150	11.696	.780	5.900
APR	1984	2.310	9.500	1.691	7.944	.850	5.130
MAY	1984	3.550	8.940	2.317	7.862	1.780	5.260
JUN	1984	3.550	10.290	1.715	8.004	.820	5.760
JUL	1984	2.140	10.850	1.542	8.651	1.010	7.070
AUG	1984	2.050	17.910	1.319	11.457	.930	7.350
SEP	1984	4.270	19.300	2.760	14.959	1.640	7.350
OCT	1984	3.670	22.310	2.289	15.809	1.710	8.960
NOV	1984	5.320	17.050	3.161	10.954	2.010	7.630
DEC	1984	3.170	14.590	2.526	9.747	2.030	5.190
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		3.095	16.501	1.976	11.944	1.296	6.944
LAST 3 MONTHS ONLY		4.053	17.983	2.659	12.170	1.917	7.260

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: WYSE   GROUP I.D. 01

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
NOV	1984	3.550	13.520	2.556	11.263	1.350	9.840
DEC	1984	2.110	17.230	1.731	12.733	1.220	7.770
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
2 MONTHS		2.830	15.375	2.144	12.008	1.285	8.805
LAST 3 MONTHS ONLY		2.830	15.375	2.144	12.008	1.285	8.805

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 01

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
ST65	01 84	12 84	12	2.954	15.103	1.721	11.318	.947	6.959
SVIC	01 84	12 84	12	2.632	15.873	1.705	12.007	.984	7.543
TOB	01 84	12 84	12	3.825	17.472	1.981	12.572	1.053	6.697
TPI	01 34	12 84	12	3.977	16.581	1.819	12.410	1.021	8.054
TPR	01 84	12 84	12	2.304	14.457	1.504	10.452	.915	6.483
WYN	01 84	12 84	12	3.160	17.503	1.829	11.802	1.023	7.362
WYS	01 84	12 84	12	3.095	16.501	1.976	11.944	1.296	6.944
WYSE	11 84	12 84	2	2.830	15.375	2.144	12.008	1.285	8.805
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR: 2 MONTHS				3.097	16.108	1.835	11.814	1.066	7.356
LAST 3 MONTHS ONLY				3.847	18.377	2.245	12.744	1.214	7.632

PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FOE   GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	3.100	23.610	2.110	19.444	1.700	10.210
FEB	1984	3.100	23.610	2.242	16.010	1.310	11.570
MAR	1984	2.980	23.190	2.181	15.048	1.310	9.990
APR	1984	2.960	12.750	1.758	10.023	.830	7.320
MAY	1984	2.120	10.980	1.665	8.725	.830	6.990
JUN	1984	2.240	12.350	1.859	9.302	1.460	6.680
JUL	1984	2.110	11.780	1.135	8.970	.920	6.390
AUG	1984	1.700	15.030	1.216	10.176	.860	6.480
SEP	1984	2.950	18.700	1.741	14.009	.860	6.480
OCT	1984	2.770	22.450	2.404	16.582	1.260	11.240
NOV	1984	3.070	15.600	2.002	13.559	1.260	11.240
DEC	1984	1.700	15.600	1.302	8.317	.920	6.490
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.568	17.137	1.801	12.680	1.130	8.423
LAST 3 MONTHS ONLY		2.513	17.883	1.903	12.819	1.147	9.657

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FON GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1984	2.530	22.390	1.920	19.166	.540	8.860
FEB	1984	3.000	24.400	1.818	15.895	1.040	8.830
MAR	1984	2.400	14.920	1.974	10.041	1.590	6.060
APR	1984	1.860	7.690	1.206	6.639	.800	5.850
MAY	1984	1.550	8.000	1.241	7.150	.940	5.700
JUN	1984	2.060	10.630	1.298	7.058	.660	3.630
JUL	1984	1.360	10.110	1.010	8.273	.760	4.430
AUG	1984	1.270	12.950	1.081	9.070	.930	5.940
SEP	1984	2.280	18.830	1.438	13.574	.890	5.940
OCT	1984	3.900	18.830	1.949	14.434	1.110	9.850
NOV	1984	3.900	16.600	1.896	11.532	1.190	6.720
DEC	1984	3.000	15.950	2.206	12.404	1.280	5.000

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	2.427	15.112	1.586	11.270	.977	6.417
LAST 3 MONTHS ONLY	3.600	17.127	2.017	12.790	1.193	7.190

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FONW   GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	2.960	21.200	2.249	17.815	.860	9.460
FEB	1984	2.600	21.200	2.033	16.610	1.860	10.530
MAR	1984	2.600	19.870	1.796	13.702	1.010	8.330
APR	1984	1.860	12.080	1.423	10.285	1.120	5.330
MAY	1984	2.920	11.560	2.031	10.017	1.660	8.650
JUN	1984	2.920	11.430	1.652	9.637	1.270	7.750
JUL	1984	2.000	11.970	1.360	10.234	.900	8.460
AUG	1984	1.910	14.540	1.349	10.567	.940	6.550
SEP	1984	5.030	31.070	2.605	18.126	1.260	8.700
OCT	1984	2.930	19.580	2.321	15.821	1.470	12.500
NOV	1984	2.140	19.390	1.740	12.536	1.470	8.080
DEC	1984	2.990	16.370	1.565	9.819	.950	4.560
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		2.738	17.522	1.844	12.932	1.231	8.493
LAST 3 MONTHS ONLY		2.687	18.447	1.875	12.725	1.297	8.380

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FOS GROUP I.D. 02

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1984	2.520	23.000	2.109	19.167	.670	8.520
FEB	1984	2.920	24.750	2.195	18.285	1.750	10.460
MAR	1984	3.040	22.410	2.196	13.876	1.520	8.620
APR	1984	2.830	12.220	1.693	10.330	.760	7.410
MAY	1984	3.000	12.780	1.719	10.271	.550	7.410
JUN	1984	1.160	11.090	.986	9.026	.630	7.220
JUL	1984	1.950	11.340	1.412	9.684	.830	7.890
AUG	1984	2.930	26.460	2.111	13.573	.830	8.120
SEP	1984	2.140	20.160	1.771	14.740	1.160	9.150
OCT	1984	3.340	21.550	2.106	14.462	1.000	5.640
NOV	1984	2.790	13.630	2.257	10.763	1.230	7.320
DEC	1984	2.710	17.400	1.463	11.553	1.130	9.070

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
12 MONTHS	2.612	18.066	1.835	12.979	1.067	8.087
LAST 3 MONTHS ONLY	2.947	17.527	1.942	12.266	1.120	7.343

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = FCI/M3

SITE CODE: FOSW GROUP I.D. 02

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	3.510	24.600	2.286	20.056	1.500	12.130
FEB	1984	3.310	24.600	2.253	18.150	1.540	11.190
MAR	1984	2.970	22.380	2.067	14.214	1.310	9.730
APR	1984	2.560	13.090	1.885	10.176	1.310	8.490
MAY	1984	3.170	11.540	1.496	10.511	.910	8.490
JUN	1984	3.170	10.930	1.262	9.150	.690	7.570
JUL	1984	2.090	11.380	1.365	9.997	.670	8.710
AUG	1984	2.090	14.430	1.428	10.734	.860	7.270
SEP	1984	2.530	18.850	1.876	14.227	.920	9.980
OCT	1984	6.610	21.900	2.944	14.449	1.230	7.300
NOV	1984	2.010	18.980	1.558	14.662	1.230	11.000
DEC	1984	2.870	18.980	2.095	14.764	1.300	7.780
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		3.074	17.638	1.877	13.424	1.122	9.137
LAST 3 MONTHS ONLY		3.830	19.953	2.199	14.625	1.253	8.693

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = FCI/M3

GROUP I.D. 02

SITE CODE	BEGIN MO	BEGIN YR	END MO	END YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FOE	01	84	12	84	12	2.568	17.137	1.801	12.660	1.130	8.423
FON	01	84	12	84	12	2.427	15.112	1.586	11.270	.977	6.417
FONW	01	84	12	84	12	2.738	17.522	1.844	12.932	1.231	8.493
FOS	01	84	12	84	12	2.612	18.066	1.835	12.979	1.007	8.087
FOSW	01	84	12	84	12	3.074	17.638	1.877	13.424	1.122	9.137
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:											
12 MONTHS						2.684	17.095	1.769	12.657	1.093	8.112
LAST 3 MONTHS ONLY						3.115	18.187	1.967	13.045	1.202	8.253

PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

APPENDIX B

SECTION 6 OF THE DEMONSTRATION VOLUMES

ENVIRONMENTAL SURVEY GAMMA SPECTROSCOPY RESULTS

FOR SOIL, VEGETATION AND WATER FOR

THE YEARS 1986 THROUGH 1989

11/89

ANNUAL ENVIRONMENTAL SURVEY INFORMATION

Appendix B provides information on the gamma scan results of samples collected during the annual environmental surveys for the years 1984 - 1988 (starting with the most recent year).

A map showing the location of these samples is also provide for each year. In addition, a description of these samples is provided in table 6.1-3 of the demonstration section of the license renewal.

TABLE I 6.1-3

ANNUAL ENVIRONMENTAL SURVEY SAMPLING SITES (16 SITES)

CURRENT 16 SITES (AS OF 1988)

SITE CODE	DESCRIPTION
C	Stream bed near culvert at Interstate off-ramp and Roselle Street near Sorrento Road. This is storm drainage from entire eastern slope of laboratory facilities.
C2	Northwest corner of service yard for Hot Cell facility behind waste retention tanks where storm drainage enters uncontrolled area.
D	Stream bed near intersection of Dunhill Street and GA Sorrento Valley access road.
D2	At the east end of culvert under Roselle Street at the south side of Fuel Fabrication 'A' Building.
E2	At the east end of culvert under Roselle Street at the northeast side of Fuel Fabrication 'A' Building.
G2	Northwest of entrance to laboratory facility on east side of Torrey Pines Road.
T1	Southern part of Torrey Pines State Preserve at Los Penasquitos Creek; one-half mile from entrance to Torrey Pines State Reserve.
L1	About 350 feet from the mouth of the bottom of the Hot Cell Canyon.

TABLE I 6.1-3 (Continued)

ANNUAL ENVIRONMENTAL SURVEY SAMPLING SITES

SITE CODE	DESCRIPTION
AA	SV-A North in ice plant area - adjacent to storage building (added in 1988).
AC	Scripps - Old Miramar Road; across from Scripps Hospital (replacement of area I which was changed due to new construction in the area; (added in 1988).
AD	Science Laboratories Building drainage - Canyon area below location where L-307 tank was located; (added in 1988).
AE	TRIGA Fuel Fabrication (TFF) Southwest - In close proximity to TFF environmental air sampler (added in 1988).
AF	TRIGA Fuel Fabrication (TFF) Northeast - Outside fences area in drainage area from TRIGA Fuel Fabrication Facility; about 20 feet from the fence (added in 1988).
AG	TRIGA Fuel Fabrication (TFF) Drainage Ditch South of Test Tower about 200 feet upstream from the end of the ditch (added in 1988).
AH	Hot Cell middle of canyon; about 30 feet below old LINAC 40 meter flight path; at the site boundary. (Added in 1988)
AI	At the site boundary behind EA-1 (Building 27) and TRIGA (Building 22), (added in 1988).

TABLE I 6.1-3 (Continued)

ANNUAL ENVIRONMENTAL SURVEY SAMPLING SITES

SITE CODE	DESCRIPTION
AA	SV-A North in ice plant area - adjacent to storage building (added in 1988).
AC	Scripps - Old Miramar Road; across from Scripps Hospital (replacement of area I which was changed due to new construction in the area; (added in 1988).
AD	Science Laboratories Building drainage - Canyon area below location where L-307 tank was located; (added in 1988).
AE	TRIGA Fuel Fabrication (TFF) Southwest - In close proximity to TFF environmental air sampler (added in 1988).
AF	TRIGA Fuel Fabrication (TFF) Northeast - Outside fences area in drainage area from TRIGA Fuel Fabrication Facility; about 20 feet from the fence (added in 1988).
AG	TRIGA Fuel Fabrication (TFF) Drainage Ditch South of Test Tower about 200 feet upstream from the end of the ditch (added in 1988).
AH	Hot Cell middle of canyon; about 30 feet below old LINAC 40 meter flight path; at the site boundary. (Added in 1988)
AI	At the site boundary behind EA-1 (Building 27) and TRIGA (Building 22), (added in 1988).

TABLE I 6.1-3 (Continued)

ANNUAL ENVIRONMENTAL SURVEY SAMPLING SITES

SITES DELETED (FROM 1986 THROUGH 1987)

SITE CODE	DESCRIPTION
A2	Next to L-307 Hot Waste Tank (deleted because the tank was removed in 1984; results were within the criteria for release to unrestricted use).
B2	Next to L-540 Hot Waste Tank (deleted because the tank was removed in 1984; (previous results were backgound).
F2	Calbiochem-Behring Corporation (CBC); previous results were backgound.
H	North of Scripps Hospital at IVAC corporation at the extreme NorthWest parking lot (construction around the area; new location picked nearby; previous results were backgound).
H2	Waste Yard - North (WY-N); (1986 and 1987 results were backgound). This Waste Yard has been decommissioned and the area released to unrestricted use; previous results met the criteria for release to unrestricted use.
I2	Southwest of SV-A building on lip of canyon behind Spin Physics company on Torreyana Road; previous results were backgound.

TABLE I 6.1-3 (Continued)

ANNUAL ENVIRONMENTAL SURVEY SAMPLING SITES

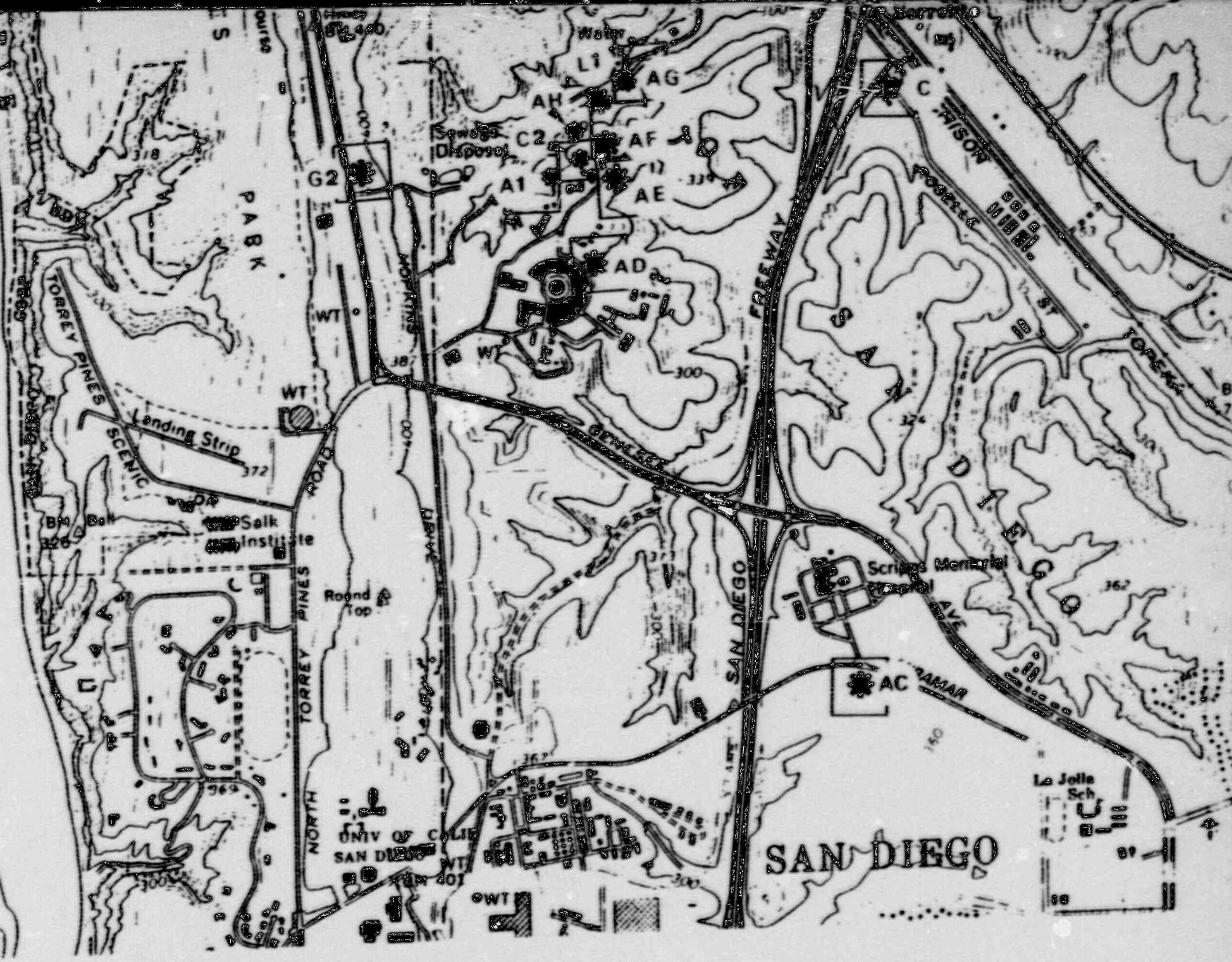
I3	Scripps Hospital (Scripps) -- East of Surgeon's Center, 9900 Genesse Ave. East of fence near drainage grate and west of Scripps Hospital on Scripps property; previous results were backgound.
J1	10110 Sorrento Valley Road at Stream Bed at Southeast corner of Building (JI on results in the appendix); (previous results were backgound).
K2	Northwest of SV-A and SV-B buildings on the lip of canyon behind Hybertech Corporation on Torreyana Blvd; (previous results were backgound).
O2	East of Torrey Pines Industrial Park near the fence line at Entrance to Los Penesquitos Regional Park; (previous results were backgound).
P	Entrance to Hot Cell Canyon at fence line off of I-5 on the ramp from Sorrento Valley Road; area was released to unrestricted use; the results were below the release criteria.
Q	East of old chemical disposal area and east of GA boundry fence. Part of the Waste Processing area that was decommissioned; the sampe results met the criteria for release to unrestricted use.
R	Entrance to TRIGA Canyon; south of site P and of of the on ramp to I-5 from Sorrento Valley; area has been released to unrestricted use during the decommissioning of the former Waste Yard; results met the limits for release to unrestricted use.

TABLE I 6.1-3 (Continued)

ANNUAL ENVIRONMENTAL SURVEY SAMPLING SITES

S	East of Mini Cafe at culvert under I-5 and East of Sorrento Valley Road; previous results were at background levels.
U	Below of TRIGA Fuel Element Storage Area at the Waste Yard and in the runn-off ditch; Waste Yard was decommissioned; soil sample results were below the release criteria.
W	Below the Waste Processing Facility evaporation ponds at the entrance to the Hot Cell Canyon; Waste Yard was decommissioned; soil sample results were below the release criteria.

Substa
SOLEDAD
VALLEY
T1
E2
D2
AA
AB
BM
Sewage Disposal
PUEBLO
RESERVE
TORREY PINES ROAD
TORREY PINES
PARK ROAD
TORREY
PIN
Golf
Picnic Area
STATE
PINES
RES
360
365



1989 & 1988

ANNUAL ENVIRONMENTAL SURVEY LOCATIONS

(SOIL / VEGETATION / WATER)

SI
APERTURE
CARD
Also Available On
Aperture Card

8912180211-07

ENVIRONMENTAL SURVEY OF GAMMA SPECTROSCOPY RESULTS

FOR SOIL, VEGETATION AND WATER

FOR 1989

GAMMA SPEC RESULTS ANNUAL ENVIRONMENTAL SOIL 1989 (PICOCURIES/GRAM)

SITE ID	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
AC	ND	ND	0.90 ±0.12	0.91 ±0.13	0.66 ±0.13	1.23 ±0.23	0.05 ±0.03
G2	ND	0.09 ±0.02	ND	ND	0.60 ±0.13	0.89 ±0.20	0.04 ±0.03
AD	ND	0.07 ±0.02	1.37 ±0.18	1.40 ±0.20	0.79 ±0.19	2.29 ±0.37	0.11 ±0.05
AE	ND	0.15 ±0.02	ND	ND	0.31 ±0.10	ND	ND
AF	0.05 ±0.00	0.09 ±0.02	1.09 ±0.13	1.18 ±0.15	0.67 ±0.14	1.71 ±0.27	0.10 ±0.04
T1	ND	ND	1.60 ±0.20	1.56 ±0.22	1.25 ±0.23	2.39 ±0.40	0.13 ±0.07
E2	ND	ND	0.93 ±0.14	0.95 ±0.15	0.62 ±0.15	1.32 ±0.27	0.07 ±0.04
AA	ND	0.07 ±0.02	1.12 ±0.15	1.11 ±0.16	0.68 ±0.16	1.86 ±0.31	0.21 ±0.06
AB	ND	0.05 ±0.02	ND	ND	0.56 ±0.14	1.13 ±0.24	0.05 ±0.03
D2	ND	ND	1.01 ±0.12	1.06 ±0.13	0.82 ±0.13	1.77 ±0.25	ND
D	ND	0.15 ±0.02	ND	ND	0.57 ±0.12	1.05 ±0.21	ND
C	ND	0.15 ±0.02	ND	ND	0.49 ±0.17	0.94 ±0.27	ND
AG	ND	ND	1.01 ±0.12	1.06 ±0.13	0.82 ±0.13	1.77 ±0.25	ND
L1	ND	0.15 ±0.02	1.67 ±0.16	1.61 ±0.16	1.25 ±0.17	2.35 ±0.29	ND
C2	3.05 ±0.15	17.00 ±0.87	ND	ND	0.40 ±0.12	ND	ND
AH	0.89 ±0.05	6.18 ±0.33	1.06 ±0.15	1.08 ±0.17	0.75 ±0.17	2.08 ±0.33	ND
A1	ND	0.21 ±0.03	1.17 ±0.17	1.14 ±0.18	0.69 ±0.18	1.65 ±0.33	0.10 ±0.05
ND VALUES:	<0.05	<0.05	<1.5	<1.5	<1.5	<3.0	<0.10

GAMMA SPEC RESULTS ANNUAL ENVIRONMENTAL VEGETATION 1989 (PICOCURIES/GRAM)

SITE ID	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
AC	ND	ND	ND	ND	0.08 ±0.14	ND	ND
G2	ND	ND	ND	ND	0.14 ±0.23	ND	ND
AD	ND	ND	ND	ND	ND	ND	ND
AE	ND	ND	ND	ND	0.09 ±0.17	ND	ND
AF	ND	ND	ND	ND	ND	ND	ND
T1	ND	ND	ND	ND	0.12 ±0.21	ND	ND
E2	ND	ND	ND	ND	0.19 ±0.29	ND	ND
AA	ND	ND	ND	ND	0.05 ±0.0[illegible]	ND	0.09 ±0.05
AB	ND	ND	1.28 ± 0.06	ND	ND	ND	ND
D2	ND	ND	ND	ND	0.07 ± 0.12	ND	ND
D	ND	ND	ND	ND	0.14 ±0.47	ND	ND
C	ND	ND	ND	ND	0.13 ±0.23	ND	ND
AG	ND	ND	ND	ND	0.16 ±0.27	ND	ND
L1	ND	ND	ND	ND	ND	ND	ND
C2	ND	ND	ND	ND	0.12 ±0.22	ND	ND
AH	ND	ND	ND	ND	ND	ND	ND
A1	ND	ND	ND	ND	0.01 ±0.03	ND	ND
ND VALUES:	<0.05	<0.05	<1.5	<1.5	<1.5	<3.0	<0.10

GAMMA SPEC RESULTS ANNUAL ENVIRONMENTAL WATER 1989 (PICOCURIES/GRAM)

SITE ID	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
D2	ND	ND	ND	ND	ND	ND	ND
C	ND	ND	ND	ND	ND	ND	ND
ND VALUES:	<0.05	<0.05	<1.5	<1.5	<1.5	<3.0	<0.10

ENVIRONMENTAL SURVEY OF GAMMA SPECTROSCOPY RESULTS

FOR SOIL, VEGETATION AND WATER

FOR 1988

GAMMA SPECTROSCOPY RESULTS FOR ANNUAL ENVIRONMENTAL SOIL 1988 (PICOCURIES/GRAM)

SITE ID	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
AC	ND	ND	0.67 ± 0.05	0.70 ± 0.04	0.51 ± 0.03	1.23 ± 0.24	0.04 ± 0.02
G2	ND	0.06 ± 0.02	0.44 ± 0.04	0.51 ± 0.03	0.36 ± 0.02	0.71 ± 0.19	0.03 ± 0.02
AD	ND	0.03 ± 0.02	0.73 ± 0.05	0.81 ± 0.04	0.48 ± 0.02	ND	0.02 ± 0.01
AE	ND	0.52 ± 0.05	0.34 ± 0.03	0.30 ± 0.02	0.28 ± 0.01	0.46 ± 0.17	0.05 ± 0.02
AF	0.17 ± 0.01	0.30 ± 0.03	0.77 ± 0.05	0.81 ± 0.04	0.65 ± 0.03	1.09 ± 0.19	0.06 ± 0.03
T1	ND	ND	2.03 ± 0.12	1.98 ± 0.10	2.31 ± 0.12	4.49 ± 0.43	0.24 ± 0.12
E2	ND	ND	1.29 ± 0.08	1.45 ± 0.07	0.94 ± 0.05	ND	0.10 ± 0.05
AA	ND	ND	1.19 ± 0.07	1.45 ± 0.07	0.86 ± 0.04	ND	0.10 ± 0.05
AB	ND	0.04 ± 0.02	0.72 ± 0.05	0.69 ± 0.04	0.60 ± 0.03	1.19 ± 0.23	0.08 ± 0.04
D2	ND	ND	0.80 ± 0.06	0.81 ± 0.04	0.60 ± 0.03	1.33 ± 0.25	0.07 ± 0.03
D	ND	0.15 ± 0.03	0.56 ± 0.04	0.68 ± 0.04	0.64 ± 0.03	ND	ND
C	ND	ND	0.64 ± 0.05	0.70 ± 0.04	0.53 ± 0.03	1.05 ± 0.21	0.06 ± 0.03
AG	ND	0.04 ± 0.02	0.82 ± 0.05	0.89 ± 0.05	0.67 ± 0.03	1.06 ± 0.20	0.05 ± 0.03
L1	ND	ND	1.16 ± 0.07	1.09 ± 0.06	1.08 ± 0.05	1.73 ± 0.25	0.06 ± 0.04
C2	0.60 ± 0.03	1.78 ± 0.11	1.00 ± 0.06	1.04 ± 0.05	0.83 ± 0.04	1.69 ± 0.25	0.06 ± 0.03
AH	ND	ND	1.44 ± .09	1.49 ± 0.08	1.40 ± 0.08	2.40 ± 0.33	0.09 ± 0.06
A1	ND	ND	0.86 ± 0.06	ND	0.53 ± 0.03	ND	ND
ND VALUES:	<0.05	<0.05	<1.5	<1.5	<1.5	<3.0	<0.10

GAMMA SPECTROSCOPY RESULTS FOR ANNUAL ENVIRONMENTAL VEGETATION 1988 (PICOCURIES/GRAM)

SITE ID	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
AC	ND	ND	ND	ND	ND	ND	ND
G2	ND	ND	1.13 ± 0.06	ND	ND	2.45 ± 1.74	ND
AD	ND	ND	ND	ND	ND	0.87 ± 0.74	ND
AE	ND	ND	0.59 ± 0.03	ND	ND	ND	ND
AF	ND	ND	ND	ND	ND	ND	ND
T1	ND	ND	0.80 ± 0.04	ND	1.26 ± 0.07	ND	ND
E2	ND	ND	0.26 ± 0.01	ND	ND	1.34 ± 1.03	0.28 ± 0.10
AA	ND	ND	0.98 ± 0.05	ND	ND	1.46 ± 1.07	ND
AB	ND	ND	ND	ND	ND	1.58 ± 1.28	ND
D2	ND	ND	1.21 ± 0.06	ND	ND	ND	0.28 ± 0.13
D	ND	ND	ND	ND	ND	0.08 ± 0.08	ND
C	ND	ND	ND	ND	ND	0.66 ± 0.58	ND
AG	ND	ND	ND	ND	ND	0.02 ± 0.02	ND
L1	ND	ND	ND	ND	ND	ND	ND
C2	ND	ND	ND	ND	ND	ND	ND
AH	ND	ND	ND	ND	ND	ND	0.16 ± 0.08
AI	ND	ND	ND	ND	ND	0.71 ± 0.60	ND
ND VALUES:	<0.05	<0.05	<1.5	<1.5	<1.5	<3.0	<0.10

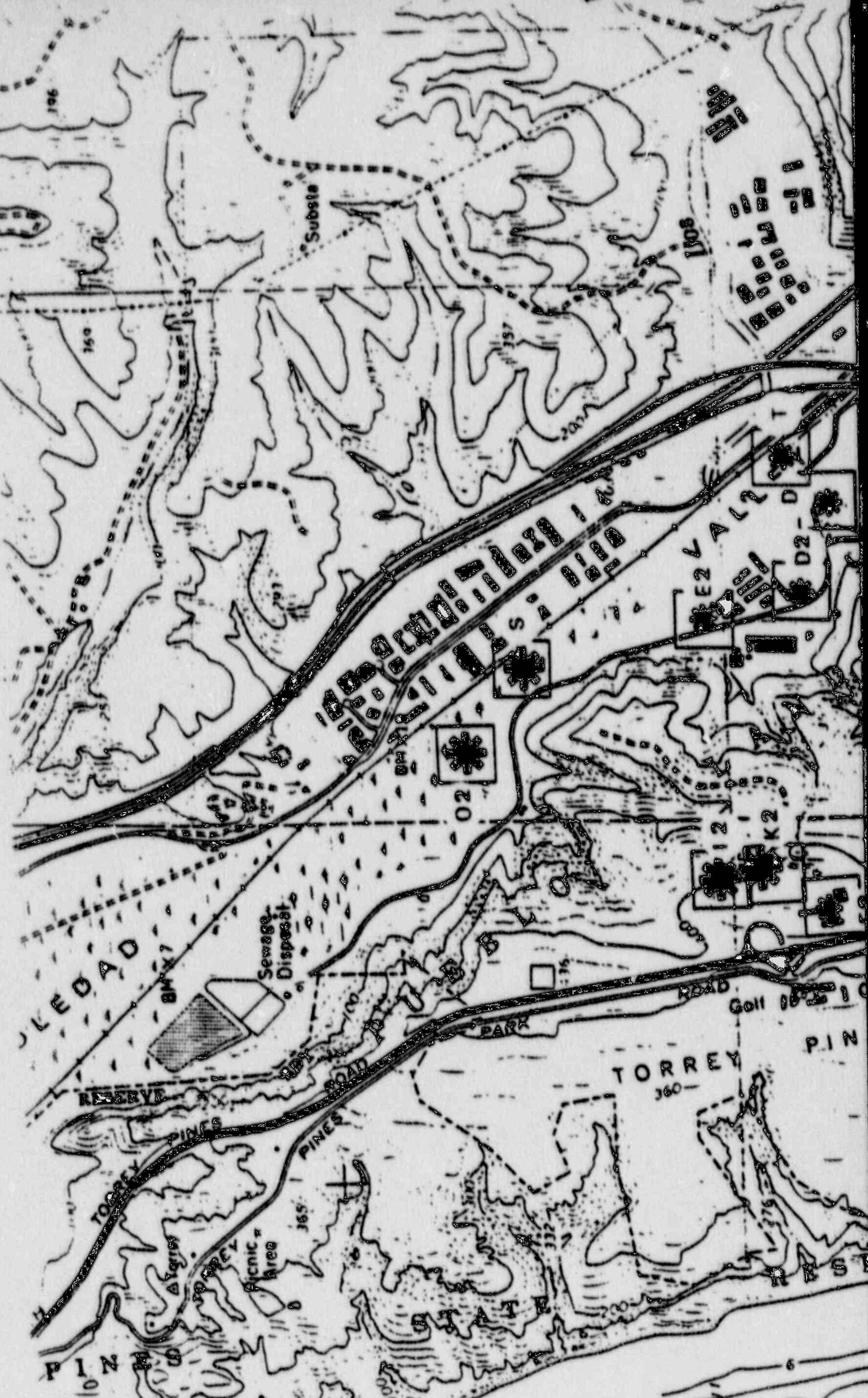
GAMMA SPEC RESULTS
ANNUAL ENVIRONMENTAL WATER 1988
PICOCURIES/GRAM

SITE ID	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
D2	ND	ND	ND	ND	ND	0.25 ± 0.22	ND
C	ND	ND	ND	ND	ND	ND	ND
ND VALUES:	<0.05	<0.05	<1.5	<1.5	<1.5	<3.0	<0.10

ENVIRONMENTAL SURVEY OF GAMMA SPECTROSCOPY RESULTS

FOR SOIL, VEGETATION AND WATER

FOR 1987



Substa
OLEDAD
Sewage Disposal
RESERVE
TORREY
PINES ROAD
PARK
ROAD
TORREY
360
PIN
Picnic Area
STATE
PINES

1987

ANNUAL ENVIRONMENTAL SURVEY LOCATIONS

(SOIL / vegetation / WATER

SI
APERTURE
CARD
Also Available On
Aperture Card

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GAMMA SPEC RESULTS ANNUAL ENVIRONMENTAL SOIL 1987 (PICOCURIES/GRAM)

SITE	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
A2	ND	0.16 ± 0.02	ND	ND	0.87 ± 0.04	1.82 ± 0.20	ND
B2	ND	0.05 ± 0.02	1.21 ± 0.10	1.25 ± 0.06	0.84 ± 0.04	1.91 ± 0.29	ND
C	ND	ND	1.97 ± 0.15	1.46 ± 0.07	1.09 ± 0.06	2.02 ± 0.30	ND
C2	7.93 ± 0.40	33.51 ± 1.69	ND	ND	0.70 ± 0.04	1.25 ± 0.22	ND
D	ND	0.32 ± 0.03	1.27 ± 0.09	1.23 ± 0.06	0.89 ± 0.05	1.83 ± 0.25	ND
D2	ND	0.06 ± 0.01	ND	ND	0.55 ± 0.03	1.01 ± 0.19	ND
E2	ND	ND	ND	ND	0.68 ± 0.03	1.29 ± 0.22	ND
F2	ND	ND	ND	4.52 ± 0.23	0.64 ± 0.03	1.10 ± 0.20	ND
G2	ND	0.11 ± 0.02	ND	ND	0.70 ± 0.04	1.13 ± 0.22	ND
H	ND	ND	2.86 ± 0.20	2.00 ± 0.10	1.12 ± 0.06	2.48 ± 0.33	ND
I2	ND	ND	1.09 ± 0.09	1.19 ± 0.06	0.79 ± 0.04	1.96 ± 0.28	ND
I3	ND	ND	1.11 ± 0.09	1.05 ± 0.05	0.95 ± 0.05	2.01 ± 0.27	ND
J1	ND	ND	ND	ND	0.45 ± 0.02	ND	ND
J2	ND	ND	1.08 ± 0.05	ND	1.19 ± 0.06	ND	ND
K2	ND	ND	2.22 ± 0.15	2.24 ± 0.11	1.19 ± 0.06	ND	0.11 ± 0.06
L	ND	0.22 ± 0.03	ND	ND	0.62 ± 0.03	1.19 ± 0.26	0.12 ± 0.05
O2	ND	0.10 ± 0.02	1.07 ± 0.09	1.17 ± 0.06	0.90 ± 0.05	1.74 ± 0.29	ND
P	ND	0.22 ± 0.03	ND	0.98 ± 0.05	0.62 ± 0.03	1.24 ± 0.27	0.12 ± 0.05
Q	ND	0.22 ± 0.03	ND	ND	0.62 ± 0.03	1.19 ± 0.26	0.12 ± 0.05
R	ND	0.09 ± 0.02	1.57 ± 0.11	1.67 ± 0.09	1.08 ± 0.05	2.10 ± 0.30	0.10 ± 0.05
S	ND	ND	1.10 ± 0.08	1.16 ± 0.06	0.86 ± 0.04	1.57 ± 0.22	ND
T	ND	ND	1.00 ± 0.08	1.06 ± 0.05	1.06 ± 0.05	2.01 ± 0.27	0.12 ± 0.06
U	ND	2.00 ± 0.22	1.17 ± 0.09	1.17 ± 0.06	0.97 ± 0.05	1.59 ± 0.23	ND
W	0.69 ± 0.04	7.07 ± 0.37	2.05 ± 0.14	2.04 ± 0.10	1.12 ± 0.06	2.35 ± 0.33	0.26 ± 0.08
ND VALUES:	<0.05	<0.05	<1.50	<1.50	<1.5	<3.00	<0.10

GAMMA SPEC RESULTS ANNUAL ENVIRONMENTAL VEGETATION 1987 (PICOCURIES/GRAM)

SITE ID	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
A2	ND	ND	ND	ND	ND	ND	ND
B2	ND	ND	ND	ND	ND	ND	ND
C	ND	ND	ND	ND	ND	ND	ND
C2	ND	ND	ND	ND	ND	ND	ND
D	ND	ND	ND	ND	ND	ND	ND
D2	ND	ND	ND	ND	ND	ND	ND
E2	ND	0.19 ± 0.11	ND	ND	ND	ND	[illegible]
F2	ND	ND	ND	ND	ND	ND	ND
G2	ND	ND	ND	ND	ND	ND	ND
H	ND	ND	ND	ND	ND	ND	ND
I2	ND	ND	ND	ND	ND	ND	ND
I3	ND	ND	ND	ND	ND	ND	ND
J1	ND	ND	ND	ND	ND	ND	ND
J2	ND	ND	ND	ND	0.05 ± 0.00	ND	ND
K2	ND	ND	ND	ND	ND	ND	ND
L1	ND	[illegible]	1.42 ± 0.07	ND	1.60 ± 0.09	ND	ND
O2	ND	ND	ND	ND	ND	ND	ND
P	ND	ND	ND	ND	ND	ND	ND
Q	ND	ND	ND	ND	ND	ND	ND
R	ND	ND	ND	ND	0.18 ± 0.01	ND	ND
S	ND	ND	ND	ND	ND	ND	0.28 ± 0.01
T	ND	ND	ND	ND	ND	ND	ND
U	ND	ND	ND	ND	ND	ND	ND
W	ND	ND	ND	ND	0.39 ± 0.02	ND	ND
ND VALUES:	<0.05	<0.05	<1.50	<1.50	1.50	<3.00	<0.10

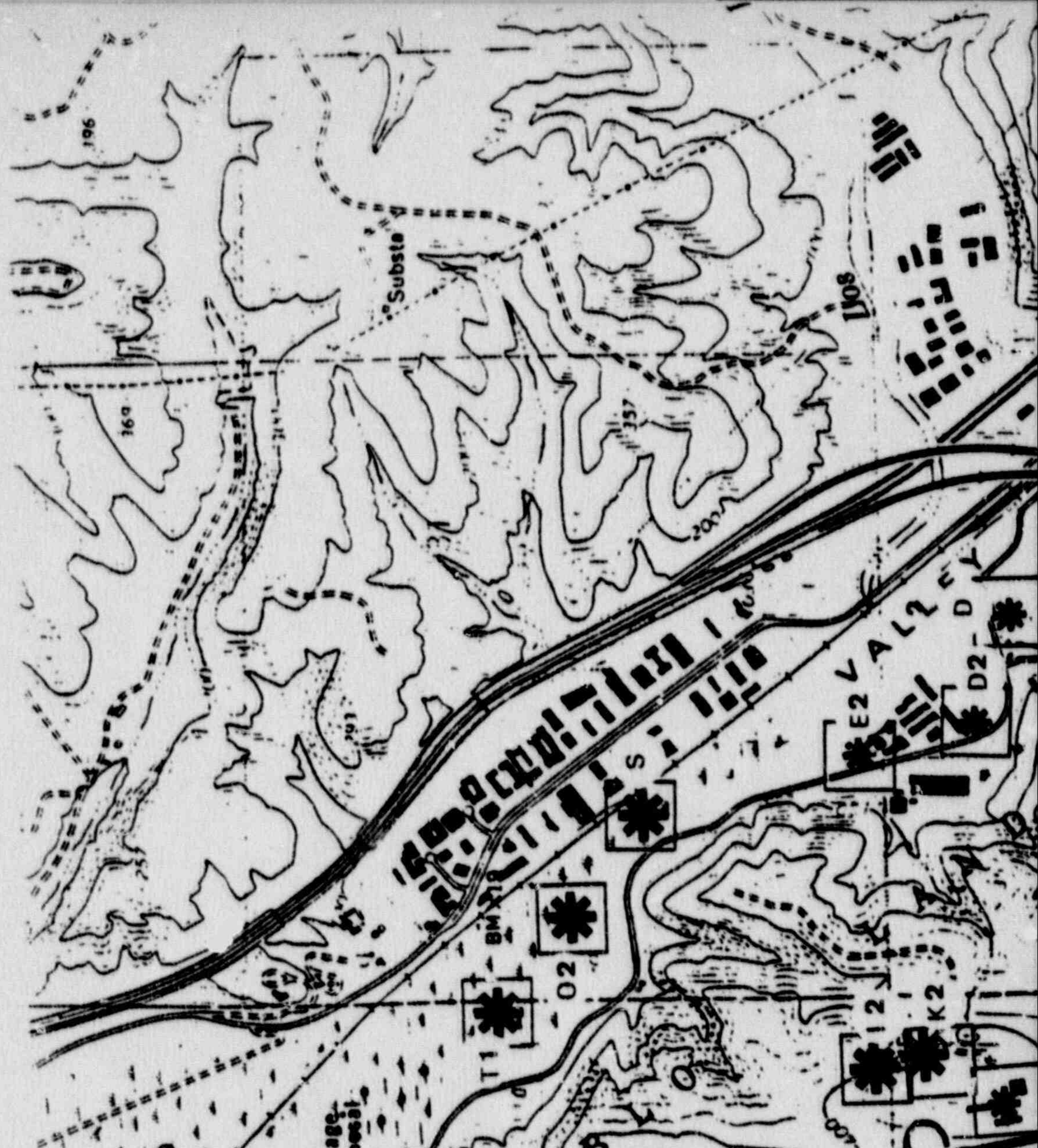
GAMMA SPEC RESULTS ANNUAL ENVIRONMENTAL WATER 1987 (PICOCURIES/GRAM)

SITE ID	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
C	ND	ND	ND	ND	ND	ND	ND
D	ND	ND	ND	ND	ND	ND	ND
D2	ND	ND	ND	ND	ND	ND	ND
J1	ND	ND	ND	ND	ND	ND	ND
O2	ND	ND	ND	ND	ND	ND	ND
R	ND	ND	ND	ND	ND	ND	ND
T	ND	ND	ND	ND	ND	ND	ND
ND VALUES:	<0.05	<0.05	<1.50	<1.50	1.50	<3.00	<0.10

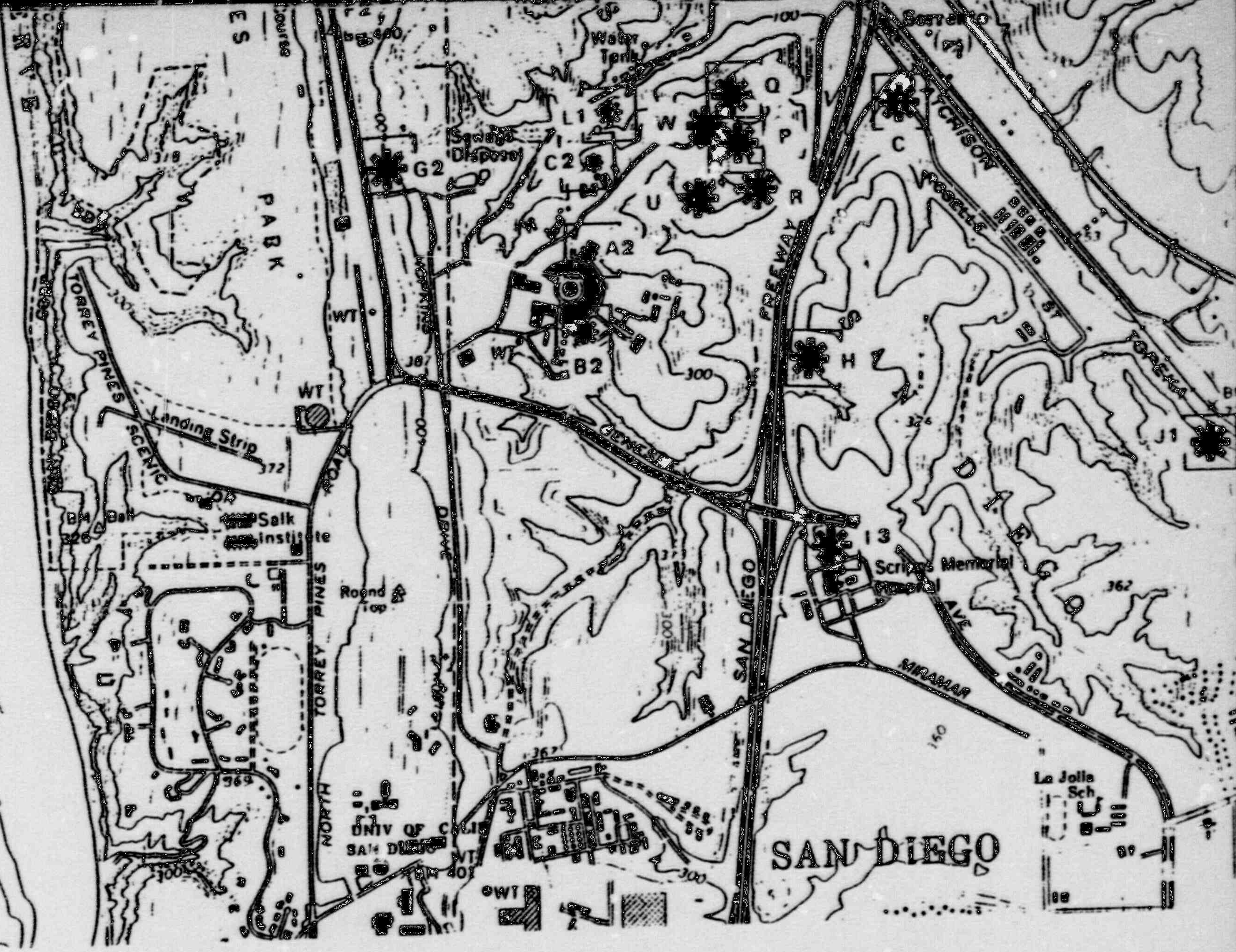
ENVIRONMENTAL SURVEY OF GAMMA SPECTROSCOPY RESULTS

FOR SOIL, VEGETATION AND WATER

FOR 1986



Substa
Los
VALLEY
E2
D2
O2
T1
K2
Sewage Disposal
LEDAD
ROAD
Golf
PARK
TORREY
360
RESERVE
TORREY PINES ROAD
PINES
365
Picnic Area
STATE
PINES
RES



1986

ANNUAL ENVIRONMENTAL SURVEY

(SOIL / VEGETATION / WATER)

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GAMMA SPEC RESULTS ANNUAL ENVIRONMENTAL SOIL 1986 (PICOCURIES/GRAM)

SITE	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
A2	ND	ND	1.09 ± 0.49	ND	0.85 ± 0.53	ND	ND
B2	ND	ND	1.34 ± 0.52	1.12 ± 0.61	0.74 ± 0.58	ND	ND
C	ND	ND	1.56 ± 0.08	1.36 ± 0.61	0.93 ± 0.59	ND	ND
C2	11.22 ± 0.56	19.18 ± 0.98	1.31 ± 0.07	ND	0.41 ± 0.46	ND	0.13 ± 0.05
D	ND	0.28 ± 0.04	1.27 ± 0.62	1.60 ± 0.64	0.77 ± 0.60	ND	0.16 ± 0.08
D2	ND	ND	1.00 ± 0.47	1.19 ± 0.50	0.76 ± 0.52	ND	0.14 ± 0.03
E2	ND	ND	1.21 ± 0.06	ND	0.58 ± 0.44	ND	ND
F2	ND	ND	ND	1.18 ± 0.51	0.72 ± 0.54	ND	ND
G2	ND	0.09 ± 0.02	ND	ND	0.60 ± 0.50	ND	ND
H	ND	ND	1.27 ± 0.62	1.15 ± 0.55	0.80 ± 0.62	ND	ND
I2	ND	ND	1.22 ± 0.52	1.18 ± 0.64	0.68 ± 0.57	ND	ND
I3	ND	0.05 ± 0.02	ND	ND	0.71 ± 0.48	ND	ND
J1	ND	ND	ND	ND	0.52 ± 0.43	ND	ND
K2	ND	ND	2.47 ± 0.62	3.02 ± 0.65	1.08 ± 0.66	ND	0.14 ± 0.06
L	ND	ND	ND	1.22 ± 0.46	0.91 ± 0.54	ND	ND
O2	ND	ND	ND	ND	0.69 ± 0.56	ND	ND
P	ND	0.64 ± 0.07	1.53 ± 0.82	2.18 ± 0.11	1.09 ± 0.81	ND	ND
Q	ND	0.16 ± 0.03	1.92 ± 0.62	1.82 ± 0.55	1.07 ± 0.61	ND	ND
R	ND	ND	1.74 ± 0.79	1.75 ± 0.71	0.95 ± 0.76	ND	0.17 ± 0.09
S	ND	ND	ND	ND	0.47 ± 0.40	ND	ND
T	ND	ND	ND	ND	0.62 ± 0.50	ND	ND
U	ND	ND	1.78 ± 0.09	1.52 ± 0.61	[illegible] ± 0.74	ND	ND
W	ND	ND	1.85 ± 0.69	1.94 ± 0.6[illegible]	[illegible] 0.65	ND	ND
ND VALUES:	<0.05	<0.05	<1.50	<1.50	[illegible]	<3.00	<0.10

GAMMA SPEC RESULTS ANNUAL ENVIRONMENTAL VEGETATION 1986 (PICOCURIES/GRAM)

SITE ID	CO-60	CS-137	TH-228	RA-228	RA-226	U-238	U-235
A2	ND	ND	ND	ND	ND	ND	ND
B2	ND	0.25 ± 0.17	ND	ND	[illegible]	ND	ND
C	ND	0.19 ± 0.12	ND	ND	ND	ND	ND
C2	ND	0.12 ± 0.09	ND	ND	0.20 ± 0.20	ND	ND
D	ND	0.16 ± 0.10	ND	ND	0.17 ± 0.17	ND	ND
D2	ND	0.27 ± 0.13	ND	ND	ND	ND	ND
E2	ND	0.45 ± 0.20	ND	ND	0.37 ± 0.02	ND	ND
F2	ND	ND	ND	ND	ND	ND	ND
G2	ND	ND	ND	ND	ND	ND	ND
H	ND	0.14 ± 0.10	ND	ND	ND	ND	ND
I2	ND	0.36 ± 0.13	ND	ND	ND	ND	ND
I3	ND	0.24 ± 0.14	ND	ND	0.13 ± 0.16	ND	ND
J1	ND	0.46 ± 0.19	ND	ND	ND	ND	ND
J2	ND	0.52 ± 0.30	ND	ND	0.37 ± 0.39	ND	ND
K2	ND	ND	ND	ND	ND	ND	ND
L1	ND	0.19 ± 0.15	ND	ND	0.66 ± 0.44	ND	ND
O2	ND	0.35 ± 0.17	ND	ND	0.15 ± 0.18	ND	ND
P	ND	ND	ND	ND	ND	1.74 ± 1.39	ND
Q	ND	ND	ND	ND	ND	ND	ND
R	ND	ND	ND	ND	ND	ND	ND
S	ND	ND	1.20 ± 0.06	ND	0.51 ± 0.03	ND	ND
T	ND	1.59 ± 0.08	ND	3.12 ± 0.17	ND	ND	ND
U	ND	0.19 ± 0.11	ND	ND	ND	ND	ND
W	ND	0.53 ± 0.15	ND	ND	ND	ND	ND
ND VALUES:	<0.05	<0.05	<1.50	<1.50	1.50	<3.00	<0.10

GAMMA SPEC RESULTS ANNUAL ENVIRONMENTAL WATER 1986 (PICOCURIES/GRAM)

SITE ID	CO-60	CS-137	TH-226	RA-228	RA-226	U-238	U-235
C	D	ND	ND	ND	ND	ND	ND
D	ND	ND	ND	ND	ND	ND	ND
D2	ND	ND	ND	ND	ND	ND	ND
J1	ND	ND	ND	ND	ND	ND	ND
02	ND	ND	ND	ND	ND	ND	ND
R	ND	ND	ND	ND	ND	ND	ND
T	ND	ND	ND	ND	ND	ND	ND
ND VALUES:	<0.05	<0.05	<1.50	<1.50	<1.50	<3.00	<0.10

APPENDIX C

SECTION 6 OF THE DEMONSTRATION VOLUMES

STACK SAMPLE RESULTS FOR THE

YEARS 1984 THROUGH 1988

STACK INFORMATION

Background Information

Stack effluents in selected facilities are monitored. The samples are collected on a weekly basis and analyzed using low-level alpha/beta counting systems.

The average concentration (pCi/M^3) over the six month period is obtained for each stack (alpha and beta concentrations are added). Using the stack flow rate (M^3/sec), the total release in microcuries is calculated and reported in the **semiannual effluent reports** submitted to the NRC (and the State of California). Health Physics file entitled "Backup information for the semiannual effluent report for the period ....." details the information for each semiannual effluent report.

The attached information for the past five years provides the average, high and low concentration averaged for each month, the last 3 months of each year and each of the years; 1988, 1987, 1986, 1985 and 1984. Information on the stack flows are provided below for each facility in the order they appear in the attached reports. Note: A summary page for each facility is also provided at the end of the stacks for the facility.

Pages 3 and 4 provide a map of GA's facilities.

STACK ID	FLOW RATE (FT/MIN)	STACK AREA (FT^2)	M^3/MIN	BACK-UP INFORMATION ENVIRONMENTAL LOGBOOK/ DATE MEASURED
SV-A HTGR FUEL FABRICATION FACILITY (Building 37)				
G-36	837	7.9	187.2	"
G-38	1818	7.9	406.7	"
P-31	2393	7.9	535.2	Pg. 78 of Logbook #8337 1/11/89
P-34	1512	7.9	338.24	Measured 1/11/89; No work in Progress (shut-down); Pg. 78
P-35	1631	7.9	364.9	pg 78 of Logbook #8337 (1/11/89)
P-47	3540	3.14	314.8	pg 78 of Logbook #8337 (Not used, but measured 1/11/89)

SV-B (Building 39)

FB1	2187	3.7	229.1	Pg 78 Log #8337 (1/11/89)
FB2	1300	3.7	136.20	Pg 78 Log #8337 (1/11/89)
FB3	860	3.79	92.3	Pg 78 Log #8337 (1/11/89)
FB4	350	0.09	0.89	Pg 37 of Log #8337 (**Not used,** Not measured)
TRIGA REACTORS (Building 21)	1420	1.51	60.7	"

Nuclear WASTE PROCESSING FACILITY (Building 41)

WPCF	2944	3.14	261.77	"

TRIGA FUEL FABRICATION FACILITY (Building 22)

TFL 1	1400	6.875	272.5	Pg 78 of Log #8337 (1/12/89)
TFL V	1550	5.812	255.1	Pg 78 of Log #8337 (1/12/89)
Hot Cell (Building 23)	3440	3.14	305.9	Pg 80 of Log #8337 (1/25/89)

EA-1 BUNKER FACILITY (Building 27-1)

EA-1 BRK 1 3080 0.11 9.59Pg 80 of Logbook #8337 (1/25/89)
EA-1 BKR 2 1500 1.33 56.49Pg 80 of Logbook #8337
(1/25/89)

Note: 0.0283168 m^3= ft^3

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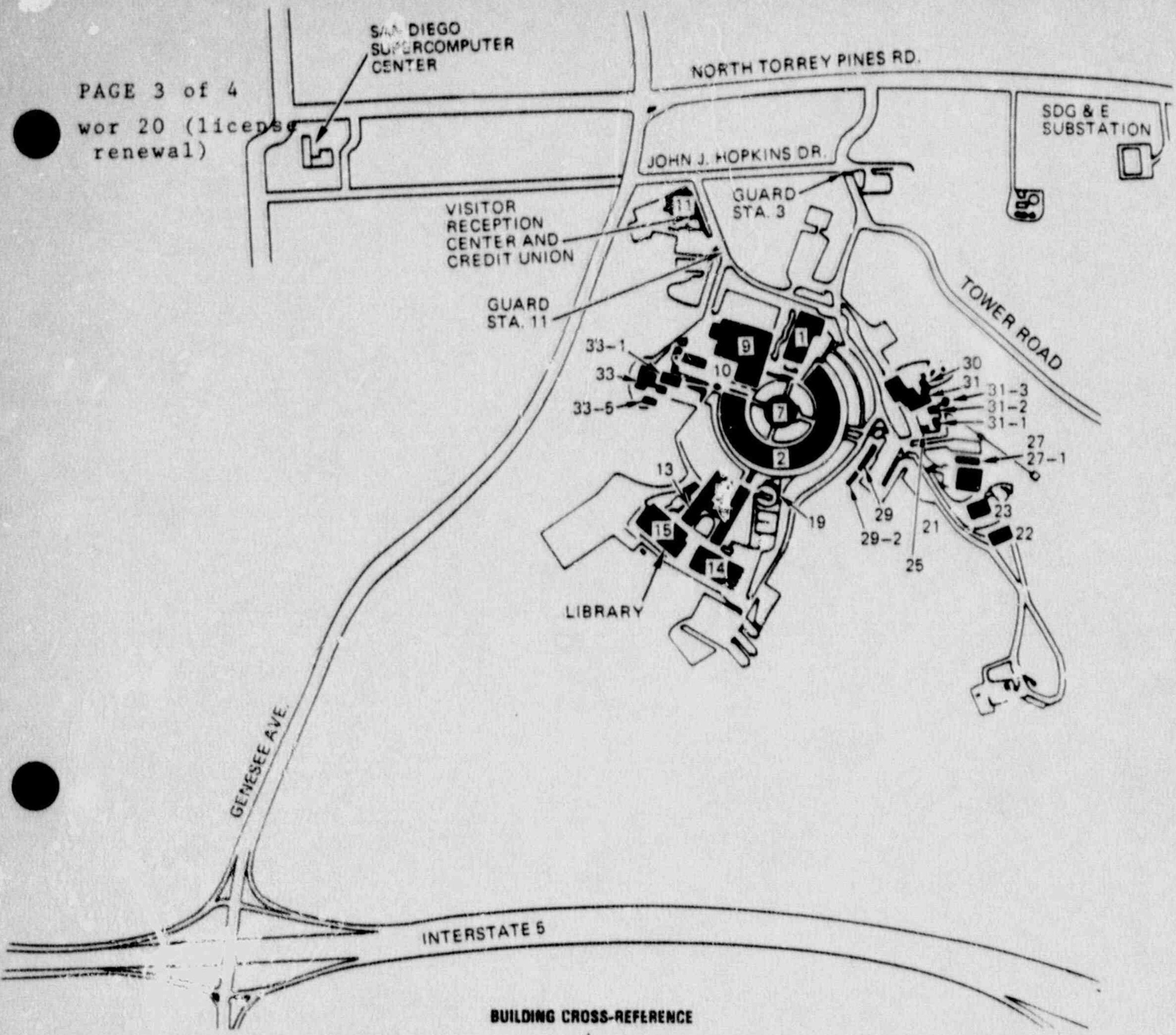
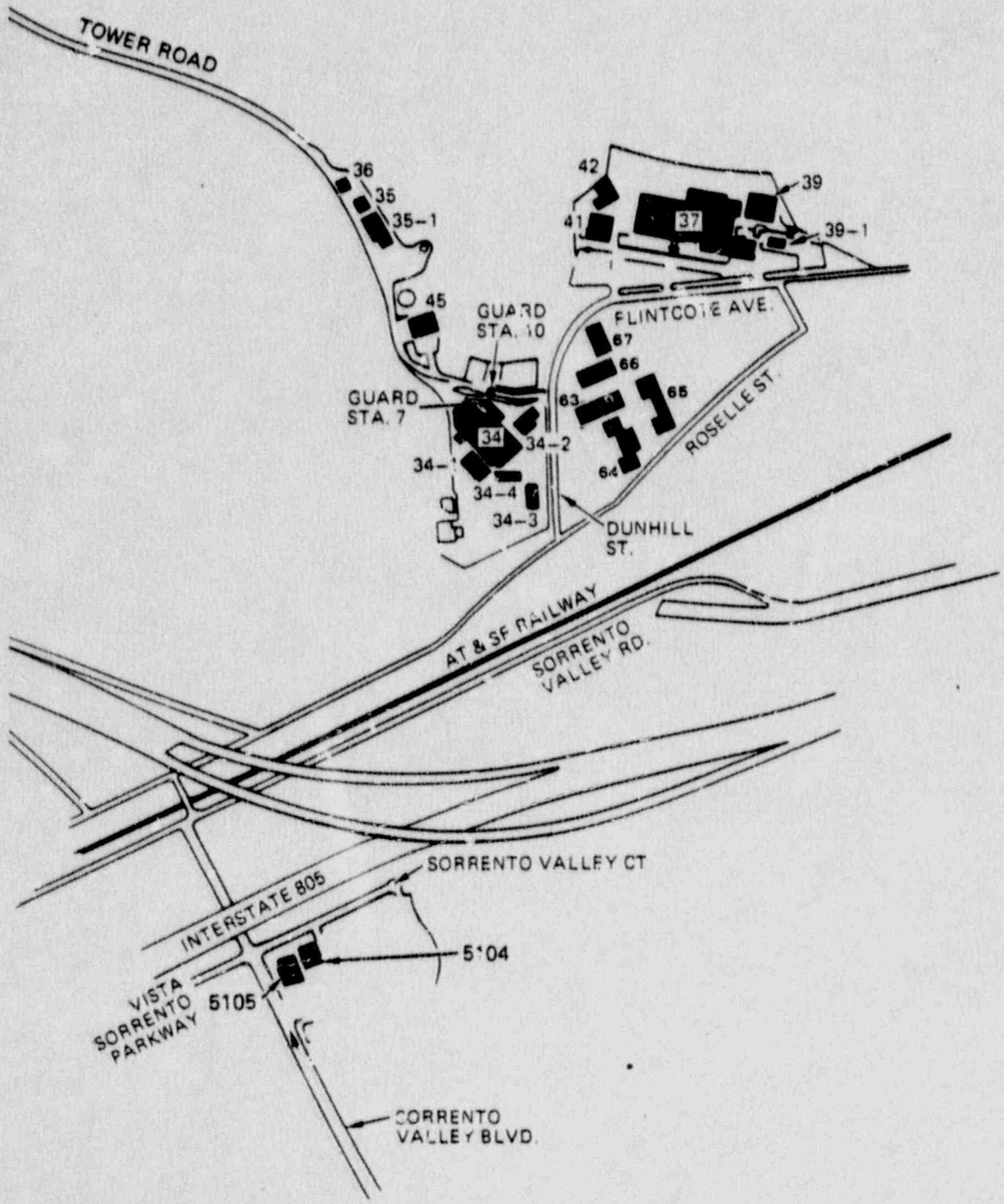


BUILDING CROSS-REFERENCE

NEW	OLD	NAME
Building 1	O Building	Administration
Building 2	L Building	Science Laboratories A,B,C
Building 7	T Building	Cafeteria
Building 9	E Building	Experimental Building
Building 10	M Building	Maintenance Building
Building 11	S Building	Service Building
Building 13	T.O. Building	Technical Office Building
Building 14	T.O.E. No. 1	Technical Office East
Building 15	T.O.E. No. 2	Technical Office East
Building 19		Swimming Pool Building
Building 21		TRIGA Building
Building 22		TRIGA Fuel Lab Building
Building 23		Hot Cell
Building 25		Waste Yard Building
Building 27	EA No. 1	Experimental Area
Building 27-1	EA No. 1 - Bunker	Experimental Area
Building 29	EA No. 2	Experimental Area
Building 29-2		Emergency Vehicle Storage Building
Building 30		Linac Complex
Building 31		TRIGA Storage Building
Building 31-1		Neutron Radiography Building
Building 31-2		ECF Critical Building
Building 31-3		Storage Building
Building 33		Fusion Building
Building 33-1		Fusion Lab Building
Building 33-5	Carpenter Shop	Fusion Building Annex 5
Building 34		Fusion Doublet III Building
Building 34-1		Fusion Doublet III Capacitor Building
Building 34-2		Fusion Doublet III Lab Building
Building 34-3		Fusion Doublet III Storage Building
Building 35		Test Tower Building
Building 35-1		Facilities Building
Building 36		Blower Assembly Building
Building 37	"A" Building	Sorrento Valley Building
Building 39	"B" Building	Sorrento Valley Building
Building 39-1		Storage Building
Building 41		Raw Stock Facility
Building 42		NDT Facility
Building 45		Helium Circulator Test Facility
Building 63		3550 Dunhill St
Building 64		11030 Roselle St
Building 65		11040 Roselle St
Building 66		3520 Dunhill St
Building 67		3510 Dunhill St
APPLIED SUPERCONETICS (ASC)		
Building 5104	SP-4	11045 Sorrento Valley Ct
Building 5106	SP-5	11025 Sorrento Valley Ct
SAN DIEGO SUPERCOMPUTER CENTER		10110 John Jay Hopkins Dr.

(wor 20 license renewal)
(stack information)



STACK SAMPLE RESULTS

1988

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: G36 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.015	.027	.005	.022	.002	.019
FEB	1988	.027	.020	.010	.010	.002	.001
MAR	1988	.006	.009	.005	.007	.003	.006
APR	1988	.006	.007	.003	.004	.001	.001
MAY	1988	.006	.013	.003	.007	.001	.001
JUN	1988	.005	.049	.002	.016	.001	.003
JUL	1988	.001	.017	.001	.011	.001	.004
AUG	1988	.013	.028	.004	.007	.001	.002
SEP	1988	.004	.007	.002	.003	.001	.001
OCT	1988	.011	.010	.004	.006	.002	.002
NOV	1988	.003	.007	.002	.003	.001	.001
DEC	1988	.009	.008	.004	.004	.002	.001
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.009	.017	.004	.008	.001	.003
LAST 3 MONTHS ONLY		.008	.008	.003	.004	.002	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: G38 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.004	.016	.002	.011	.001	.006
FEB	1988	.003	.016	.002	.006	.001	.004
MAR	1988	.003	.007	.002	.006	.002	.005
APR	1988	.010	.017	.003	.007	.001	.004
MAY	1988	.010	.023	.003	.016	.001	.006
JUN	1988	.001	.022	.001	.013	.001	.003
JUL	1988	.006	.025	.002	.013	.001	.007
AUG	1988	.006	.025	.001	.010	.001	.004
SEP	1988	.002	.009	.001	.004	.001	.002
OCT	1988	.011	.010	.003	.004	.001	.001
NOV	1988	.001	.002	.001	.001	.001	.001
DEC	1988	.001	.003	.001	.002	.001	.001
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.005	.015	.002	.008	.001	.004
LAST 3 MONTHS ONLY		.004	.005	.002	.002	.001	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P31   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1988	.003	.014	.002	.008	.001	.004
FEB	1988	.009	.019	.004	.008	.002	.002
MAR	1988	.005	.015	.003	.007	.001	.002
APR	1988	.011	.019	.003	.006	.001	.002
MA	1988	.011	.019	.002	.003	.001	.002
JUN	1988	.001	.007	.001	.004	.001	.003
JUL	1988	.001	.009	.001	.005	.001	.001
AUG	1988	.002	.005	.001	.003	.001	.002
SEP	1988	.002	.004	.001	.002	.001	.001
OCT	1988	.001	.002	.001	.001	.001	.001
NOV	1988	.006	.007	.002	.002	.001	.001
DEC	1988	.011	.004	.005	.002	.002	.001
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.005	.010	.002	.004	.001	.002
LAST 3 MONTHS ONLY		.006	.004	.003	.002	.001	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P34 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.003	.017	.002	.012	.001	.008
FEB	1988	.003	.021	.002	.017	.001	.010
MAR	1988	.001	.018	.001	.013	.001	.007
APR	1988	.011	.015	.003	.007	.001	.002
MAY	1988	.002	.020	.001	.010	.001	.002
JUN	1988	.006	.008	.002	.006	.001	.004
JUL	1988	.005	.019	.002	.009	.001	.006
AUG	1988	.002	.019	.001	.010	.001	.004
SEP	1988	.002	.008	.001	.004	.001	.002
OCT	1988	.001	.004	.001	.003	.001	.001
NOV	1988	.003	.003	.002	.002	.001	.001
DEC	1988	.002	.004	.001	.002	.001	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	BETA	WEIGHTED ALPHA	BETA	LOWEST ALPHA	BETA
12 MONTHS	.003	.013	.002	.008	.001	.004
LAST 3 MONTHS ONLY	.002	.004	.001	.002	.001	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P35   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.003	.017	.002	.010	.001	.002
FEB	1988	.002	.015	.002	.006	.001	.001
MAR	1988	.007	.012	.002	.007	.001	.003
APR	1988	.007	.010	.002	.003	.001	.001
MAY	1988	.002	.006	.001	.005	.001	.001
JUN	1988	.007	.011	.002	.006	.001	.002
JUL	1988	.001	.009	.001	.005	.001	.002
AUG	1988	.001	.003	.001	.002	.001	.002
SEP	1988	.001	.004	.001	.002	.001	.001
OCT	1988	.001	.002	.001	.002	.001	.001
NOV	1988	.003	.002	.001	.001	.001	.001
DEC	1988	.002	.002	.001	.001	.001	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.003	.006	.001	.004	.001	.001
LAST 3 MONTHS ONLY	.002	.002	.001	.001	.001	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P47 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.007	.017	.005	.013	.004	.007
FEB	1988	.006	.021	.004	.016	.000	.000
MAR	1988	.011	.016	.005	.013	.001	.005
APR	1988	.008	.011	.004	.007	.001	.005
MAY	1988	.004	.011	.002	.007	.001	.004
JUN	1988	.004	.029	.002	.010	.001	.004
JUL	1988	.005	.029	.002	.014	.001	.006
AUG	1988	.005	.016	.001	.002	.001	.001
SEP	1988	.016	.064	.007	.016	.001	.001
OCT	1988	.002	.016	.001	.012	.001	.002
NOV	1988	.005	.011	.002	.007	.001	.005
DEC	1988	.006	.007	.003	.003	.001	.001
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.007	.021	.003	.010	.001	.003
LAST 3 MONTHS ONLY		.004	.011	.002	.007	.001	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 04

SITE	BEGIN		END		#	AVERAGE HIGHEST VALUE		AVERAGE WEIGHTED AVERAGE		AVERAGE LOWEST VALUE	
CODE	MO	YR	MO	YR	MO	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
G36	01	88	12	88	12	.009	.017	.004	.008	.001	.003
G38	01	88	12	88	12	.005	.015	.002	.008	.001	.004
P31	01	88	12	88	12	.005	.010	.002	.004	.001	.002
P34	01	88	12	88	12	.003	.013	.002	.008	.001	.004
P35	01	88	12	88	12	.003	.008	.001	.004	.001	.001
P47	01	88	12	88	12	.007	.021	.003	.010	.001	.003
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:											
12 MONTHS						.005	.014	.002	.007	.001	.003
LAST 3 MONTHS ONLY						.004	.006	.002	.003	.001	.001

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FE1 GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA **	BETA	WEIGHTED AVERAGE ALPHA **	BETA	LOWEST VALUE ALPHA **	BETA
JAN	1988	.001	.011	.001	.006	.001	.003
FEB	1988	.001	.011	.001	.007	.001	.002
MAR	1988	.004	.006	.002	.004	.001	.001
APR	1988	.006	.154	.002	.038	.001	.001
MAY	1988	.005	.010	.002	.005	.001	.002
JUN	1988	.002	.018	.001	.010	.001	.004
JUL	1988	.002	.023	.001	.009	.001	.003
AUG	1988	.004	.023	.002	.011	.001	.004
SEP	1988	.005	.023	.002	.010	.001	.001
OCT	1988	.001	.011	.001	.006	.001	.001
NOV	1988	.002	.002	.001	.001	.001	.001
DEC	1988	.006	.004	.004	.002	.002	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	.003	.025	.002	.009	.001	.002
LAST 3 MONTHS ONLY	.003	.006	.002	.003	.001	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB2   GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.004	.012	.002	.008	.001	.004
FEB	1988	.003	.014	.002	.011	.001	.004
MAR	1988	.001	.018	.001	.012	.001	.004
APR	1988	.003	.012	.001	.005	.001	.001
MAY	1988	.001	.001	.001	.001	.001	.001
JUN	1988	.001	.013	.001	.006	.001	.002
JUL	1988	.001	.010	.001	.006	.001	.004
AUG	1988	.003	.017	.001	.007	.001	.002
SEP	1988	.023	.015	.005	.008	.001	.002
OCT	1988	.003	.011	.002	.007	.001	.003
NOV	1988	.002	.003	.001	.002	.001	.001
DEC	1988	.001	.006	.001	.004	.001	.003

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.004	.011	.002	.006	.001	.003
LAST 3 MONTHS ONLY	.002	.007	.001	.004	.001	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB3 GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.003	.031	.002	.024	.001	.015
FEB	1988	.002	.031	.001	.022	.001	.016
MAR	1988	.007	.031	.003	.021	.001	.017
APR	1988	.002	.050	.001	.034	.001	.013
MAY	1988	.100	.020	.024	.012	.001	.007
JUN	1988	.003	.024	.001	.014	.001	.001
JUL	1988	.002	.029	.001	.018	.001	.009
AUG	1988	.003	.031	.001	.025	.001	.019
SEP	1988	.004	.030	.002	.016	.001	.006
OCT	1988	.009	.031	.005	.024	.001	.015
NOV	1988	.003	.032	.001	.015	.001	.010
DEC	1988	.004	.032	.003	.022	.002	.008

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.012	.031	.004	.021	.001	.011
LAST 3 MONTHS ONLY	.005	.032	.003	.020	.001	.011

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

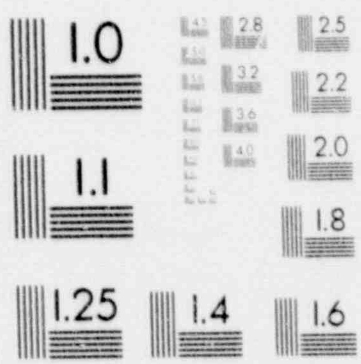
IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6″

1

IMAGE EVALUATION TEST TARGET (MT-3)

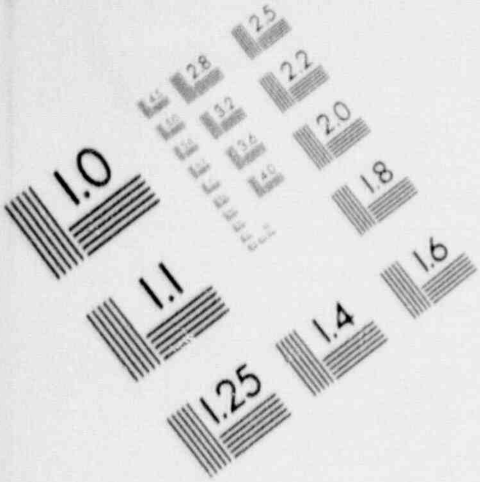


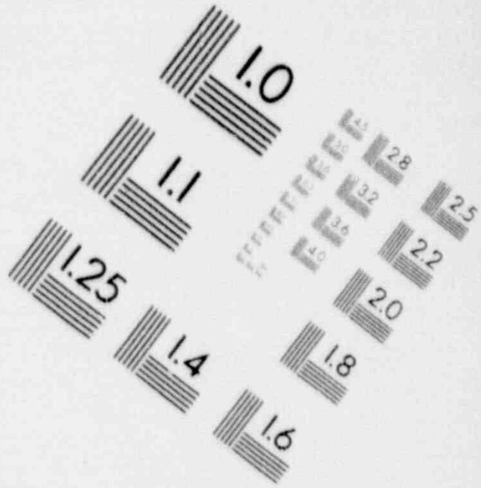
150mm

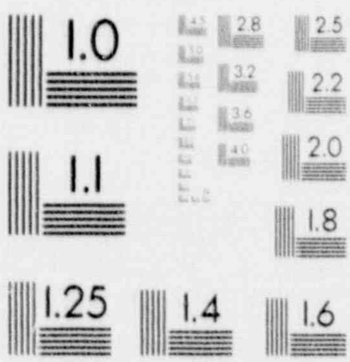
6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

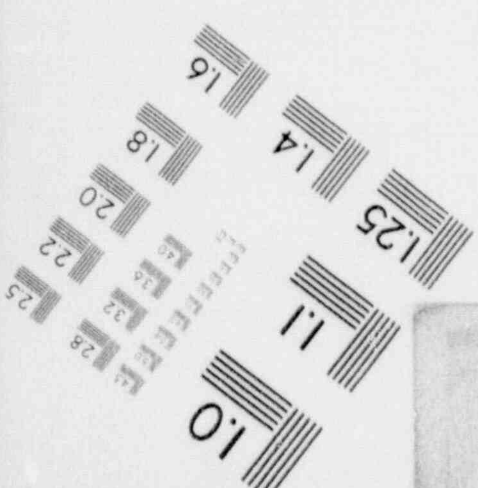


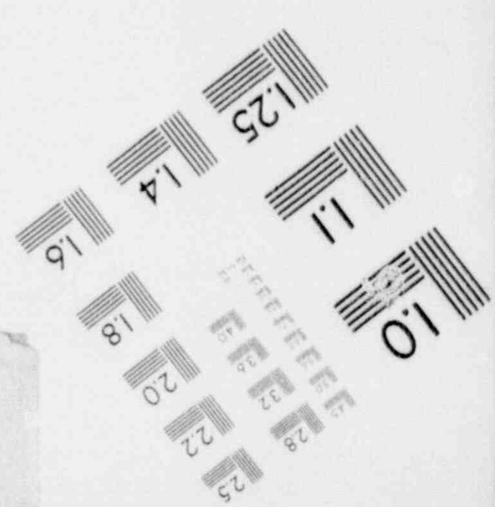




150mm

6″





RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB4   GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.003	.048	.002	.028	.001	.014
FEB	1988	.011	.066	.005	.038	.002	.011
MAR	1988	.008	.080	.004	.065	.002	.048
APR	1988	.004	.048	.001	.010	.001	.001
MAY	1988	.001	.110	.001	.047	.001	.009
JUN	1988	.001	.017	.001	.010	.001	.005
JUL	1988	.001	.021	.001	.013	.001	.004
AUG	1988	.001	.028	.001	.017	.001	.006
SEP	1988	.002	.033	.001	.015	.001	.003
OCT	1988	.004	.017	.002	.012	.001	.007
NOV	1988	.003	.025	.001	.007	.001	.001
DEC	1988	.004	.075	.002	.029	.001	.007

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.004	.047	.002	.024	.001	.010
LAST 3 MONTHS ONLY	.004	.039	.002	.016	.001	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 07

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FB1	01 88	12 88	12	.003	.025	.002	.009	.001	.002
FB2	01 88	12 88	12	.004	.011	.002	.006	.001	.003
FB3	01 88	12 88	12	.012	.031	.004	.021	.001	.011
FB4	01 88	12 88	12	.004	.047	.002	.024	.001	.010
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.006	.028	.002	.015	.001	.006
LAST 3 MONTHS ONLY				.003	.021	.002	.011	.001	.005

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TMI   GROUP I.D. 12

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1988	.001	.040	.001	.028	.001	.009
FEB	1988	.001	.055	.001	.037	.001	.020
MAR	1988	.005	.073	.002	.068	.001	.052
APR	1988	.005	.060	.002	.036	.001	.007
MAY	1988	.004	.079	.002	.049	.001	.024
JUN	1988	.002	.052	.001	.026	.001	.005
JUL	1988	.001	.045	.001	.028	.001	.007
AUG	1988	.001	.058	.001	.038	.001	.026
SEP	1988	.003	.558	.002	.191	.001	.005
OCT	1988	.003	2.130	.001	.574	.001	.052
NOV	1988	.001	.132	.001	.068	.001	.016
DEC	1988	.001	.093	.001	.036	.001	.008
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.002	.281	.001	.096	.001	.019
LAST 3 MONTHS ONLY		.002	.785	.001	.226	.001	.025

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 12

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGH T VALUE ALPHA	* BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TMI	01 88	12 88	12	.002	.281	.001	.098	.001	.019

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:	HIGH ALPHA	HIGH BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	.002	.281	.001	.098	.001	.019
LAST 3 MONTHS ONLY	.002	.785	.001	.226	.001	.025

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCS GROUP I.D. 13

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1988	.001	.841	.001	.300	.001	.026
FEB	1988	.001	.364	.001	.048	.001	.015
MAR	1988	.002	.495	.001	.269	.001	.055
APR	1988	.001	.542	.001	.404	.001	.054
MAY	1988	.006	4.492	.002	1.174	.001	.023
JUN	1988	.002	.086	.001	.048	.001	.010
JUL	1988	.001	.100	.001	.074	.001	.010
AUG	1988	.002	.151	.001	.092	.001	.060
SEP	1988	.003	1.896	.002	.810	.001	.149
OCT	1988	.003	1.716	.001	.263	.001	.035
NOV	1988	.002	1.946	.001	.493	.001	.035
DEC	1988	.001	.182	.001	.112	.001	.050
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.002	1.069	.001	.341	.001	.043
LAST 3 MONTHS ONLY		.002	1.281	.001	.289	.001	.040

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 13

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
HCS	01 88	12 88	12	.002	1.069	.001	.341	.001	.043
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.002	1.069	.001	.341	.001	.043
LAST 3 MONTHS ONLY				.002	1.281	.001	.289	.001	.040

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WPC GROUP I.D. 14

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.015	.043	.006	.023	.001	.016
FEB	1988	.007	.026	.004	.015	.001	.001
MAR	1988	.030	.074	.011	.029	.004	.001
APR	1988	.024	.040	.011	.022	.001	.005
MAY	1988	.051	.127	.024	.059	.001	.010
JUN	1988	.063	.175	.019	.044	.001	.005
JUL	1988	.083	.175	.017	.040	.001	.001
AUG	1988	.020	.042	.003	.011	.001	.007
SEP	1988	.002	.009	.002	.005	.001	.001
OCT	1988	.011	.027	.004	.009	.001	.002
NOV	1988	.008	.011	.004	.006	.001	.001
DEC	1988	.005	.014	.004	.010	.002	.003
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.028	.064	.009	.023	.001	.005
LAST 3 MONTHS ONLY		.008	.017	.004	.008	.001	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 14

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
WPC	01 88	12 88	12	.028	.064	.009	.023	.001	.005
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.028	.064	.009	.023	.001	.005
LAST 3 MONTHS ONLY				.008	.017	.004	.008	.001	.002

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFL1   GROUP I.D. 16

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1988	.003	.019	.002	.006	.001	.001
FEB	1988	.003	.019	.002	.004	.001	.001
MAR	1988	.006	.004	.003	.003	.001	.001
APR	1988	.006	.013	.002	.008	.001	.002
MAY	1988	.004	.015	.002	.006	.001	.001
JUN	1988	.004	.013	.002	.008	.001	.003
JUL	1988	.001	.016	.001	.009	.001	.005
AUG	1988	.001	.007	.001	.004	.001	.002
SEP	1988	.131	.215	.031	.051	.001	.001
OCT	1988	.001	.009	.001	.003	.001	.001
NOV	1988	.007	.003	.003	.001	.001	.001
DEC	1988	.011	.006	.004	.003	.001	.001
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.015	.028	.004	.009	.001	.002
LAST 3 MONTHS ONLY		.006	.006	.003	.002	.001	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 16

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TFL1	01 88	12 88	12	.015	.028	.004	.009	.001	.002

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

	Highest Alpha	Highest Beta	Weighted Alpha	Weighted Beta	Lowest Alpha	Lowest Beta
12 MONTHS	.015	.028	.004	.009	.001	.002
LAST 3 MONTHS ONLY	.006	.006	.003	.002	.001	.001

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFLV   GROUP I.D. 17

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1988	.005	.015	.002	.007	.001	.003
FEB	1988	.131	.016	.038	.007	.001	.003
MAR	1988	.130	.016	.029	.006	.001	.001
APR	1988	.049	.006	.013	.004	.001	.001
MAY	1988	.018	.005	.005	.002	.001	.001
JUN	1988	.063	.011	.016	.006	.001	.003
JUL	1988	.001	.011	.001	.006	.001	.001
AUG	1988	.097	.020	.026	.009	.001	.002
SEP	1988	.040	.007	.009	.004	.001	.002
OCT	1988	.061	.020	.014	.004	.001	.002
NOV	1988	3.369	.209	.905	.095	.001	.003
DEC	1988	.007	.004	.003	.002	.001	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
12 MONTHS	.331	.028	.088	.013	.001	.002
LAST 3 MONTHS ONLY	1.146	.078	.307	.034	.001	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 17

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TFLV	01 88	12 88	12	.331	.028	.068	.013	.001	.002

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.331	.028	.068	.013	.001	.002
LAST 3 MONTHS ONLY	1.146	.078	.307	.034	.001	.002

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCS1   GROUP I.D. 19

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.000	.010	.000	.008	.000	.001
FEB	1988	.000	.012	.000	.006	.000	.001
MAR	1988	.000	.011	.000	.007	.000	.001
APR	1988	.000	.015	.000	.007	.000	.000
MAY	1988	.000	.011	.000	.009	.000	.008
JUN	1988	.000	.011	.000	.006	.000	.001
JUL	1988	.000	.021	.000	.009	.000	.002
AUG	1988	.000	.060	.000	.013	.000	.000
SEP	1988	.000	.355	.000	.068	.000	.001
OCT	1988	.000	.355	.000	.121	.000	.025
NOV	1988	.000	.025	.000	.013	.000	.001
DEC	1988	.000	.041	.000	.015	.000	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.000	.077	.000	.023	.000	.003
LAST 3 MONTHS ONLY	.000	.140	.000	.050	.000	.009

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 19

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
HCSI	01 88	12 88	12	.000	.077	.000	.023	.000	.003

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:						
12 MONTHS	.000	.077	.000	.023	.000	.003
LAST 3 MONTHS ONLY	.000	.140	.000	.050	.000	.009

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: BKR1   GROUP I.D. 20

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.001	.021	.001	.013	.001	.009
FEB	1988	.001	.099	.001	.050	.001	.012
MAR	1988	.001	.047	.001	.020	.001	.006
APR	1988	.001	.220	.001	.063	.001	.005
MAY	1988	.001	.012	.001	.010	.001	.005
JUN	1988	.001	.012	.001	.007	.001	.002
JUL	1988	.001	.016	.001	.011	.001	.007
AUG	1988	.001	.015	.001	.009	.001	.006
SEP	1988	.001	.016	.001	.009	.001	.005
OCT	1988	.001	.016	.001	.011	.001	.002
NOV	1988	.003	.076	.002	.026	.001	.005
DEC	1988	.002	.230	.001	.132	.001	.027
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.001	.065	.001	.030	.001	.008
LAST 3 MONTHS ONLY		.002	.107	.001	.056	.001	.011

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 20

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
BKR1	01 88	12 88	12	.001	.065	.001	.030	.001	.008
BKR2	01 88	12 88	12	.009	.056	.003	.019	.001	.002
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.005	.060	.002	.024	.001	.005
LAST 3 MONTHS ONLY				.002	.057	.001	.030	.001	.006

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: BKR2   GROUP I.D. 20

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1988	.001	.026	.001	.011	.001	.003
FEB	1988	.001	.058	.001	.033	.001	.003
MAR	1988	.001	.021	.001	.013	.001	.001
APR	1988	.001	.011	.001	.006	.001	.001
MAY	1988	.001	.049	.001	.025	.001	.001
JUN	1988	.090	.449	.021	.108	.001	.001
JUL	1988	.001	.015	.001	.009	.001	.001
AUG	1988	.001	.008	.001	.004	.001	.003
SEP	1988	.001	.008	.001	.004	.001	.001
OCT	1988	.001	.003	.001	.002	.001	.001
NOV	1988	.001	.010	.001	.002	.001	.001
DEC	1988	.003	.010	.001	.006	.001	.002
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.009	.056	.003	.019	.001	.002
LAST 3 MONTHS ONLY		.002	.008	.001	.003	.001	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

STACK SAMPLE RESULTS

1987

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: 036 GROUP I.D. 04

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	.029	.025	.011	.014	.002	.006
FEB	1987	.005	.009	.004	.006	.002	.005
MAR	1987	.034	.037	.006	.011	.002	.006
APR	1987	.010	.023	.004	.010	.000	.004
MAY	1987	.006	.013	.004	.009	.003	.006
JUN	1987	.014	.036	.007	.018	.000	.006
JUL	1987	.015	.016	.009	.011	.004	.006
AUG	1987	.025	.028	.012	.018	.001	.004
SEP	1987	.010	.042	.005	.020	.003	.009
OCT	1987	.013	.052	.007	.028	.001	.007
NOV	1987	.011	.052	.008	.018	.001	.006
DEC	1987	.015	.062	.009	.027	.001	.004

SITE AVERAGE: AVERAGE OF SITE DATA FOR:						
12 MONTHS	.016	.033	.007	.016	.002	.006
LAST 3 MONTHS ONLY	.013	.055	.008	.024	.001	.006

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: G38   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.003	.007	.001	.005	.000	.002
FEB	1987	.004	.009	.002	.006	.001	.002
MAR	1987	.004	.027	.003	.011	.001	.005
APR	1987	.022	.011	.006	.004	.001	.000
MAY	1987	.005	.012	.004	.008	.002	.003
JUN	1987	.047	.066	.016	.031	.003	.006
JUL	1987	.006	.014	.004	.009	.001	.003
AUG	1987	.010	.021	.002	.005	.000	.002
SEP	1987	.027	.021	.009	.012	.001	.007
OCT	1987	.005	.050	.004	.026	.001	.010
NOV	1987	.005	.050	.003	.018	.001	.011
DEC	1987	.006	.026	.004	.012	.002	.004

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.012	.028	.005	.012	.001	.005
LAST 3 MONTHS ONLY	.005	.042	.004	.019	.001	.008

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P31 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.004	.008	.003	.005	.003	.003
FEB	1987	.003	.011	.002	.005	.001	.003
MAR	1987	.009	.013	.004	.006	.001	.002
APR	1987	.004	.007	.002	.005	.001	.002
MAY	1987	.002	.005	.001	.003	.001	.002
JUN	1987	.003	.050	.002	.017	.001	.000
JUL	1987	.018	.050	.005	.020	.001	.003
AUG	1987	.018	.045	.003	.011	.002	.003
SEP	1987	.006	.042	.002	.012	.001	.004
OCT	1987	.006	.110	.003	.044	.001	.001
NOV	1987	.003	.110	.001	.017	.001	.003
DEC	1987	.004	.097	.002	.025	.001	.004
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.007	.046	.002	.014	.001	.002
LAST 3 MONTHS ONLY		.004	.106	.002	.029	.001	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P34 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1987	.031	.010	.008	.006	.001	.004
FEB	1987	.001	.009	.001	.005	.001	.004
MAR	1987	.002	.009	.001	.004	.001	.002
APR	1987	.001	.009	.001	.006	.000	.003
MAY	1987	.001	.005	.001	.004	.000	.004
JUN	1987	.002	.071	.001	.020	.001	.003
JUL	1987	.002	.011	.002	.007	.001	.003
AUG	1987	.005	.012	.002	.006	.001	.003
SEP	1987	.022	.062	.004	.019	.000	.004
OCT	1987	.022	.027	.007	.018	.001	.008
NOV	1987	.013	.011	.002	.009	.001	.005
DEC	1987	.003	.025	.002	.014	.001	.008

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.009	.022	.003	.010	.001	.004
LAST 3 MONTHS ONLY	.013	.021	.004	.014	.001	.007

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P35   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.010	.028	.003	.015	.001	.008
FEB	1987	.001	.012	.001	.008	.001	.007
MAR	1987	.001	.019	.001	.009	.001	.006
APR	1987	.003	.019	.002	.013	.000	.005
MAY	1987	.002	.013	.001	.006	.000	.003
JUN	1987	.002	.028	.001	.010	.000	.002
JUL	1987	.002	.010	.001	.006	.000	.001
AUG	1987	.007	.150	.002	.045	.001	.006
SEP	1987	.004	.018	.002	.010	.001	.003
OCT	1987	.004	.026	.002	.014	.001	.001
NOV	1987	.004	.026	.001	.009	.001	.006
DEC	1987	.004	.013	.002	.007	.001	.002
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.004	.030	.002	.013	.001	.004
LAST 3 MONTHS ONLY		.004	.022	.002	.010	.001	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P47 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
FEB	1987	.002	.014	.001	.005	.001	.002
MAR	1987	.004	.014	.002	.003	.001	.001
APR	1987	.002	.006	.002	.003	.001	.001
NOV	1987	.023	.063	.008	.011	.001	.002
DEC	1987	.014	.023	.008	.016	.004	.013

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

5 MONTHS	.009	.028	.004	.006	.002	.004
LAST 3 MONTHS ONLY	.013	.037	.006	.010	.002	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 04

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
G36	01 87	12 87	12	.016	.033	.007	.016	.002	.006
G38	01 87	12 87	12	.012	.028	.005	.012	.001	.005
P31	01 87	12 87	12	.007	.046	.002	.014	.001	.002
P34	01 87	12 87	12	.009	.022	.003	.010	.001	.004
P35	01 87	12 87	12	.004	.030	.002	.013	.001	.004
P47	02 87	12 87	5	.009	.028	.004	.008	.002	.004
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
5 MONTHS				.009	.031	.004	.012	.001	.004
LAST 3 MONTHS ONLY				.009	.047	.004	.018	.001	.005

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB1 GROUP I.D. 07

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	.008	.029	.002	.009	.001	.002
FEB	1987	.001	.008	.001	.004	.000	.001
MAR	1987	.005	.034	.001	.010	.000	.001
APR	1987	.005	.034	.002	.011	.001	.002
MAY	1987	.002	.006	.001	.004	.000	.002
JUN	1987	.002	.072	.001	.021	.001	.003
JUL	1987	.003	.007	.002	.003	.001	.000
AUG	1987	.002	.007	.001	.003	.001	.002
SEP	1987	.002	.007	.002	.004	.001	.002
OCT	1987	.001	.019	.001	.011	.001	.004
NOV	1987	.001	.006	.001	.005	.001	.003
DEC	1987	.001	.010	.001	.006	.001	.002

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.003	.020	.001	.008	.001	.002
LAST 3 MONTHS ONLY	.001	.012	.001	.007	.001	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB2 GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.011	.027	.005	.019	.001	.007
FEB	1987	.011	.028	.006	.019	.001	.005
MAR	1987	.018	.096	.007	.031	.001	.005
APR	1987	.033	.110	.020	.075	.003	.010
MAY	1987	.029	.064	.022	.051	.003	.010
JUN	1987	.033	.100	.017	.050	.011	.028
JUL	1987	.031	.093	.020	.050	.014	.030
AUG	1987	.022	.100	.007	.065	.001	.004
SEP	1987	.004	.083	.003	.044	.001	.020
OCT	1987	.002	.031	.001	.018	.001	.006
NOV	1987	.002	.019	.001	.013	.001	.006
DEC	1987	.001	.012	.001	.010	.001	.006
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.016	.064	.009	.037	.003	.011
LAST 3 MONTHS ONLY		.002	.021	.001	.014	.001	.006

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB3   GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.008	.030	.004	.020	.000	.004
FEB	1987	.010	.041	.006	.019	.001	.004
MAR	1987	.010	.096	.004	.026	.003	.015
APR	1987	.007	.096	.004	.033	.001	.014
MAY	1987	.009	.035	.007	.023	.003	.014
JUN	1987	.016	.058	.008	.027	.001	.016
JUL	1987	.016	.034	.009	.022	.005	.013
AUG	1987	.009	.025	.006	.015	.000	.003
SEP	1987	.008	.030	.004	.012	.001	.003
OCT	1987	.004	.046	.002	.027	.001	.013
NOV	1987	.002	.033	.001	.023	.001	.013
DEC	1987	.003	.026	.002	.016	.001	.011

SITE AVERAGE: AVERAGE OF SITE DATA FOR:	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	.008	.046	.005	.022	.001	.010
LAST 3 MONTHS ONLY	.003	.035	.002	.023	.001	.012

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB4   GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.007	.027	.002	.011	.000	.000
FEB	1987	.002	.032	.001	.018	.000	.000
MAR	1987	.003	.032	.001	.011	.000	.005
APR	1987	.002	.032	.001	.022	.001	.014
MAY	1987	.002	.019	.001	.014	.001	.010
JUN	1987	.002	.014	.001	.011	.000	.007
JUL	1987	.003	.016	.001	.010	.000	.006
AUG	1987	.007	.018	.001	.011	.000	.001
SEP	1987	.007	.036	.003	.022	.001	.008
OCT	1987	.003	.036	.002	.024	.001	.006
NOV	1987	.004	.074	.002	.036	.001	.006
DEC	1987	.002	.031	.001	.020	.001	.011
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.004	.031	.001	.017	.000	.006
LAST 3 MONTHS ONLY		.003	.047	.002	.027	.001	.008

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 07

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FB1	01 87	12 87	12	.003	.020	.001	.008	.001	.002
FB2	01 87	12 87	12	.016	.064	.009	.037	.003	.011
FB3	01 87	12 87	12	.008	.046	.005	.022	.001	.010
FB4	01 87	12 87	12	.004	.031	.001	.017	.000	.006

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.008	.040	.004	.021	.001	.007
LAST 3 MONTHS ONLY	.002	.029	.001	.018	.001	.007

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: EXRF   GROUP I.D. 08

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	.040	.023	.017	.014	.001	.008
FEB	1987	.015	.019	.015	.017	.010	.008

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

2 MONTHS	.027	.021	.016	.015	.005	.008
LAST 3 MONTHS ONLY	.027	.021	.016	.015	.005	.008

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 08

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
EXRF	01 87	02 87	2	.027	.021	.016	.015	.005	.008
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
2 MONTHS				.027	.021	.016	.015	.005	.008
LAST 3 MONTHS ONLY				.027	.021	.016	.015	.005	.008

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TMI   GROUP I.D. 12

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.001	.025	.000	.016	.000	.007
FEB	1987	.002	.120	.001	.036	.000	.004
MAR	1987	.001	.036	.000	.024	.000	.007
APR	1987	.001	.028	.000	.013	.000	.001
MAY	1987	.007	.023	.002	.020	.000	.013
JUN	1987	.001	.034	.000	.022	.000	.006
JUL	1987	.001	.034	.001	.022	.000	.017
AUG	1987	.005	.030	.000	.019	.000	.004
SEP	1987	.001	.040	.001	.023	.000	.012
OCT	1987	.001	.087	.001	.061	.000	.040
NOV	1987	.001	.053	.001	.036	.001	.028
DEC	1987	.001	.038	.001	.024	.001	.009
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.002	.046	.001	.026	.000	.012
LAST 3 MONTHS ONLY		.001	.059	.001	.040	.001	.026

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 12

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TMI	01 87	12 87	12	.002	.046	.001	.026	.000	.012

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
12 MONTHS	.002	.046	.001	.026	.000	.012
LAST 3 MONTHS ONLY	.001	.059	.001	.040	.001	.026

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCS   GROUP I.D. 13

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	.002	4.780	.001	1.121	.001	.230
FEB	1987	.002	4.780	.001	.491	.001	.083
MAR	1987	.002	1.430	.001	.525	.001	.038
APR	1987	.002	.530	.001	.397	.001	.230
MAY	1987	.003	.630	.002	.459	.001	.310
JUN	1987	.002	.570	.001	.323	.000	.058
JUL	1987	.001	.520	.001	.344	.000	.210
AUG	1987	.001	.520	.001	.452	.001	.373
SEP	1987	.001	2.180	.001	.714	.001	.280
OCT	1987	.002	1.866	.001	.708	.001	.030
NOV	1987	.002	2.440	.001	.901	.001	.048
DEC	1987	.001	3.494	.001	.866	.001	.026

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.002	1.976	.001	.608	.001	.160
LAST 3 MONTHS ONLY	.002	2.600	.001	.825	.001	.035

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 13

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA **	BETA	AVERAGE WEIGHTED AVERAGE ALPHA **	BETA	AVERAGE LOWEST VALUE ALPHA **	BETA
HCS	01 87	12 87	12	.002	1.976	.001	.608	.001	.160
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.002	1.976	.001	.608	.001	.160
LAST 3 MONTHS ONLY				.002	2.600	.001	.525	.001	.035

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WPC GROUP I.D. 14

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.023	.058	.012	.039	.003	.027
FEB	1987	.036	.058	.016	.046	.003	.033
MAR	1987	.065	.120	.044	.069	.006	.037
APR	1987	.160	.340	.056	.136	.010	.041
MAY	1987	.120	.290	.089	.215	.013	.030
JUN	1987	.240	.570	.133	.341	.049	.130
JUL	1987	.150	.310	.078	.169	.042	.076
AUG	1987	1.460	2.720	.136	.221	.004	.018
SEP	1987	.158	.298	.056	.117	.000	.000
OCT	1987	.009	.026	.003	.015	.001	.006
NOV	1987	.020	.032	.007	.019	.001	.007
DEC	1987	.015	.043	.006	.029	.001	.020

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	.208	.410	.053	.120	.011	.037
LAST 3 MONTHS ONLY	.015	.034	.005	.021	.001	.011

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 14

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
WPC	01 87	12 87	12	.208	.410	.053	.120	.011	.037

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
12 MONTHS	.208	.410	.053	.120	.011	.037
LAST 3 MONTHS ONLY	.015	.034	.005	.021	.001	.011

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFL1   GROUP I.D. 16

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
FEB	1987	.015	.011	.004	.006	.001	.002
MAR	1987	.010	.023	.001	.012	.000	.002
APR	1987	.017	.021	.004	.005	.000	.000
MAY	1987	.017	.003	.004	.002	.001	.001
JUN	1987	.068	.068	.017	.026	.001	.001
JUL	1987	.068	.013	.018	.006	.001	.001
AUG	1987	.011	.056	.004	.023	.001	.003
SEP	1987	.002	.037	.001	.017	.001	.003
OCT	1987	.002	.037	.001	.019	.001	.001
NOV	1987	.003	.018	.001	.008	.001	.002
DEC	1987	.001	.009	.001	.003	.001	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

11 MONTHS	.019	.027	.005	.012	.001	.002
LAST 3 MONTHS ONLY	.002	.021	.001	.010	.001	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 16

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TFL1	02 87	12 87	11	.019	.027	.005	.012	.001	.002
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
11 MONTHS				.019	.027	.005	.012	.001	.002
LAST 3 MONTHS ONLY				.002	.021	.001	.010	.001	.001

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFLV   GROUP I.D. 17

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1987	.001	.003	.001	.003	.000	.002
FEB	1987	.001	.010	.001	.006	.000	.002
MAR	1987	.001	.009	.001	.003	.000	.002
APR	1987	.003	.018	.002	.005	.000	.002
MAY	1987	.002	.009	.001	.003	.000	.002
JUN	1987	.002	.063	.001	.006	.000	.002
JUL	1987	.002	.063	.001	.025	.000	.001
AUG	1987	.013	.037	.006	.018	.001	.002
SEP	1987	.001	.022	.001	.010	.000	.002
OCT	1987	.001	.021	.001	.012	.000	.001
NOV	1987	.007	.018	.002	.007	.001	.002
DEC	1987	.002	.011	.001	.006	.001	.002

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.003	.024	.002	.009	.000	.002
LAST 3 MONTHS ONLY	.003	.017	.001	.008	.001	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 17

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TFLV	01 87	12 87	12	.003	.024	.002	.009	.000	.002
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.003	.024	.002	.009	.000	.002
LAST 3 MONTHS ONLY				.003	.017	.001	.008	.001	.002

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCS1   GROUP I.D. 19

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.000	.005	.000	.004	.000	.000
FEB	1987	.000	.010	.000	.008	.000	.004
MAR	1987	.000	.009	.000	.005	.000	.000
APR	1987	.000	.021	.000	.009	.000	.000
MAY	1987	.000	.014	.000	.008	.000	.000
JUN	1987	.000	.010	.000	.007	.000	.000
JUL	1987	.000	.016	.000	.006	.000	.000
AUG	1987	.000	.017	.000	.010	.000	.000
SEP	1987	.000	.016	.000	.013	.000	.000
OCT	1987	.000	.011	.000	.004	.000	.000
NOV	1987	.000	.100	.000	.051	.000	.005
DEC	1987	.000	.001	.000	.001	.000	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.000	.019	.000	.010	.000	.001
LAST 3 MONTHS ONLY	.000	.037	.000	.019	.000	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 19

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
HCSI	01 87	12 87	12	.000	.019	.000	.010	.000	.001

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.000	.019	.000	.010	.000	.001
LAST 3 MONTHS ONLY	.000	.037	.000	.019	.000	.002

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: BKR1   GROUP I.D. 20

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.002	.018	.001	.012	.001	.007
FEB	1987	.001	.015	.001	.009	.000	.005
MAR	1987	.001	.013	.001	.009	.000	.001
APR	1987	.001	.057	.001	.023	.000	.011
MAY	1987	.001	.020	.001	.008	.001	.004
JUN	1987	.001	.058	.001	.019	.000	.006
JUL	1987	.002	.012	.001	.009	.000	.005
AUG	1987	.001	.021	.001	.014	.000	.009
SEP	1987	.003	.063	.001	.021	.001	.009
OCT	1987	.001	.063	.001	.024	.001	.010
NOV	1987	.001	.022	.001	.015	.001	.010
DEC	1987	.002	.029	.001	.014	.001	.007
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.001	.033	.001	.015	.000	.007
LAST 3 MONTHS ONLY		.001	.038	.001	.018	.001	.009

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 20

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
BKR1	01 87	12 87	12	.001	.033	.001	.015	.000	.007
BKR2	01 87	12 87	12	.002	.022	.001	.011	.000	.004

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.002	.027	.001	.013	.000	.005
LAST 3 MONTHS ONLY	.002	.032	.001	.018	.001	.009

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: BKR2   GROUP I.D. 20

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1987	.001	.005	.001	.003	.000	.002
FEB	1987	.003	.030	.001	.011	.000	.003
MAR	1987	.003	.030	.001	.012	.000	.000
APR	1987	.001	.010	.000	.005	.000	.004
MAY	1987	.001	.007	.001	.004	.000	.001
JUN	1987	.001	.020	.001	.009	.001	.002
JUL	1987	.002	.019	.001	.007	.000	.002
AUG	1987	.001	.024	.001	.010	.000	.001
SEP	1987	.001	.046	.001	.017	.000	.001
OCT	1987	.001	.024	.001	.014	.000	.003
NOV	1987	.003	.027	.002	.021	.001	.013
DEC	1987	.004	.027	.002	.022	.001	.011

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.002	.022	.001	.011	.000	.004
LAST 3 MONTHS ONLY	.003	.026	.002	.019	.001	.009

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

STACK SAMPLE RESULTS

1986

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: G36   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.790	1.530	.084	.144	.005	.010
FEB	1986	.790	1.530	.168	.299	.015	.013
MAR	1986	.099	.220	.058	.095	.021	.020
APR	1986	.210	.410	.087	.169	.001	.010
MAY	1986	.005	.049	.002	.026	.000	.006
JUN	1986	.004	.014	.003	.010	.000	.006
JUL	1986	.009	.012	.003	.007	.000	.006
AUG	1986	.060	.100	.017	.028	.003	.005
SEP	1986	.027	.072	.013	.028	.005	.000
OCT	1986	.006	.016	.005	.012	.003	.007
NOV	1986	.006	.013	.004	.006	.001	.002
DEC	1986	.003	.006	.002	.005	.001	.002

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.167	.331	.037	.069	.005	.007
LAST 3 MONTHS ONLY	.005	.012	.004	.008	.002	.004

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: 638   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.360	.830	.038	.097	.002	.005
FEB	1986	.360	.830	.101	.167	.006	.006
MAR	1986	.046	.098	.009	.020	.001	.003
APR	1986	2.460	5.070	.742	1.518	.001	.006
MAY	1986	.024	.140	.009	.048	.000	.005
JUN	1986	.039	.088	.020	.046	.000	.004
JUL	1986	.001	.005	.001	.003	.000	.000
AUG	1986	.007	.020	.003	.011	.001	.004
SEP	1986	.027	.072	.008	.019	.001	.003
OCT	1986	.007	.018	.003	.009	.000	.003
NOV	1986	.002	.005	.001	.003	.000	.001
DEC	1986	.002	.005	.001	.004	.001	.002

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.260	.598	.078	.162	.001	.003
LAST 3 MONTHS ONLY	.004	.009	.002	.005	.000	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P31 GROUP I.D. 04

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1986	.023	.036	.011	.012	.006	.008
FEB	1986	.020	.036	.006	.013	.002	.002
MAR	1986	.008	.021	.005	.008	.003	.004
APR	1986	.060	.130	.033	.048	.001	.003
MAY	1986	.007	.059	.003	.033	.001	.003
JUN	1986	.003	.010	.002	.006	.001	.005
JUL	1986	.003	.004	.001	.003	.000	.002
AUG	1986	.014	.015	.005	.007	.002	.004
SEP	1986	.004	.012	.003	.005	.001	.003
OCT	1986	.002	.008	.001	.006	.001	.003
NOV	1986	.005	.007	.003	.005	.001	.003
DEC	1986	.028	.006	.008	.005	.003	.003

SITE AVERAGE: AVERAGE OF SITE DATA FOR:						
12 MONTHS	.016	.029	.007	.013	.002	.004
LAST 3 MONTHS ONLY	.012	.007	.004	.005	.002	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P34 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1986	.039	.080	.009	.029	.002	.007
FEB	1986	.039	.080	.011	.021	.000	.002
MAR	1986	.016	.032	.005	.009	.001	.003
APR	1986	.064	.180	.032	.068	.000	.001
MAY	1986	.025	.120	.005	.074	.000	.015
JUN	1986	.029	.020	.002	.005	.000	.006
JUL	1986	.029	.012	.010	.008	.001	.003
SEP	1986	.002	.012	.001	.005	.000	.002
OCT	1986	.001	.007	.000	.006	.000	.004
NOV	1986	.004	.006	.002	.004	.000	.002
DEC	1986	.004	.009	.001	.006	.000	.002
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
11 MONTHS		.025	.051	.007	.022	.000	.004
LAST 3 MONTHS ONLY		.003	.007	.001	.005	.000	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P35   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
FEB	1986	.027	.056	.009	.017	.002	.006
MAR	1986	.007	.020	.003	.007	.001	.002
APR	1986	.100	.210	.038	.076	.001	.002
MAY	1986	.006	.210	.003	.063	.001	.005
JUN	1986	.005	.011	.003	.007	.001	.003
JUL	1986	.003	.007	.001	.004	.000	.002
AUG	1986	.003	.007	.002	.005	.001	.004
SEP	1986	.023	.038	.006	.010	.001	.002
OCT	1986	.002	.007	.001	.006	.001	.005
NOV	1986	.007	.005	.003	.002	.001	.001
DEC	1986	.008	.025	.003	.015	.001	.003
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
11 MONTHS		.017	.054	.007	.019	.001	.003
LAST 3 MONTHS ONLY		.006	.012	.002	.008	.001	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P47   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
FEB	1986	.038	.085	.013	.024	.006	.005
MAR	1986	.061	.085	.038	.045	.001	.007
APR	1986	.200	.430	.092	.209	.000	.002
MAY	1986	.010	.210	.006	.107	.000	.002
JUN	1986	.002	.004	.002	.003	.000	.002
JUL	1986	.003	.005	.002	.004	.000	.002
AUG	1986	.006	.016	.003	.012	.002	.004
SEP	1986	.009	.017	.004	.008	.001	.003
OCT	1986	.003	.004	.002	.003	.001	.003
NOV	1986	.005	.012	.002	.005	.000	.000
DEC	1986	.002	.004	.001	.003	.001	.002

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

11 MONTHS	.031	.079	.015	.038	.001	.003
LAST 3 MONTHS ONLY	.003	.007	.002	.004	.001	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 04

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
G36	01 86	12 86	12	.167	.331	.037	.069	.005	.007
G38	01 86	12 86	12	.280	.598	.078	.162	.001	.003
P31	01 86	12 86	12	.016	.029	.007	.013	.002	.004
P34	01 86	12 86	11	.025	.051	.007	.022	.000	.004
P35	02 86	12 86	11	.017	.054	.007	.019	.001	.003
P47	02 86	12 86	11	.031	.079	.015	.038	.001	.003

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

11 MONTHS	.089	.190	.025	.054	.002	.004
LAST 3 MONTHS ONLY	.005	.009	.002	.006	.001	.003

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB1   GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.004	.021	.002	.017	.001	.011
FEB	1986	.012	.011	.003	.006	.002	.001
MAR	1986	.010	.010	.006	.004	.001	.001
APR	1986	.009	.021	.006	.007	.003	.005
MAY	1986	.008	.034	.005	.019	.003	.005
JUN	1986	.007	.016	.005	.007	.001	.005
JUL	1986	.008	.016	.002	.011	.000	.005
AUG	1986	.008	.019	.005	.010	.003	.003
SEP	1986	.004	.012	.001	.004	.000	.001
OCT	1986	.004	.050	.002	.019	.001	.008
NOV	1986	.004	.017	.002	.010	.001	.004
DEC	1986	.004	.017	.001	.004	.001	.003

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.007	.020	.004	.010	.001	.004
LAST 3 MONTHS ONLY	.004	.028	.002	.011	.001	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB2   GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.012	.040	.003	.020	.001	.010
FEB	1986	.012	.040	.005	.017	.003	.009
MAR	1986	.005	.017	.004	.014	.003	.009
APR	1986	.021	.069	.008	.026	.001	.009
MAY	1986	.008	.200	.004	.118	.001	.021
JUN	1986	.005	.036	.002	.019	.001	.006
JUL	1986	.002	.020	.001	.009	.000	.005
AUG	1986	.007	.048	.003	.028	.001	.008
SEP	1986	.004	.016	.002	.010	.001	.004
OCT	1986	.008	.044	.004	.027	.002	.015
NOV	1986	.012	.037	.005	.022	.001	.006
DEC	1986	.003	.027	.001	.013	.001	.007

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.008	.049	.003	.027	.001	.009
LAST 3 MONTHS ONLY	.008	.036	.003	.021	.001	.010

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB3   GROUP I.D. 07

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1986	.002	.018	.002	.008	.001	.005
FEB	1986	.009	.016	.003	.009	.000	.005
MAR	1986	.015	.021	.002	.007	.001	.004
APR	1986	.021	.031	.009	.016	.003	.008
MAY	1986	.021	.060	.004	.038	.001	.013
JUN	1986	.003	.027	.002	.013	.001	.009
JUL	1986	.002	.021	.001	.014	.001	.007
AUG	1986	.010	.045	.005	.024	.001	.007
SEP	1986	.006	.045	.002	.014	.001	.008
OCT	1986	.006	.048	.003	.025	.002	.014
NOV	1986	.010	.036	.004	.020	.001	.006
DEC	1986	.004	.022	.002	.012	.000	.004
SITE AVERAGE: AVERAGE OF SITE DATA FOR: 12 MONTHS		.009	.032	.003	.017	.001	.007
LAST 3 MONTHS ONLY		.007	.035	.003	.019	.001	.008

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB4 GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.002	.026	.001	.017	.001	.013
FEB	1986	.002	.015	.001	.010	.001	.007
MAR	1986	.001	.015	.001	.010	.000	.004
APR	1986	.007	.022	.003	.015	.000	.004
MAY	1986	.001	.280	.001	.132	.001	.004
JUN	1986	.003	.067	.001	.026	.001	.007
JUL	1986	.003	.027	.002	.016	.001	.005
AUG	1986	.003	.022	.002	.018	.001	.014
SEP	1986	.002	.022	.001	.016	.001	.012
OCT	1986	.001	.019	.001	.018	.001	.014
NOV	1986	.002	.029	.001	.018	.001	.010
DEC	1986	.021	.280	.005	.072	.000	.003

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.004	.069	.002	.031	.001	.008
LAST 3 MONTHS ONLY	.008	.109	.002	.036	.001	.009

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 07

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FB1	01 86	12 86	12	.007	.020	.004	.010	.001	.004
FB2	01 86	12 86	12	.008	.049	.003	.027	.001	.009
FB3	01 86	12 86	12	.009	.032	.003	.017	.001	.007
FB4	01 86	12 86	12	.004	.069	.002	.031	.001	.008
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.007	.043	.003	.021	.001	.007
LAST 3 MONTHS ONLY				.007	.052	.003	.022	.001	.008

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: EXRF   GROUP I.D. 08

MONTH	YEAR	HIGHEST VALUE ALPHA **	BETA	WEIGHTED AVERAGE ALPHA **	BETA	LOWEST VALUE ALPHA **	BETA
JAN	1986	1.400	.810	.015	.009	.010	.006
FEB	1986	.041	.018	.026	.012	.011	.008
MAR	1986	.023	.014	.013	.010	.000	.000
APR	1986	.037	.019	.016	.008	.000	.000
MAY	1986	.044	.047	.018	.021	.001	.001
JUN	1986	.047	.025	.030	.017	.001	.001
JUL	1986	.020	.017	.009	.010	.000	.001
AUG	1986	.063	.049	.032	.021	.000	.001
SEP	1986	.063	.049	.026	.019	.014	.009
OCT	1986	.027	.042	.020	.022	.014	.009
NOV	1986	.048	.031	.026	.018	.012	.007
DEC	1986	.018	.018	.011	.012	.007	.010

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.158	.095	.020	.015	.006	.004
LAST 3 MONTHS ONLY	.031	.030	.019	.017	.011	.009

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 08

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
EXRF	01 86	12 86	12	.158	.095	.020	.015	.006	.004

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
12 MONTHS	.158	.095	.020	.015	.006	.004
LAST 3 MONTHS ONLY	.031	.030	.019	.017	.011	.009

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TMI GROUP I.D. 12

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1986	.002	.019	.001	.014	.001	.010
FEB	1986	.002	.020	.001	.013	.000	.007
MAR	1986	.001	.180	.000	.052	.000	.004
APR	1986	.002	.016	.001	.011	.000	.008
MAY	1986	.002	.079	.001	.056	.000	.009
JUN	1986	.002	.038	.001	.023	.000	.010
DEC	1986	.001	.026	.000	.013	.000	.007

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
7 MONTHS	.002	.054	.001	.026	.000	.008
LAST 3 MONTHS ONLY	.002	.048	.001	.031	.000	.009

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 12

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TMI	01 86	12 86	7	.002	.054	.001	.026	.000	.008

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:	HIGHEST ALPHA	BETA	WEIGHTED ALPHA	BETA	LOWEST ALPHA	BETA
7 MONTHS	.002	.054	.001	.026	.000	.008
LAST 3 MONTHS ONLY	.002	.048	.001	.031	.000	.009

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCS   GROUP I.D. 13

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1986	.016	.600	.004	.227	.000	.010
FEB	1986	.002	.520	.001	.262	.001	.034
MAR	1986	.001	.520	.001	.212	.000	.076
APR	1986	.013	.900	.003	.343	.000	.002
MAY	1986	.013	.700	.004	.265	.000	.002
JUN	1986	.001	.780	.001	.301	.000	.000
JUL	1986	.003	3.430	.001	.921	.000	.000
AUG	1986	.003	.780	.001	.395	.001	.100
SEP	1986	.002	.670	.002	.411	.001	.300
OCT	1986	.005	.830	.003	.443	.001	.110
NOV	1986	.004	.430	.001	.248	.000	.120
DEC	1986	.001	.290	.001	.242	.000	.120

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.005	.871	.002	.356	.000	.073
LAST 3 MONTHS ONLY	.003	.517	.002	.311	.000	.117

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 13

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
HCS	01 86	12 86	12	.005	.871	.002	.356	.000	.073

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
12 MONTHS	.005	.871	.002	.356	.000	.073
LAST 3 MONTHS ONLY	.003	.517	.002	.311	.000	.117

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WPC   GROUP I.D. 14

MONTH	YEAR	HIGHEST VALUE ALPHA **	BETA	WEIGHTED AVERAGE ALPHA **	BETA	LOWEST VALUE ALPHA **	BETA
JUL	1986	.460	.450	.460	.450	.460	.450
AUG	1986	.460	.450	.088	.143	.018	.022
SEP	1986	.048	.200	.017	.055	.001	.000
OCT	1986	.017	.067	.009	.030	.003	.000
NOV	1986	.076	.170	.024	.062	.003	.009
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
5 MONTHS		.212	.267	.120	.148	.097	.096
LAST 3 MONTHS ONLY		.047	.146	.017	.049	.002	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 14

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
WPC	07 86	11 86	5	.212	.267	.120	.148	.097	.096
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
5 MONTHS				.212	.267	.120	.148	.097	.096
LAST 3 MONTHS ONLY				.047	.146	.017	.049	.002	.003

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFL1   GROUP I.D. 16

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.010	.004	.003	.003	.001	.002
FEB	1986	.001	.024	.001	.005	.000	.001
MAR	1986	.002	.024	.001	.005	.000	.002
APR	1986	.017	.500	.002	.044	.000	.002
MAY	1986	.017	.500	.004	.079	.001	.002
JUN	1986	.002	.029	.001	.009	.001	.002
JUL	1986	.026	.006	.006	.004	.000	.002
AUG	1986	.002	.006	.001	.003	.000	.002
SEP	1986	.002	.002	.001	.002	.001	.001
OCT	1986	.002	.010	.001	.005	.001	.002
NOV	1986	.047	.007	.015	.004	.001	.003
DEC	1986	.014	.006	.003	.003	.001	.002

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.012	.093	.003	.014	.001	.002
LAST 3 MONTHS ONLY	.021	.008	.006	.004	.001	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 16

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TFL1	01 86	12 86	12	.012	.093	.003	.014	.001	.002

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
12 MONTHS	.012	.093	.003	.014	.001	.002
LAST 3 MONTHS ONLY	.021	.008	.006	.004	.001	.002

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFLV GROUP I.D. 17

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1986	.002	.006	.001	.005	.000	.002
FEB	1986	.002	.017	.001	.005	.000	.002
MAR	1986	.001	.017	.001	.005	.000	.002
APR	1986	.025	.300	.003	.028	.000	.002
MAY	1986	.025	.300	.004	.057	.001	.004
JUN	1986	.001	.004	.001	.003	.000	.002
JUL	1986	.001	.007	.001	.004	.000	.002
AUG	1986	.002	.410	.001	.081	.000	.000
SEP	1986	.008	.034	.002	.002	.000	.000
OCT	1986	.002	.089	.001	.024	.000	.003
NOV	1986	.002	.005	.001	.004	.001	.002
DEC	1986	.002	.003	.001	.002	.001	.002

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
12 MONTHS	.006	.097	.001	.018	.000	.002
LAST 3 MONTHS ONLY	.002	.032	.001	.010	.001	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 17

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TFLV	01 86	12 86	12	.006	.097	.001	.018	.000	.002

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.006	.097	.001	.018	.000	.002
LAST 3 MONTHS ONLY	.002	.032	.001	.010	.001	.002

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: EA1S   GROUP I.D. 18

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1986	.001	.069	.001	.041	.001	.019
FEB	1986	.001	.056	.001	.031	.000	.015
MAR	1986	.001	.036	.000	.021	.000	.010
APR	1986	.003	.025	.001	.018	.000	.003
MAY	1986	.001	.035	.001	.018	.000	.000
JUN	1986	.004	.089	.001	.024	.000	.019

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	ALPHA (HIGHEST)	BETA (HIGHEST)	ALPHA (WEIGHTED)	BETA (WEIGHTED)	ALPHA (LOWEST)	BETA (LOWEST)
6 MONTHS	.002	.052	.001	.025	.000	.011
LAST 3 MONTHS ONLY	.003	.050	.001	.020	.000	.007

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 18

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
EA1S	01 86	06 86	6	.002	.052	.001	.025	.000	.011

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
6 MONTHS	.002	.052	.001	.025	.000	.011
LAST 3 MONTHS ONLY	.003	.050	.001	.020	.000	.007

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCSI   GROUP I.D. 19

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1986	.000	.000	.000	.000	.000	.000
FEB	1986	.000	.000	.000	.000	.000	.000
MAR	1986	.000	.000	.000	.000	.000	.000
APR	1986	.000	.000	.000	.000	.000	.000
MAY	1986	.000	.016	.000	.002	.000	.000
JUN	1986	.000	.170	.000	.041	.000	.000
JUL	1986	.000	.000	.000	.000	.000	.000
AUG	1986	.000	.000	.000	.000	.000	.000
SEP	1986	.000	.190	.000	.054	.000	.000
OCT	1986	.000	.093	.000	.043	.000	.010
NOV	1986	.000	.014	.000	.009	.000	.004
DEC	1986	.000	.014	.000	.004	.000	.000

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.000	.041	.000	.013	.000	.001
LAST 3 MONTHS ONLY	.000	.040	.000	.019	.000	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 19

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
HCSI	01 86	12 86	12	.000	.041	.000	.013	.000	.001
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.000	.041	.000	.013	.000	.001
LAST 3 MONTHS ONLY				.000	.040	.000	.019	.000	.005

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: BKR1 GROUP I.D. 20

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1986	.001	.030	.001	.014	.000	.005
FEB	1986	.001	.010	.000	.007	.000	.005
MAR	1986	.001	.011	.000	.006	.000	.003
APR	1986	.002	.082	.001	.016	.000	.005
MAY	1986	.003	.180	.001	.106	.000	.031
JUN	1986	.004	.031	.001	.016	.000	.002
JUL	1986	.007	.008	.003	.006	.000	.002
AUG	1986	.002	.008	.001	.006	.001	.002
SEP	1986	.001	.013	.001	.008	.000	.002
OCT	1986	.002	.023	.001	.013	.000	.000
NOV	1986	.001	.019	.001	.014	.000	.008
DEC	1986	.001	.014	.001	.013	.001	.009

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
12 MONTHS	.002	.036	.001	.019	.000	.006
LAST 3 MONTHS ONLY	.001	.019	.001	.013	.000	.006

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 20

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
BKR1	01 86	12 86	12	.002	.036	.001	.019	.000	.006
BKR2	01 86	12 86	12	.004	.087	.001	.019	.000	.002

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.003	.061	.001	.019	.000	.004
LAST 3 MONTHS ONLY	.001	.015	.001	.010	.000	.004

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: BKR2   GROUP I.D. 20

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1986	.001	.006	.000	.004	.000	.003
FEB	1986	.003	.003	.001	.003	.000	.002
MAR	1986	.003	.005	.001	.003	.000	.002
APR	1986	.011	.003	.001	.002	.000	.001
MAY	1986	.011	.025	.002	.016	.001	.001
JUN	1986	.001	.470	.000	.014	.000	.002
JUL	1986	.002	.470	.001	.161	.000	.002
AUG	1986	.006	.016	.002	.005	.000	.002
SEP	1986	.002	.010	.001	.005	.000	.002
OCT	1986	.001	.019	.001	.010	.000	.003
NOV	1986	.002	.009	.001	.005	.000	.002
DEC	1986	.001	.005	.001	.004	.000	.002
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.004	.087	.001	.019	.000	.002
LAST 3 MONTHS ONLY		.001	.011	.001	.006	.000	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

STACK SAMPLE RESULTS

1985

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: G36 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.010	.040	.005	.013	.000	.002
FEB	1985	.006	.007	.004	.003	.002	.002
MAR	1985	.019	.014	.009	.006	.004	.002
APR	1985	.005	.010	.004	.006	.001	.003
MAY	1985	.012	.010	.007	.006	.005	.004
JUN	1985	.024	.025	.009	.008	.002	.003
JUL	1985	.034	.010	.012	.006	.002	.002
AUG	1985	.026	.058	.011	.015	.001	.005
SEP	1985	.026	.060	.010	.023	.003	.004
OCT	1985	.077	.060	.035	.042	.003	.003
NOV	1985	.077	.042	.029	.022	.007	.006
DEC	1985	.014	.047	.010	.021	.005	.006

SITE AVERAGE: AVERAGE OF SITE DATA FOR:	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	.027	.032	.012	.014	.003	.003
LAST 3 MONTHS ONLY	.056	.050	.025	.028	.005	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: G38 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.050	.070	.007	.022	.000	.001
FEB	1985	.030	.020	.009	.005	.002	.003
MAR	1985	.010	.013	.004	.007	.001	.002
APR	1985	.005	.008	.002	.003	.001	.002
MAY	1985	.069	.140	.017	.036	.001	.003
JUN	1985	.014	.073	.004	.019	.001	.003
JUL	1985	.014	.013	.002	.007	.001	.002
AUG	1985	.012	.028	.006	.013	.001	.002
SEP	1985	.055	.123	.016	.036	.001	.003
OCT	1985	.055	.120	.029	.062	.001	.002
NOV	1985	.009	.018	.004	.012	.002	.008
DEC	1985	.009	.740	.006	.223	.002	.007

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.029	.114	.009	.037	.001	.003
LAST 3 MONTHS ONLY	.024	.293	.013	.099	.002	.006

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P31   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1985	.008	.003	.004	.002	.001	.001
FEB	1985	.003	.003	.003	.002	.001	.001
MAR	1985	.020	.180	.007	.051	.000	.001
APR	1985	.047	.032	.012	.009	.001	.002
MAY	1985	.003	.005	.002	.003	.001	.002
JUN	1985	.003	.005	.001	.003	.001	.002
JUL	1985	.015	.008	.008	.006	.001	.004
AUG	1985	.002	.005	.001	.003	.001	.002
SEP	1985	.007	.005	.004	.003	.001	.002
OCT	1985	.005	.079	.003	.038	.002	.005
NOV	1985	.008	.079	.004	.018	.002	.005
DEC	1985	.023	.012	.014	.009	.007	.006
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.012	.035	.005	.012	.002	.003
LAST 3 MONTHS ONLY		.012	.057	.007	.022	.004	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P34   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.002	.004	.001	.002	.000	.001
FEB	1985	.002	.003	.001	.002	.001	.001
MAR	1985	.005	.010	.003	.005	.001	.001
APR	1985	.002	.004	.001	.003	.000	.002
MAY	1985	.001	.004	.001	.003	.001	.001
JUN	1985	.002	.004	.001	.003	.001	.002
JUL	1985	.016	.018	.007	.009	.000	.001
AUG	1985	.004	.010	.002	.004	.000	.001
AUG	1985	.004	.010	.002	.004	.000	.001
SEP	1985	.002	.010	.001	.004	.001	.002
OCT	1985	.019	.017	.005	.010	.001	.004
NOV	1985	.007	.017	.004	.008	.001	.003
DEC	1985	.018	.051	.009	.036	.001	.003

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

13 MONTHS	.006	.012	.003	.007	.001	.002
LAST 3 MONTHS ONLY	.015	.028	.006	.018	.001	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 85

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA **	AVERAGE HIGHEST VALUE BETA	AVERAGE WEIGHTED AVERAGE ALPHA **	AVERAGE WEIGHTED AVERAGE BETA	AVERAGE LOWEST VALUE ALPHA **	AVERAGE LOWEST VALUE BETA
G36	01 85	12 85	12	.027	.032	.012	.014	.003	.003
G38	01 85	12 85	12	.029	.114	.009	.037	.001	.003
P31	01 85	12 85	12	.012	.035	.005	.012	.002	.003
P34	01 85	12 85	13	.006	.012	.003	.007	.001	.002
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
13 MONTHS				.019	.048	.007	.018	.002	.003
LAST 3 MONTHS ONLY				.027	.107	.013	.042	.003	.005

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P35   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1985	.002	.110	.001	.052	.001	.002
FEB	1985	.005	.003	.002	.003	.001	.002
MAR	1985	.003	.005	.001	.003	.001	.002
APR	1985	.005	.004	.002	.003	.001	.002
MAY	1985	.002	.007	.001	.004	.000	.002
JUN	1985	.004	.005	.002	.004	.001	.003
JUL	1985	.011	.027	.004	.017	.001	.002
AUG	1985	.002	.007	.001	.004	.001	.002
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
8 MONTHS		.004	.021	.002	.011	.001	.002
LAST 3 MONTHS ONLY		.006	.013	.002	.008	.001	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P47   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.004	.004	.002	.003	.001	.001
FEB	1985	.005	.030	.003	.010	.001	.001
MAR	1985	.003	.005	.002	.004	.002	.003
APR	1985	.010	.013	.004	.007	.001	.002
MAY	1985	.005	.013	.003	.011	.001	.005
JUN	1985	.003	.011	.002	.007	.002	.005
JUL	1985	.007	.025	.004	.019	.002	.011
AUG	1985	.050	.019	.018	.014	.003	.010

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

8 MONTHS	.011	.015	.005	.009	.002	.005
LAST 3 MONTHS ONLY	.020	.018	.008	.013	.002	.009

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 04

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
P35	01 85	08 85	8	.004	.021	.002	.011	.001	.002
P47	01 85	08 85	8	.011	.015	.005	.009	.002	.005
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
8 MONTHS				.008	.018	.003	.010	.001	.003
LAST 3 MONTHS ONLY				.013	.016	.005	.011	.002	.005

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB1   GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.010	.100	.003	.025	.001	.003
FEB	1985	.001	.015	.001	.011	.001	.006
MAR	1985	.002	.012	.001	.010	.001	.009
APR	1985	.010	.050	.003	.020	.000	.009
MAY	1985	.001	.012	.001	.010	.000	.008
JUN	1985	.005	.018	.002	.011	.000	.007
JUL	1985	.008	.019	.003	.011	.001	.005
AUG	1985	.001	.013	.001	.010	.001	.008
SEP	1985	.001	.010	.001	.009	.001	.007
OCT	1985	.002	.007	.001	.004	.000	.001
NOV	1985	.001	.005	.001	.004	.000	.002
DEC	1985	.001	.026	.001	.012	.000	.002
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.004	.024	.002	.011	.000	.006
LAST 3 MONTHS ONLY		.001	.013	.001	.007	.000	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB2 GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.020	.020	.007	.013	.001	.004
FEB	1985	.003	.015	.001	.012	.001	.008
MAR	1985	.002	.020	.001	.012	.001	.008
APR	1985	.001	.014	.001	.009	.000	.005
MAY	1985	.008	.025	.003	.016	.000	.008
JUN	1985	.004	.070	.002	.028	.001	.013
JUL	1985	.007	.023	.003	.014	.001	.008
AUG	1985	.002	.014	.002	.013	.001	.010
SEP	1985	.002	.018	.001	.012	.001	.009
OCT	1985	.003	.021	.002	.016	.001	.009
NOV	1985	.013	.021	.004	.013	.001	.009
DEC	1985	.003	.030	.002	.019	.001	.009

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.006	.024	.002	.015	.001	.008
LAST 3 MONTHS ONLY	.006	.024	.003	.016	.001	.009

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB3 GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.007	.010	.001	.007	.000	.002
FEB	1985	.010	.010	.002	.009	.001	.007
MAR	1985	.006	.012	.002	.009	.001	.008
APR	1985	.006	.021	.004	.011	.001	.006
MAY	1985	.001	.013	.001	.009	.001	.005
JUN	1985	.004	.017	.002	.013	.001	.007
JUL	1985	.004	.017	.001	.011	.000	.003
AUG	1985	.002	.012	.001	.011	.001	.009
SEP	1985	.001	.020	.001	.014	.000	.011
OCT	1985	.003	.022	.002	.019	.001	.015
NOV	1985	.002	.020	.001	.015	.001	.011
DEC	1985	.009	.026	.002	.019	.001	.011
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.005	.017	.002	.012	.001	.008
LAST 3 MONTHS ONLY		.005	.023	.002	.018	.001	.012

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB4 GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.007	.010	.002	.007	.000	.002
FEB	1985	.004	.024	.002	.019	.001	.010
MAR	1985	.003	.018	.002	.011	.002	.009
APR	1985	.005	.019	.003	.013	.002	.009
MAY	1985	.006	.026	.004	.019	.002	.014
JUN	1985	.002	.014	.001	.011	.001	.007
JUL	1985	.003	.015	.001	.011	.000	.003
AUG	1985	.001	.014	.001	.011	.000	.010
SEP	1985	.001	.015	.001	.012	.001	.008
OCT	1985	.004	.030	.002	.021	.000	.015
NOV	1985	.002	.030	.001	.015	.001	.011
DEC	1985	.002	.026	.001	.016	.000	.008

SITE AVERAGE: AVERAGE OF SITE DATA FOR:	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	.003	.020	.002	.014	.001	.009
LAST 3 MONTHS ONLY	.003	.029	.001	.017	.000	.011

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 07

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FB1	01 85	12 85	12	.004	.024	.002	.011	.000	.006
FB2	01 85	12 85	12	.006	.024	.002	.015	.001	.008
FB3	01 85	12 85	12	.005	.017	.002	.012	.001	.008
FB4	01 85	12 85	12	.003	.020	.002	.014	.001	.009
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.004	.021	.002	.013	.001	.008
LAST 3 MONTHS ONLY				.004	.022	.002	.014	.001	.009

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: EXRF   GROUP I.D. 08

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1985	.020	.020	.002	.003	.000	.001
FEB	1985	.001	.009	.001	.003	.000	.001
MAR	1985	3.730	1.550	1.336	.575	.001	.001
APR	1985	.070	.018	.026	.011	.000	.002
MAY	1985	.040	.028	.015	.013	.003	.005
JUN	1985	.110	.048	.054	.027	.020	.013
JUL	1985	.063	.050	.026	.017	.000	.001
AUG	1985	.110	.030	.042	.018	.020	.010
SEP	1985	.110	.032	.055	.020	.028	.010
OCT	1985	.048	.032	.030	.023	.021	.014
NOV	1985	.035	.019	.018	.014	.008	.007
DEC	1985	1.460	.810	.108	.068	.019	.018

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
12 MONTHS	.483	.220	.143	.066	.010	.007
LAST 3 MONTHS ONLY	.514	.287	.052	.035	.016	.013

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 08

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
EXRF	01 85	12 85	12	.463	.220	.143	.066	.010	.007

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
12 MONTHS	.463	.220	.143	.066	.010	.007
LAST 3 MONTHS ONLY	.514	.287	.092	.035	.016	.013

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TMI GROUP I.D. 12

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.020	.030	.002	.011	.000	.002
FEB	1985	.001	.016	.001	.007	.000	.002
MAR	1985	.009	.020	.003	.011	.000	.006
APR	1985	.001	.021	.001	.009	.000	.005
MAY	1985	.002	.011	.001	.008	.000	.005
JUN	1985	.002	.014	.001	.010	.001	.006
JUL	1985	.002	.019	.001	.014	.001	.006
AUG	1985	.001	.014	.001	.011	.000	.008
SEP	1985	.001	.014	.001	.009	.000	.002
OCT	1985	.001	.014	.001	.011	.000	.010
NOV	1985	.004	.027	.002	.016	.001	.007
DEC	1985	.003	.044	.001	.019	.000	.007
SITE AVERAGE: AVERAGE OF SITE DATA FOR: 12 MONTHS		.004	.020	.001	.011	.000	.005
LAST 3 MONTHS ONLY		.003	.028	.001	.015	.000	.008

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 12

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TMI	01 85	12 85	12	.004	.020	.001	.011	.000	.005

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.004	.020	.001	.011	.000	.005
LAST 3 MONTHS ONLY	.003	.028	.001	.015	.000	.008

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCS GROUP I.D. 13

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.009	.280	.001	.193	.001	.130
FEB	1985	.002	.210	.001	.152	.000	.100
MAR	1985	.011	.150	.004	.093	.000	.051
APR	1985	.001	.190	.001	.068	.000	.009
MAY	1985	.001	.190	.001	.074	.000	.034
JUN	1985	.004	.110	.002	.090	.000	.042
JUL	1985	.004	.100	.001	.045	.000	.011
AUG	1985	.004	.089	.001	.051	.000	.032
SEP	1985	.001	.170	.001	.069	.000	.003
OCT	1985	.006	.080	.002	.045	.000	.003
NOV	1985	.003	2.960	.001	1.150	.000	.030
DEC	1985	.016	.160	.002	.111	.000	.028

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.005	.391	.001	.178	.000	.039
LAST 3 MONTHS ONLY	.008	1.067	.002	.435	.000	.020

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 13

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA **	BETA	AVERAGE WEIGHTED AVERAGE ALPHA **	BETA	AVERAGE LOWEST VALUE ALPHA **	BETA
HCS	01 85	12 85	12	.005	.391	.001	.178	.000	.039

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
12 MONTHS	.005	.391	.001	.178	.000	.039
LAST 3 MONTHS ONLY	.008	1.067	.002	.435	.000	.020

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WPC GROUP I.D. 14

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1985	.160	.050	.160	.050	.160	.050
FEB	1985	.003	.003	.003	.003	.003	.003
JUN	1985	.003	.020	.003	.020	.003	.020
JUL	1985	.940	.740	.940	.740	.940	.740
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
4 MONTHS		.276	.203	.276	.203	.276	.203
LAST 3 MONTHS ONLY		.315	.254	.315	.254	.315	.254

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 14

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
WPC	01 85	07 85	4	.276	.203	.276	.203	.276	.203

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
4 MONTHS	.276	.203	.276	.203	.276	.203
LAST 3 MONTHS ONLY	.315	.254	.315	.254	.315	.254

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFL1   GROUP I.D. 16

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.020	.007	.004	.002	.000	.001
FEB	1985	.009	.002	.003	.002	.001	.002
MAR	1985	.011	.015	.005	.006	.001	.002
APR	1985	.018	.070	.005	.020	.001	.002
MAY	1985	.004	.006	.002	.004	.001	.002
JUN	1985	.012	.008	.005	.006	.001	.004
JUL	1985	.002	.007	.001	.003	.001	.002
AUG	1985	.010	.003	.003	.002	.000	.002
SEP	1985	.002	.013	.001	.005	.000	.000
OCT	1985	.017	.024	.006	.005	.000	.000
NOV	1985	.006	.025	.003	.014	.000	.003
DEC	1985	.026	.020	.007	.009	.000	.002
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.011	.017	.004	.006	.000	.002
LAST 3 MONTHS ONLY		.016	.023	.005	.009	.000	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 16

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TFL1	01 85	12 85	12	.011	.017	.004	.006	.000	.002

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.011	.017	.004	.006	.000	.002
LAST 3 MONTHS ONLY	.016	.023	.005	.009	.000	.002

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFLV   GROUP I.D. 17

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.020	.008	.001	.003	.000	.002
FEB	1985	.001	.008	.000	.004	.000	.002
MAR	1985	.060	.170	.015	.069	.000	.002
APR	1985	.010	.016	.004	.007	.001	.003
MAY	1985	.002	.005	.001	.005	.001	.004
JUN	1985	.003	.005	.002	.003	.001	.002
JUL	1985	.003	.013	.001	.006	.001	.003
AUG	1985	.001	.004	.001	.004	.000	.002
SEP	1985	.003	.020	.001	.007	.000	.000
OCT	1985	.017	.038	.004	.010	.000	.000
NOV	1985	.011	.010	.003	.008	.001	.006
DEC	1985	.011	.010	.002	.007	.000	.004
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.012	.026	.003	.011	.000	.002
LAST 3 MONTHS ONLY		.013	.019	.003	.008	.000	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 17

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TFLV	01 85	12 85	12	.012	.026	.003	.011	.000	.002

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:						
12 MONTHS	.012	.026	.003	.011	.000	.002
LAST 3 MONTHS ONLY	.013	.019	.003	.008	.000	.003

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: EA1S GROUP I.D. 18

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.008	.060	.001	.034	.001	.008
FEB	1985	.001	.060	.000	.029	.000	.003
MAR	1985	.011	.030	.001	.024	.001	.003
APR	1985	.001	.720	.001	.183	.001	.019
MAY	1985	.001	.032	.001	.024	.000	.018
JUN	1985	.005	.057	.001	.023	.000	.008
JUL	1985	.054	.057	.008	.020	.001	.013
AUG	1985	.001	.024	.001	.018	.001	.016
SEP	1985	.001	.029	.001	.023	.001	.016
OCT	1985	.001	.037	.001	.022	.001	.009
NOV	1985	.007	.060	.002	.036	.001	.001
DEC	1985	.010	.039	.003	.030	.001	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.007	.102	.002	.039	.001	.010
LAST 3 MONTHS ONLY	.006	.045	.002	.030	.001	.004

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 18

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA **	AVERAGE HIGHEST VALUE BETA	AVERAGE WEIGHTED AVERAGE ALPHA **	AVERAGE WEIGHTED AVERAGE BETA	AVERAGE LOWEST VALUE ALPHA **	AVERAGE LOWEST VALUE BETA
EA1S	01 85	12 85	12	.007	.102	.002	.039	.001	.010

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.007	.102	.002	.039	.001	.010
LAST 3 MONTHS ONLY	.006	.045	.002	.030	.001	.004

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCSI   GROUP I.D. 19

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1985	.000	.000	.000	.000	.000	.000
FEB	1985	.000	.000	.000	.000	.000	.000
MAR	1985	.000	.000	.000	.000	.000	.000
APR	1985	.000	.000	.000	.000	.000	.000
MAY	1985	.000	.000	.000	.000	.000	.000
JUN	1985	.000	.000	.000	.000	.000	.000
JUL	1985	.000	.000	.000	.000	.000	.000
AUG	1985	.000	.000	.000	.000	.000	.000
SEP	1985	.000	.000	.000	.000	.000	.000
OCT	1985	.000	.000	.000	.000	.000	.000
NOV	1985	.000	.000	.000	.000	.000	.000
DEC	1985	.000	.000	.000	.000	.000	.000
SITE AVERAGE: AVERAGE OF SITE DATA FOR: 12 MONTHS		.000	.000	.000	.000	.000	.000
LAST 3 MONTHS ONLY		.000	.000	.000	.000	.000	.000

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCSI GROUP I.D. 19

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1985	.000	.000	.000	.000	.000	.000
FEB	1985	.000	.000	.000	.000	.000	.000
MAR	1985	.000	.000	.000	.000	.000	.000
APR	1985	.000	.000	.000	.000	.000	.000
MAY	1985	.000	.000	.000	.000	.000	.000
JUN	1985	.000	.000	.000	.000	.000	.000
JUL	1985	.000	.000	.000	.000	.000	.000
AUG	1985	.000	.000	.000	.000	.000	.000
SEP	1985	.000	.000	.000	.000	.000	.000
OCT	1985	.000	.000	.000	.000	.000	.000
NOV	1985	.000	.000	.000	.000	.000	.000
DEC	1985	.000	.000	.000	.000	.000	.000
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.000	.000	.000	.000	.000	.000
LAST 3 MONTHS ONLY		.000	.000	.000	.000	.000	.000

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 19

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
HCS1	01 85	12 85	12	.000	.000	.000	.000	.000	.000

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
12 MONTHS	.000	.000	.000	.000	.000	.000
LAST 3 MONTHS ONLY	.000	.000	.000	.000	.000	.000

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: BKR1 GROUP I.D. 2D

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JUN	1985	.009	.023	.005	.020	.003	.016
JUL	1985	.008	.038	.003	.016	.001	.008
AUG	1985	.058	43.800	.006	.369	.000	.008
SEP	1985	.001	.011	.001	.008	.000	.006
OCT	1985	.001	.013	.001	.010	.001	.007
NOV	1985	.007	.016	.002	.014	.001	.009
DEC	1985	.002	.130	.001	.039	.001	.009

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

7 MONTHS	.012	6.290	.003	.071	.001	.009
LAST 3 MONTHS ONLY	.003	.053	.001	.021	.001	.008

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 20

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
BKP1	06 85	12 85	7	.012	6.290	.003	.071	.001	.009
BKP2	06 85	12 85	7	.007	.048	.001	.009	.000	.002
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
7 MONTHS				.010	3.169	.002	.040	.001	.006
LAST 3 MONTHS ONLY				.003	.047	.001	.016	.000	.005

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: BKR2   GROUP I.D. 20

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JUN	1985	.003	.011	.002	.007	.002	.006
JUL	1985	.006	.018	.003	.011	.001	.005
AUG	1985	.032	.180	.002	.009	.000	.000
SEP	1985	.003	.003	.001	.002	.000	.001
OCT	1985	.004	.010	.001	.004	.000	.001
NOV	1985	.001	.015	.001	.008	.000	.001
DEC	1985	.001	.100	.000	.023	.000	.003

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST ALPHA	HIGHEST BETA	WEIGHTED ALPHA	WEIGHTED BETA	LOWEST ALPHA	LOWEST BETA
7 MONTHS	[illegible]7	.048	.001	.009	.000	.002
LAST 3 MONTHS ONLY	[illegible]2	.042	.001	.012	.000	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

STACK SAMPLE RESULTS

1984

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: CFE   GROUP I.D. 04

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1984	.200	.090	.200	.090	.200	.090
FEB	1984	.200	.090	.074	.032	.070	.030
MAR	1984	.120	.050	.092	.038	.050	.020
APR	1984	.110	.050	.090	.040	.090	.040
JUN	1984	.370	.850	.165	.087	.040	.010
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
5 MONTHS		.200	.226	.128	.057	.090	.038
LAST 3 MONTHS ONLY		.200	.317	.122	.055	.060	.023

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: CFEI   GROUP I.D. 04

MONTH YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JUL 1984	.100	.090	.100	.090	.100	.090
SITE AVERAGE: AVERAGE OF SITE DATA FOR:						
1 MONTHS	.100	.090	.100	.090	.100	.090
LAST 3 MONTHS ONLY	.100	.090	.100	.090	.100	.090

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: CFEO   GROUP I.D. 04

MONTH YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JUL 1984	.220	.140	.220	.140	.220	.140
SITE AVERAGE: AVERAGE OF SITE DATA FOR:						
1 MONTHS	.220	.140	.220	.140	.220	.140
LAST 3 MONTHS ONLY	.220	.140	.220	.140	.220	.140

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: G36   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.030	.010	.021	.008	.020	.006
FEB	1984	.020	.008	.018	.007	.010	.007
MAR	1984	.030	.007	.020	.007	.010	.005
APR	1984	.180	.070	.062	.023	.010	.005
MAY	1984	.030	.010	.025	.008	.020	.006
JUN	1984	.050	.010	.038	.009	.020	.008
JUL	1984	.040	.010	.022	.007	.020	.006
AUG	1984	.210	.040	.076	.017	.020	.005
SEP	1984	.060	.020	.028	.009	.007	.003
OCT	1984	.050	.020	.028	.011	.010	.006
NOV	1984	.040	.060	.028	.023	.010	.006
DEC	1984	.040	.010	.013	.004	.001	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.067	.023	.032	.011	.013	.005
LAST 3 MONTHS ONLY	.043	.030	.023	.013	.007	.004

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: G38   GROUP I.D. 04

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA	** BETA	ALPHA	** BETA	ALPHA	** BETA
JAN	1984	.020	.007	.012	.006	.010	.005
FEB	1984	.010	.006	.010	.005	.010	.005
MAR	1984	.010	.006	.010	.005	.010	.005
APR	1984	.020	.010	.012	.008	.010	.006
MAY	1984	.010	.006	.010	.006	.010	.005
JUN	1984	.010	.006	.010	.005	.010	.004
JUL	1984	.010	.006	.010	.005	.010	.004
AUG	1984	.030	.010	.013	.006	.010	.004
SEP	1984	.030	.010	.014	.006	.007	.003
OCT	1984	.010	.005	.010	.004	.010	.004
NOV	1984	.030	.010	.015	.006	.010	.004
DEC	1984	.010	.005	.005	.002	.001	.001

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.017	.007	.011	.005	.009	.004
LAST 3 MONTHS ONLY	.017	.007	.010	.004	.007	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P31 GROUP I.D. 04

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1984	.010	.005	.008	.004	.005	.002
FEB	1984	.010	.004	.009	.004	.009	.004
MAR	1984	.020	.005	.012	.004	.008	.003
APR	1984	.020	.006	.012	.005	.008	.003
MAY	1984	.020	.006	.011	.005	.010	.004
JUN	1984	.020	.006	.011	.004	.009	.004
JUL	1984	.010	.005	.010	.005	.009	.004
AUG	1984	.020	.007	.011	.005	.008	.004
SEP	1984	.020	.007	.011	.005	.010	.004
OCT	1984	.020	.005	.013	.004	.008	.004
NOV	1984	.030	.010	.016	.006	.009	.004
DEC	1984	.020	.008	.007	.002	.000	.000

SITE AVERAGE: AVERAGE OF SITE DATA FOR:						
12 MONTHS	.018	.006	.011	.004	.008	.003
LAST 3 MONTHS ONLY	.023	.008	.012	.004	.006	.003

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P34 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.040	.010	.013	.004	.000	.000
FEB	1984	.040	.004	.012	.003	.005	.002
FEB	1984	.040	.004	.012	.003	.005	.002
APR	1984	.008	.004	.007	.003	.007	.003
MAY	1984	.009	.004	.008	.003	.006	.003
JUN	1984	.010	.005	.008	.003	.006	.003
JUL	1984	.010	.006	.008	.004	.006	.003
AUG	1984	.020	.007	.010	.004	.006	.002
SEP	1984	.020	.007	.009	.004	.007	.003
OCT	1984	.009	.005	.007	.003	.006	.002
NOV	1984	.020	.009	.010	.005	.006	.002
DEC	1984	.008	.006	.004	.002	.000	.000

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.019	.006	.009	.003	.005	.002
LAST 3 MONTHS ONLY	.012	.007	.007	.003	.004	.001

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P35 GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.020	.006	.012	.005	.006	.003
FEB	1984	.010	.005	.010	.005	.010	.005
MAR	1984	.020	.007	.014	.006	.010	.005
APR	1984	.030	.008	.022	.007	.020	.006
MAY	1984	.020	.008	.017	.007	.010	.006
JUN	1984	.020	.008	.014	.006	.010	.006
JUL	1984	.020	.007	.012	.006	.010	.005
AUG	1984	.050	.020	.016	.007	.010	.004
SEP	1984	.050	.020	.013	.006	.009	.004
OCT	1984	.009	.004	.009	.004	.008	.003
NOV	1984	.030	.010	.014	.006	.007	.003
DEC	1984	.010	.005	.005	.002	.000	.000
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.024	.009	.013	.006	.009	.004
LAST 3 MONTHS ONLY		.016	.006	.009	.004	.005	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: P47   GROUP I.D. 04

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.520	.260	.091	.053	.010	.004
FEB	1984	.150	.070	.063	.028	.020	.010
MAR	1984	.220	.170	.058	.033	.020	.010
APR	1984	.200	.110	.067	.028	.030	.010
MAY	1984	.160	.070	.082	.035	.030	.010
JUN	1984	.130	.050	.041	.016	.000	.000
JUL	1984	.100	.050	.019	.007	.010	.005
AUG	1984	.020	.008	.018	.007	.010	.005
SEP	1984	.020	.007	.011	.005	.010	.005
OCT	1984	.030	.020	.015	.016	.010	.005
NOV	1984	.030	.010	.015	.006	.010	.005
DEC	1984	.010	.005	.010	.005	.010	.005
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.137	.069	.041	.020	.014	.006
LAST 3 MONTHS ONLY		.023	.012	.013	.009	.010	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 04

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
CFE	01 84	06 84	5	.200	.226	.128	.057	.090	.038
CFEI	07 84	07 84	1	.100	.090	.100	.090	.100	.090
CFEO	07 84	07 84	1	.220	.140	.220	.140	.220	.140
G36	01 84	12 84	12	.067	.023	.032	.011	.013	.005
G38	01 84	12 84	12	.017	.007	.011	.005	.009	.004
P31	01 84	12 84	12	.018	.006	.011	.004	.008	.003
P34	01 84	12 84	12	.019	.006	.009	.003	.005	.002
P35	01 84	12 84	12	.024	.009	.013	.006	.009	.004
P47	01 84	12 84	12	.137	.069	.041	.020	.014	.006
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.089	.064	.063	.037	.052	.033
LAST 3 MONTHS ONLY				.073	.068	.057	.036	.047	.030

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB1 GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.010	.010	.010	.009	.009	.006
FEB	1984	.010	.010	.010	.005	.010	.006
MAR	1984	.010	.020	.010	.010	.010	.005
APR	1984	.010	.020	.010	.010	.010	.005
MAY	1984	.020	.060	.013	.024	.010	.008
JUN	1984	.020	.008	.011	.005	.010	.005
JUL	1984	.010	.008	.010	.007	.010	.005
AUG	1984	.010	.008	.010	.006	.010	.005
SEP	1984	.020	.007	.012	.005	.010	.004
OCT	1984	.010	.010	.008	.008	.006	.005
NOV	1984	.010	.009	.010	.006	.010	.005
DEC	1984	.020	.030	.011	.012	.010	.006

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.013	.017	.010	.009	.010	.005
LAST 3 MONTHS ONLY	.013	.016	.010	.009	.009	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB2   GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.020	.020	.012	.012	.010	.006
FEB	1984	.010	.010	.010	.009	.010	.008
MAR	1984	.050	.130	.025	.050	.010	.006
APR	1984	.020	.010	.020	.009	.020	.006
MAY	1984	.020	.060	.018	.031	.010	.008
JUN	1984	.020	.010	.020	.007	.020	.006
JUL	1984	.020	.010	.020	.007	.020	.007
AUG	1984	.020	.010	.020	.009	.020	.007
SEP	1984	.020	.020	.020	.012	.020	.009
OCT	1984	.020	.020	.015	.012	.009	.009
NOV	1984	.020	.010	.020	.010	.020	.010
DEC	1984	.040	.030	.023	.013	.020	.010

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.023	.028	.019	.015	.016	.008
LAST 3 MONTHS ONLY	.027	.020	.019	.012	.016	.010

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB3   GROUP I.D. 07

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1984	.020	.020	.020	.017	.010	.010
FEB	1984	.020	.020	.020	.013	.020	.007
MAR	1984	.020	.010	.020	.009	.020	.008
APR	1984	.020	.010	.020	.010	.020	.008
MAY	1984	.020	.010	.020	.010	.020	.009
JUN	1984	.020	.010	.020	.008	.020	.008
JUL	1984	.020	.010	.020	.009	.020	.008
AUG	1984	.020	.020	.018	.010	.010	.006
SEP	1984	.040	.020	.020	.018	.020	.010
OCT	1984	.020	.020	.015	.010	.008	.007
NOV	1984	.020	.008	.020	.007	.020	.007
DEC	1984	.030	.020	.017	.009	.007	.007

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.021	.015	.019	.011	.016	.008
LAST 3 MONTHS ONLY	.023	.016	.017	.009	.012	.007

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: FB4   GROUP I.D. 07

MONTH	YEAR	HIGHEST VALUE ALPHA **	HIGHEST VALUE BETA	WEIGHTED AVERAGE ALPHA **	WEIGHTED AVERAGE BETA	LOWEST VALUE ALPHA **	LOWEST VALUE BETA
JAN	1984	.020	.030	.012	.020	.007	.010
FEB	1984	.050	.070	.021	.032	.009	.010
MAR	1984	.050	.060	.034	.045	.009	.020
APR	1984	.020	.030	.013	.022	.010	.020
MAY	1984	.030	.030	.015	.022	.009	.020
JUN	1984	.020	.020	.011	.011	.010	.010
JUL	1984	.010	.010	.010	.010	.010	.010
AUG	1984	.010	.010	.010	.010	.010	.008
SEP	1984	.010	.020	.010	.012	.010	.009
OCT	1984	.010	.020	.010	.017	.010	.010
NOV	1984	.010	.020	.010	.011	.010	.005
DEC	1984	.020	.090	.010	.029	.007	.005

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.022	.034	.014	.020	.009	.011
LAST 3 MONTHS ONLY	.013	.043	.010	.019	.009	.007

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 07

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
FB1	01 84	12 84	12	.013	.017	.010	.009	.010	.005
FB2	01 84	12 84	12	.023	.028	.019	.015	.016	.008
FB3	01 84	12 84	12	.021	.015	.019	.011	.016	.008
FB4	01 84	12 84	12	.022	.034	.014	.020	.009	.011
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.020	.023	.015	.014	.013	.008
LAST 3 MONTHS ONLY				.019	.024	.014	.012	.011	.007

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: EXRF   GROUP I.D. 08

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.030	.010	.016	.006	.006	.003
FEB	1984	.020	.008	.013	.005	.005	.002
MAR	1984	.007	.004	.005	.003	.004	.002
APR	1984	.060	.040	.021	.014	.005	.003
MAY	1984	.050	.030	.012	.009	.005	.003
JUN	1984	.050	.030	.017	.008	.005	.002
JUL	1984	.010	.006	.006	.003	.005	.002
AUG	1984	.006	.003	.005	.002	.005	.002
SEP	1984	.005	.003	.005	.002	.005	.002
OCT	1984	.030	.020	.014	.009	.005	.003
NOV	1984	.005	.004	.005	.003	.005	.002
DEC	1984	.020	.020	.010	.009	.005	.002

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	.024	.015	.011	.006	.005	.002
LAST 3 MONTHS ONLY	.018	.015	.010	.007	.005	.002

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: E6 GROUP I.D. 08

MONTH YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN 1984	.040	.030	.026	.016	.020	.009
SITE AVERAGE: AVERAGE OF SITE DATA FOR:						
1 MONTHS	.040	.030	.026	.016	.020	.009
LAST 3 MONTHS ONLY	.040	.030	.026	.016	.020	.009

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 08

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
EXRF	01 84	12 84	12	.024	.015	.011	.006	.005	.002
E6	01 84	01 84	1	.040	.030	.026	.016	.020	.009

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

1 MONTHS	.032	.022	.018	.011	.012	.006
LAST 3 MONTHS ONLY	.029	.022	.018	.011	.012	.006

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TMI GROUP I.D. 12

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.010	.020	.010	.010	.010	.008
FEB	1984	.010	.300	.010	.047	.010	.010
MAR	1984	.010	.300	.010	.049	.010	.005
APR	1984	.020	.010	.010	.008	.010	.005
MAY	1984	.020	.008	.013	.007	.010	.006
JUN	1984	.020	.010	.018	.009	.010	.006
JUL	1984	.020	.010	.012	.006	.007	.003
AUG	1984	.020	.020	.012	.010	.010	.005
SEP	1984	.020	.020	.014	.010	.010	.005
OCT	1984	.020	.020	.018	.011	.010	.007
NOV	1984	.020	.020	.018	.010	.010	.007
DEC	1984	.020	.020	.015	.010	.010	.006

SITE AVERAGE: AVERAGE OF SITE DATA FOR:	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
12 MONTHS	.017	.063	.013	.016	.010	.006
LAST 3 MONTHS ONLY	.020	.020	.017	.010	.010	.007

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 12

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TMI	01 84	12 84	12	.017	.063	.013	.016	.010	.006
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.017	.063	.013	.016	.010	.006
LAST 3 MONTHS ONLY				.020	.020	.017	.010	.010	.007

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCS GROUP I.D. 13

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.020	.270	.015	.112	.010	.050
FEB	1984	.020	.160	.020	.067	.020	.006
MAR	1984	.020	.120	.019	.093	.010	.060
APR	1984	.020	.150	.020	.046	.020	.030
MAY	1984	.020	.150	.017	.116	.010	.090
JUN	1984	.020	.120	.020	.095	.020	.060
JUL	1984	.020	.130	.020	.078	.020	.050
AUG	1984	.020	.110	.020	.075	.020	.040
SEP	1984	.020	.160	.018	.091	.010	.040
OCT	1984	.010	.850	.010	.361	.010	.050
NOV	1984	.010	.880	.010	.322	.010	.090
DEC	1984	.020	.290	.011	.196	.009	.080

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.018	.282	.017	.138	.014	.054
LAST 3 MONTHS ONLY	.013	.673	.010	.293	.010	.073

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 13

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
HCS	01 84	12 84	12	.018	.282	.017	.138	.014	.054

GROUP AVERAGE:
AVERAGE OF SITE
AVERAGES FOR:

12 MONTHS	.018	.282	.017	.138	.014	.054
LAST 3 MONTHS ONLY	.013	.673	.010	.293	.010	.073

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: WPC   GROUP I.D. 14

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1984	.010	.007	.010	.007	.010	.007
MAR	1984	.280	.120	.129	.052	.030	.010
MAY	1984	.270	.110	.155	.063	.050	.020
JUN	1984	.050	.020	.034	.012	.030	.010
AUG	1984	.010	.006	.010	.006	.010	.006
SEP	1984	19.760	3.380	18.707	3.217	.650	.420
DEC	1984	2.160	1.020	2.160	1.020	2.160	1.020

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

7 MONTHS	3.220	.666	3.029	.625	.420	.213
LAST 3 MONTHS ONLY	7.310	1.469	6.959	1.414	.940	.482

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 14

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
WPC	01 84	12 84	7	3.220	.666	3.029	.625	.420	.213
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
7 MONTHS				3.220	.666	3.029	.625	.420	.213
LAST 3 MONTHS ONLY				7.310	1.469	6.959	1.414	.940	.482

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFL1   GROUP I.D. 16

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.020	.008	.010	.006	.010	.005
FEB	1984	.010	.006	.010	.006	.010	.005
MAR	1984	.010	.006	.010	.005	.010	.004
APR	1984	.020	.006	.010	.006	.010	.005
MAY	1984	.050	.020	.030	.009	.010	.005
JUN	1984	.020	.020	.012	.009	.010	.005
JUL	1984	.010	.006	.010	.005	.010	.005
AUG	1984	.040	.006	.014	.005	.010	.005
SEP	1984	.040	.007	.013	.006	.010	.005
OCT	1984	.020	.007	.012	.005	.010	.005
NOV	1984	.230	.040	.083	.015	.010	.005
DEC	1984	.350	.050	.101	.017	.020	.006

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.068	.015	.026	.008	.011	.005
LAST 3 MONTHS ONLY	.200	.032	.065	.012	.013	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 16

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA **	BETA	AVERAGE WEIGHTED AVERAGE ALPHA **	BETA	AVERAGE LOWEST VALUE ALPHA **	BETA
TFL1	01 84	12 84	12	.068	.015	.026	.008	.011	.005
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.068	.015	.026	.008	.011	.005
LAST 3 MONTHS ONLY				.200	.032	.065	.012	.013	.005

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: TFLV   GROUP I.D. 17

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1984	.010	.006	.010	.006	.010	.005
FEB	1984	.020	.006	.013	.006	.010	.006
MAR	1984	.130	.020	.040	.009	.010	.005
APR	1984	.320	.040	.083	.013	.010	.004
MAY	1984	.010	.006	.010	.005	.010	.004
JUN	1984	.020	.008	.012	.006	.010	.005
JUL	1984	.010	.006	.010	.006	.010	.006
AUG	1984	.010	.006	.010	.006	.010	.004
SEP	1984	.020	.006	.012	.006	.010	.004
OCT	1984	.010	.006	.010	.006	.010	.005
NOV	1984	.010	.006	.010	.006	.010	.005
DEC	1984	.030	.010	.016	.007	.010	.006
SITE AVERAGE: AVERAGE OF SITE DATA FOR:							
12 MONTHS		.050	.010	.020	.007	.010	.005
LAST 3 MONTHS ONLY		.017	.007	.012	.006	.010	.005

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 17

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
TFLV	01 84	12 84	12	.050	.010	.020	.007	.010	.005

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:	ALPHA	BETA	ALPHA	BETA	ALPHA	BETA
12 MONTHS	.050	.010	.020	.007	.010	.005
LAST 3 MONTHS ONLY	.017	.007	.012	.006	.010	.005

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: EA15   GROUP I.D. 15

		HIGHEST VALUE		WEIGHTED AVERAGE		LOWEST VALUE	
MONTH	YEAR	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
JAN	1984	.010	.100	.010	.066	.008	.040
FEB	1984	.010	.080	.010	.050	.010	.020
MAR	1984	.010	.090	.010	.061	.010	.030
APR	1984	.010	.160	.010	.081	.010	.009
MAY	1984	.010	.160	.010	.102	.009	.060
JUN	1984	.010	.070	.008	.042	.001	.003
JUL	1984	.010	.030	.010	.026	.001	.003
AUG	1984	.010	.030	.010	.018	.008	.005
SEP	1984	.010	.040	.010	.029	.008	.020
OCT	1984	.010	.170	.010	.073	.010	.007
NOV	1984	.010	.100	.010	.046	.010	.020
DEC	1984	.020	.130	.011	.056	.008	.020

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

	ALPHA **	BETA	ALPHA **	BETA	ALPHA **	BETA
12 MONTHS	.011	.097	.010	.054	.008	.020
LAST 3 MONTHS ONLY	.013	.133	.010	.058	.009	.016

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 12

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA	** BETA	AVERAGE WEIGHTED AVERAGE ALPHA	** BETA	AVERAGE LOWEST VALUE ALPHA	** BETA
EA1S	01 84	12 84	12	.011	.097	.010	.054	.008	.020
GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:									
12 MONTHS				.011	.097	.010	.054	.008	.020
LAST 3 MONTHS ONLY				.013	.133	.010	.058	.009	.016

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
SUMMARY BY GROUP
UNITS = PCI/M3

GROUP I.D. 19

SITE CODE	BEGIN MO YR	END MO YR	# MO	AVERAGE HIGHEST VALUE ALPHA **	BETA	AVERAGE WEIGHTED AVERAGE ALPHA **	BETA	AVERAGE LOWEST VALUE ALPHA **	BETA
HCSI	01 84	12 84	12	.000	.110	.000	.052	.000	.000

GROUP AVERAGE: AVERAGE OF SITE AVERAGES FOR:						
12 MONTHS	.000	.110	.000	.052	.000	.000
LAST 3 MONTHS ONLY	.000	.003	.000	.000	.000	.000

** PRINTED DATA VALUES ARE AVERAGES OF DATA PROCESSED.

RUNNING AVERAGE REPORT
DETAIL BY SAMPLING SITE
UNITS = PCI/M3

SITE CODE: HCS1   GROUP I.D. 19

MONTH	YEAR	HIGHEST VALUE ALPHA	** BETA	WEIGHTED AVERAGE ALPHA	** BETA	LOWEST VALUE ALPHA	** BETA
JAN	1984	.000	1.220	.000	.596	.000	.000
FEB	1984	.000	.060	.000	.018	.000	.000
MAR	1984	.000	.000	.000	.000	.000	.000
APR	1984	.000	.000	.000	.000	.000	.000
MAY	1984	.000	.020	.000	.005	.000	.000
JUN	1984	.000	.000	.000	.000	.000	.000
JUL	1984	.000	.000	.000	.000	.000	.000
AUG	1984	.000	.010	.000	.002	.000	.000
SEP	1984	.000	.000	.000	.000	.000	.000
OCT	1984	.000	.000	.000	.000	.000	.000
NOV	1984	.000	.000	.000	.000	.000	.000
DEC	1984	.000	.010	.000	.001	.000	.000

SITE AVERAGE:
AVERAGE OF
SITE DATA FOR:

12 MONTHS	.000	.110	.000	.052	.000	.000
LAST 3 MONTHS ONLY	.000	.003	.000	.000	.000	.000

** PRINTED DATA VALUES ARE MONTHLY CALCULATED VALUES.

7. ACCIDENT ANALYSIS

7.1 INTRODUCTION

This section presents highly conservative evaluations of the potential consequences of incidents producing release of nuclear material from its normal confines. Accidental releases could result from ordinary industrial hazards (fire and explosion), natural disturbances (earthquake, windstorm, and flood), and accidental criticality. While the ultimate safety of the operation to be licensed can only be demonstrated by assuming that upper limit accidents of extremely low probability do occur, a more realistic evaluation of these events than presented here would show that no significant consequences would result from accidental release of nuclear material because of the precautions taken in recognition of the possibility of such occurrences. The maximum credible accident for the operations described in Section 3, Part I, is an accident in one of the first two categories named above and is described in Section 7.2. Accidental criticality is not considered to be credible, although the possible consequences of such an event are considered in Section 7.3.

7.2 MAXIMUM CREDIBLE ACCIDENT

7.2.1 General Analysis

The consequences of a number of types of accidents in the Fuel Fabrication Facility and in the general research and development operations subject to this license application have been analyzed. These studies included fires in work spaces and in process equipment, explosions of gas accumulations, earthquake with resultant equipment failures, cyclonic-type windstorm, and flooding. In all cases the release to individuals in unrestricted areas results in annual radiation doses below those set forth in 10 CFR Part 20.

The consequences of uranium dispersed were studied assuming 93.2% enrichment in U-235. However, the major contribution in terms of dose comes from the U-234 (up to 0.78 wt %) in the enriched uranium. The affectivities (Table I 7.2-1) of U-234 and U-235 for both soluble and insoluble cases were established in accordance with the data given in ICRP-2 (Ref.7.2-1) and ICRP-10 (Ref.7.2-2).

TABLE I 7.2-1
AFFECTIVITIES
(Rems/g inhaled)

	Soluble		Insoluble	
Nuclide	Effectivity (Rems/g)	Critical Organ	Effectivity (Rems/g)	Critical Organ
U-234	1.055×10^5	Bone	4.15×10^5	Lung
U-235	10.2	Kidney	108	Lung

The usual form of dispersal is the oxides. These are insoluble and result in exposures to the lung as the critical organ.

Most radioactive releases from the facilities will occur through roof vents. To be conservative, however, all releases are assumed to originate at ground level in the building wake. In this situation the generalized Gaussian plume model is modified to account for the initial dilution resulting from the building wake effect. The formula for the dilution factor is (see pp. 97 to 112 of Ref. 7.2-3):

$$\phi = \frac{X}{Q} = \frac{1}{\mu(\pi\sigma y\sigma z + kA)} \quad \ldots \quad (1)$$

where ϕ = atmospheric dilution factor (sec/m^3)

X = concentration at ground level (Ci/m3)

Q = source release rate (Ci/sec)

μ = wind speed (m/sec)

y = horizontal dispersion coefficient (m)

z = vertical dispersion coefficient (m)

k = coefficient related to shape of building

A = cross-sectional building area normal to the wind direction (m^2)

Because the buildings are rectangular, k is conservatively taken to be 0.5. A conservative wind speed of 1 m/sec and inversion (Pasquill condition F) are assumed as normal conditions and appropriate dilution factor curves are computed using Eq. (1).

Short-term diffusion parameters are needed to estimate the consequences of any postulated accident. The worst condition from a meteorological standpoint would be associated with a nighttime accident with a drainage breeze to the ocean. On a clear night, slow wind speeds and stable atmospheric conditions would result. Onshore winds are more likely to be associated with higher wind speeds and a marine layer of air which tends toward a neutral stability (Pasquill condition C). Additional conservatism is introduced by selecting the restricted area boundary distance closest to the release point, although the normal direction of 1 m/sec wind would not generally correspond to the closest distance.

The integrated internal dose, D(x), received by a person at a distance, x, from the point of release (present during the entire period of the release) is given by:

$$D(x) = R_b \cdot \phi(x) \cdot \Sigma_i \cdot E_i \qquad (2)$$

where R_b = breathing rate (3.47×10^{-4} m^3/sec)

$\phi(x)$ = atmospheric dilution (sec/m^3) [from Eq. (1)]

Wi = weight of isotope, i, released (g)

E_i = dose effectivity of isotope, i

The maximum dose rates, R_i, may be shown to be given by D_i . $_i/(1 - _e{}^{-} i^t)$, where D_i is the integrated dose, $_i$ is the biological decay constant for the isotope "i," and t is the period over which the dose is integrated.

A person at the outer boundary exposed to the effluent dust and fumes probably would not remain within the plume for the full duration of the release. Also, the particulates would not all be of respirable size.

The surface contamination, $A_i(x)$, which would be produced by an isotope, i, at a distance, x, is calculated from:

$$A_i(x) = W_i \cdot \phi(x) \cdot V_i(x) \quad , \qquad (3)$$

where V_i is the settling velocity (m/sec) of the aerosol particles of "i" at distance x, and W_i and (x) are as they were defined previously.

Equation 3 is only strictly applicable where there is a single settling velocity which implies a single particle size and density. Postulated fires, however, will produce particles in a wide range of sizes with a corresponding variation in settling velocities; e.g., p. 203 of Ref. 7.2-3 indicates that for particles with a density of 5 g/cm^3, the settling velocity at sea level will range from 2.5 m/sec for a particle diameter of 200 m to 0.006 m/sec for a particle diameter of 6 m. It is clear from Eq. 3 that surface contamination is proportional to settling velocity. An upper limit to the surface contamination occurring at a restricted area boundary can therefore be estimated by first estimating the maximum settling velocity that can reach that distance. Thus, for the wind speed of 1 m/sec assumed in the calculation meteorological dilution, it would take 46 sec for a plume to travel from the Fuel Fabrication Facility to the fence, 150 ft (46 m) distant. For a release height of 15 m, then, a particle with a settling velocity of 0.32 m/sec would just reach the ground when it reached the fence. Therefore, all settling velocities less than 0.32 m/sec will distribute surface contamination at off-site locations. (The assumption of a higher wind speed would mean that higher settling velocities would contribute to the off-site contamination. The increased air turbulence accompanying a higher windspeed would produce greater cloud dispersal and thus counteract the effect of the increased settling velocity on the surface contamination.)

7.2.2 Windstorm

The largest release to unrestricted areas occurs as a result of an abnormally strong windstorm. The Component and Fuel Manufacturing Building and its associated effluent control system are designed and constructed in accordance with applicable local building codes. Accordingly, no structural damage to the effluent control system will occur for the maximum wind velocities or atmospheric conditions that occur in this locality.

While tornadoes capable of damaging a building constructed in accordance with local building codes do not occur in this area, small localized cyclonic winds occasionally have been observed. Because of the extreme pressure differentials produced by such winds, internal collapse or breakthrough of one or more of the filter banks could be produced, with consequent release to the exterior of some of the material embedded on the filters. The majority of the filter systems utilize prefilters near the process equipment to collect most of the contaminants. Any true release would require that both the HEPA and prefilters collapse and that the contained materials then move, via the duct and blower systems, out the stacks.

To establish an upper limit to the consequences of this accident, it is assumed that each filter bank and soot filter contains the maximum observed burden as determined by routine gamma counting surveys over the span of a year, and each fume scrubber has an assumed burden of 175 g of U-235. The total amount dispersed is taken to be 1.54 kg of fully enriched uranium. The other assumptions are a wind speed of 25 m/sec of constant direction, extremely unstable atmospheric conditions (Pasquill condition A), and no fallout while en route.

The resultant first-year dose to an individual at the property boundary fence (150 ft) in the path of the wind is shown in Table I 7.2-2. Essentially all of the dose is received in the first year because the half-life for retention of particulate matter in the lungs is approximately 120 days.

TABLE I 7.2-2

FIRST-YEAR LUNG DOSE DUE TO WINDSTORM

Nuclide	Rem
U-234	0.434
U-235	0.015
Total	0.449

The assumptions used are very conservative. Typically, the contaminants are expected to be sucked up into the vortex of the cyclone and subsequently distributed over a wide area. This would produce very low cloud concentrations for persons out-of-doors and exposed to the cloud and very widespread and diffuse surface contamination.

7.3 CRITICALITY

7.3.1 Basic Assumptions

Part I, Section 3, "Present Operations," and Section 5, "Nuclear Safety," demonstrate that all materials in process and storage are critically safe under all conditions including flooding. Although a criticality accident is not considered credible, the theoretical effects of such an accident are of interest to demonstrate the importance of the extensive efforts made to ensure against it. For illustration, an accident in the Fuel Fabrication Facility involving 3 x 10^{18} fissions was examined. An accident of this magnitude is consistent with most accidents reported for solution systems (Ref. 7.3-1 & 7.3-2) and the nature of the operations involved fit this assumption.

7.3.2 Criticality in Fuel Fabrication Facility

An evaluation has been made of all those operations in the Fuel Fabrication Facility that involve vessels of potentially non-safe geometries. This was done using the criteria of Regulatory Guide 3.34 (Ref. 7.3-4) which states "at least two highly reliable, independent criticality controls should be assumed to be violated." The conclusion is that there is only one process conducted in which a criticality is even remotely credible; this involves the final release and transfer of waste process liquids from safe, 11 liter bottles or 5 inch columns, to 55 gallon barrels in preparation for ultimate disposal. Such release ultimately depends on procedures and people. In this case duplicate samples, replicate analysis, work sheet verification, independent party witness, and lock/key/seal procedures are all used to assure a safe transfer. The actual transfer is made by pouring the 11 liter bottles, one by one, into an otherwise locked dump sink on the south mezzanine. The liquids drain via a pipe to one of three barrels located in the liquid dump room in the annex at the north end of the building. This room is designed to mitigate the results of a criticality and has 24 inch concrete walls, a 16 inch concrete ceiling and has a close fitting door to contain any possible contamination. The alternate means of liquid transfer is from locked 5 inch diameter waste storage columns on the south mezzanine via the same piping system. A single column will contain about 30 to 35 liters of liquid.

Reference 7.3-5 estimates fission yields in solution systems of 100 gallons or less volume as having total yields of 3×10^{18} and in systems over 100 gallons as 3×10^{19}. Reference 7.3-6 treats void formation, pressures, heat losses, etc., and arrives at a value of 1×10^{17} per liter of system volume. An accepted rule of thumb is that it will require 1×10^{17} fissions to evaporate a liter of liquid. Typical liquid dumps will involve 10 to 35 liters of liquid in each increment added to a barrel although a second similar increment may soon follow. The evaporation of the liquid in one increment would require about 3×10^{18} fissions; this agrees with the rough rule from Reference 7.3-5. One other point of reference can be obtained from the two comparable geometry accidents that have actually occurred. One was 1.3×10^{18} and the other was 1.3×10^{17} fissions. On this basis the postulated design basis accident for the Fuel Fabrication Facility is taken as 3×10^{18} total fissions.

Ref. 7.3-4 indicates that criticality accident analyses should be modeled as an initial pulse followed by a series of fter pulses. Specifically it calls for an initial pulse of 1.0×10^{18} fissions followed successively at 10 minute intervals by pulses of 1.9×10^{17} fissions until the excursion is terminated. The 3×10^{18} fission design basis accident is modeled in a similar manner by assuming an initial pulse of 1×10^{18} fissions, followed, at 10 minute intervals by 10 pulses, each of 1.9×10^{17} fissions. A final pulse of 1.0×10^{17} fissions, 110 minutes after the start of the accident makes the total 3×10^{18} fissions for the entire event.

The analysis has been carried out using computer codes and methods developed at GA for use in nuclear power reactor licensing actions. Direct experimental data is also used where applicable in the analysis.

A pulse of 1 x 10^{18} fissions is equal to 30 MW Sec of fission energy. The fission product source terms, for use in subsequent release analysis, were generated by use of the RADDC code (Ref. 7.3-7) with a hypothetical reactor being operated at 30 MW for one second. Subsequent after pulses are assumed to have the same nature and therefore scale directly. The code results confirm this assumption.

The direct prompt gamma, neutron, and total doses were computed using the equations set forth in Ref. 7.3-4, section C.3.a., with an assumption of 24 inches of concrete for doses within the facility and 29.75 inches of concrete (24 inch dump room wall and 5.75 inch front building wall) for doses external to the facility. The dump room is located to the west side of the building with a floor elevation 24 feet above the point of closest non-restricted approach to the building. No credit was taken for the intervening concrete floor and earth.

The direct prompt dose vs distance from the event is shown in Fig. 7.3-1. The walls of the dump room prevent closer approach than about 3 meters from the event. Data are given for 5 minutes (between the initial pulse and the first after pulse) and for 120 minutes (after the full 12 pulse accident). The 5 minute case is the most applicable because all personnel would be evacuated from the facility before any of the after pulses occurred.

All facility ventilation exhaust filter systems and blowers are automatically shutdown on the occurrence of a criticality alarm; hence release from the facility will only be that due to natural building breathing due to the effects of external wind. This effect was evaluated by means of a test conducted at the facility to measure the pressure differentials generated by external winds and to establish the associated building breathing rate. The approach used was to measure the flow resistance of the building vs driving pressure. This can be expressed as:

$$\phi = Q/PV \qquad (1)$$

where ϕ = flow resistance (m sec/kg)
Q = air flow rate (m^3/sec)
P = pressure differential (kg/m sec^2)
V = building volume (m^3)

This assumes a linear relationship between and P, which is adequate if the actual determination of is made at pressure differentials of the same order as those caused by the mild winds assumed under the accident conditions.

The leakage rate of the building is then:

$$(2) \quad L/V = c \times \frac{u^2}{2} \times \phi$$

where L = leakage rate (m^3/sec)
C = building drag coefficient
= density of air (1.286 kg/m^3)
u = wind velocity (m/sec)

The value of C is a function of building shape and size (Ref. 7.3-8, 7.3-9) and is between 1.5 and 2.0; the larger value, being that for a long rectangular plate presented face on to the air flow, is used in the accident analysis for conservatism.

The test was conducted by measuring the differential pressures between sample lines outside of the east, north and west faces of the building and three sample lines internal to the building. Wind conditions were measured at three meteorological stations. The flow resistance was determined as 1.58×10^{-4} m sec/kg by measuring the pressure differentials caused by turning on one to three blowers exhausting through a single stack and measuring air flow at the stack outlet. The wind at the time of the measurement was 3 mph (1.34 m/sec). The value for the drag coefficient, C, from the tests was 1.7, a good confirmation of the conservative assumption of 2.0. The building air change rate is taken as linear with a value of 0.73 changes per hour per meter per second wind speed.

The breathing rate of the dump room was estimated using methods set forth in Reference 7.3-10. This room is a tight concrete structure with a gasketed door. Ref. 7.3-10, Chapter 19, Table 2 indicates that, at a pressure of 0.1 in water, each foot of frame around a good weatherstripped door will leak 17 cu ft/hr. With 22 lineal feet of door edge the leak rate will be 374 cu ft/hr and the room will have 0.5 changes per hour.

The ongoing meteorology and environmental monitoring program carried out at the facility indicates that the 50% median meteorology is a wind of 3.8 m/sec. The measured atmospheric dilution at the 46 meter fence line is 2.0×10^{-4}. Because, once diluted, reconcentration cannot occur, this dilution factor is used out to 2000 meters, where it equals the dilution factors of Ref. 7.3-4 and those are used for larger distances.

The doses external to the facility were calculated using the TDAC code (Ref. 7.3-11) with the following parameters:

TABLE 7.3-1

Fission Product Group	Percent Escape
Noble gases	100%
Halogens	25%
Other aerosols	.05%

No engineered filters operational

No plateout or fallout in building

Air exchange rate - dump room	0.5 vol/hr
- building	2.77 vol/hr
Individual's breathing rate	3.47 x 10^{-4} m^3/sec
Wind velocity	3.8 m/sec

Times of interest - 10 min, 30 min, 1 hr, 3 hr, 8 hr.

Atmospheric Dispersion

Distance of Interest meters	Parameter ($^1/Q^1$, sec/m^3)
46	2.0 x 10^{-4}
100	2.0 x 10^{-4}
268	2.0 x 10^{-4}
365	2.0 x 10^{-4}
1000	2.0 x 10^{-4}
2000	2.0 x 10^{-4}
3000	1.2 x 10^{-4}
5000	6.2 x 10^{-5}
10000	2.5 x 10^{-5}

The dose that an individual standing at the fence line (46 meters) for 8 hours starting at the time of the incident are given in Table 7.3-2.

TABLE 7.3-2

Organ	Dose,Rems
Whole body	0.27
Thyroid	0.26
Bone	0.015
Lung	0.023

It is seen that the maximum dose is well below the Protective Action Guides of the Environmental Protection Agency as restated in NUREG-0767 (Ref. 7.3-12) as "1 Rem to the whole body, 5 Rems to the thyroid, and 3 Rems to any other critical organ in the case of individuals offsite."

The time vs distance dose data are presented in Figures 7.3-2 through 7.3-6.

7.4 ANALYSIS OF POSSIBLE FIRE/EXPLOSION HAZARDS

Several fuel production processes result in off-gases containing carbon monoxide and hydrogen. Lower and upper explosive limits are 12.5% - 74.2% and 4.1% - 74.2% respectively. Fire and explosive hazards are avoided by use of either two techniques; afterburners or massive air dilution coupled with associated safety interlocks.

The nature of off-gas handling systems is such that simultaneous dual failures would have to occur before a hazard of fire or explosion can exist. The subdivision of effluent-handling systems is such that, if an explosion were to occur, only a small part of the duct work would be involved. The SNM release would be minimal and within the capacity of the filtration systems to prevent a hazard to the public.

Afterburners work on the principle of feeding gases into a separate fuel-supported flame; generally propane is used to keep the burner lit. Automatic ignition circuits are used to assure the burner is lit. The processes generating the off-gases are shut down if the burner fails.

The air dilution technique utilizes the principle of maintaining the off-gas at a concentration above the upper explosive limit until it can be diluted to a point far below the lower limit. This technique is used when it is necessary to use hydrogen as a levitation or carrier gas. The off-gases are carried in schedule-40 steel pipe to the dilution point where it is mixed with massive quantities of air. The oxygen content of the high concentration stream is monitored to assure off-gases are above the upper explosive limit and flow measurements assure adequate diluent flow exists providing reduction below lower explosive limits. Use of diluent-type systems avoids unnecessary burning of propane and subsequent release of added products of combustion.

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FIG I 7.3-1, PROMPT DOSE IN FACILITY, 24 INCH WALLS

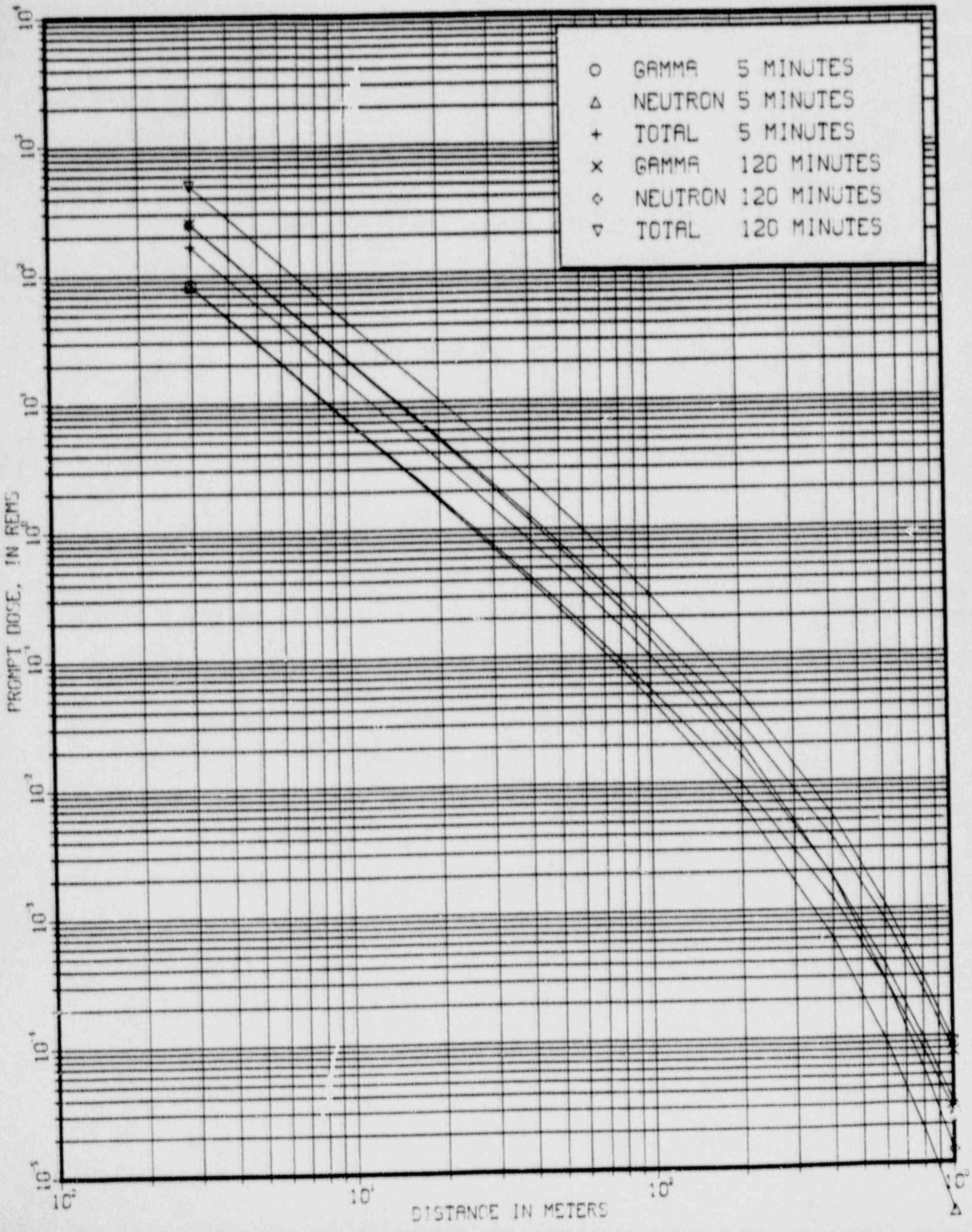


FIG I 7.3-2, 10 MIN DOSE, 12 PULSES, 3.0×E18 TOTAL FISSIONS

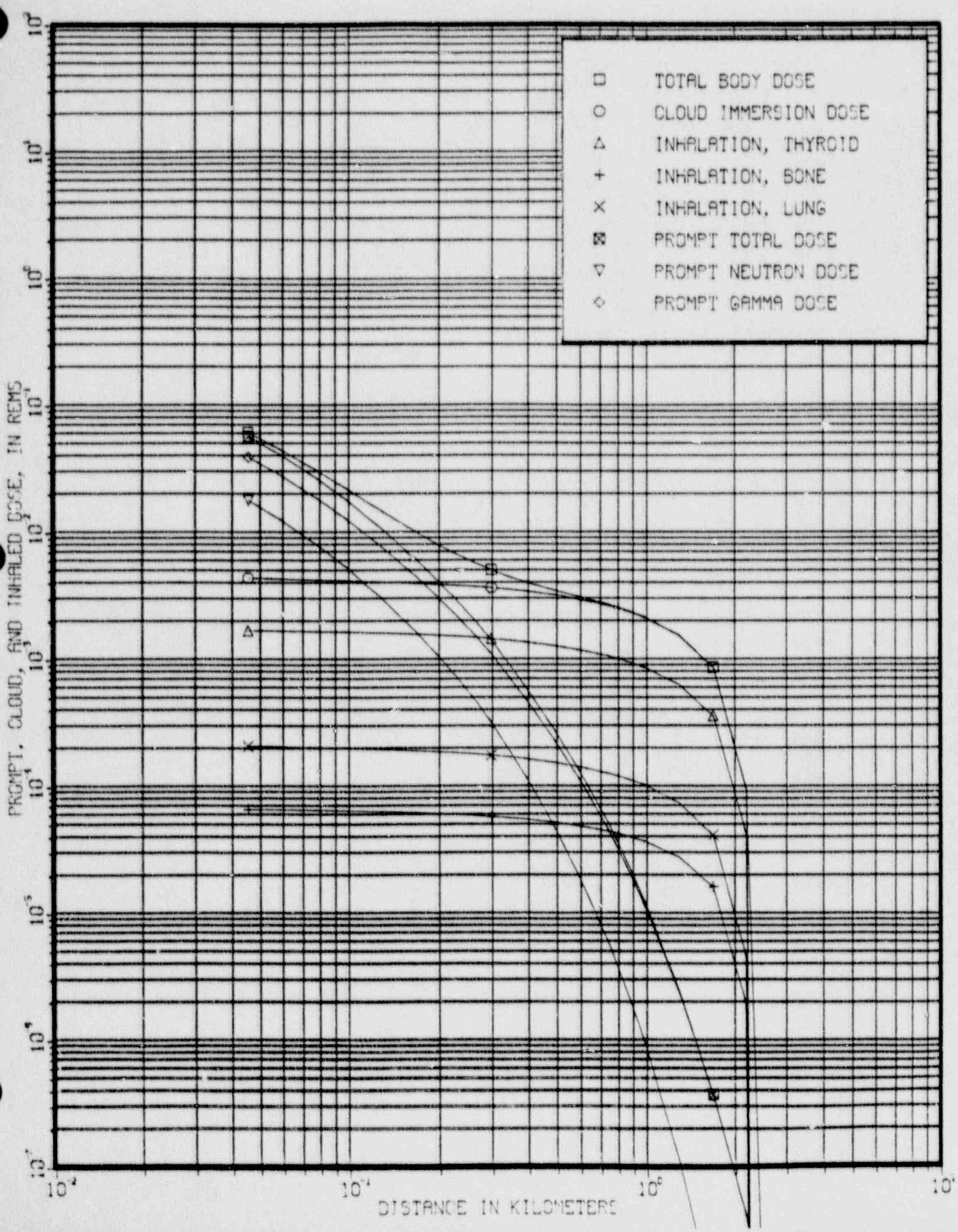


FIG I 7.3-3, 30 MIN DOSE, 12 PULSES, 3.0*E18 TOTAL FISSIONS

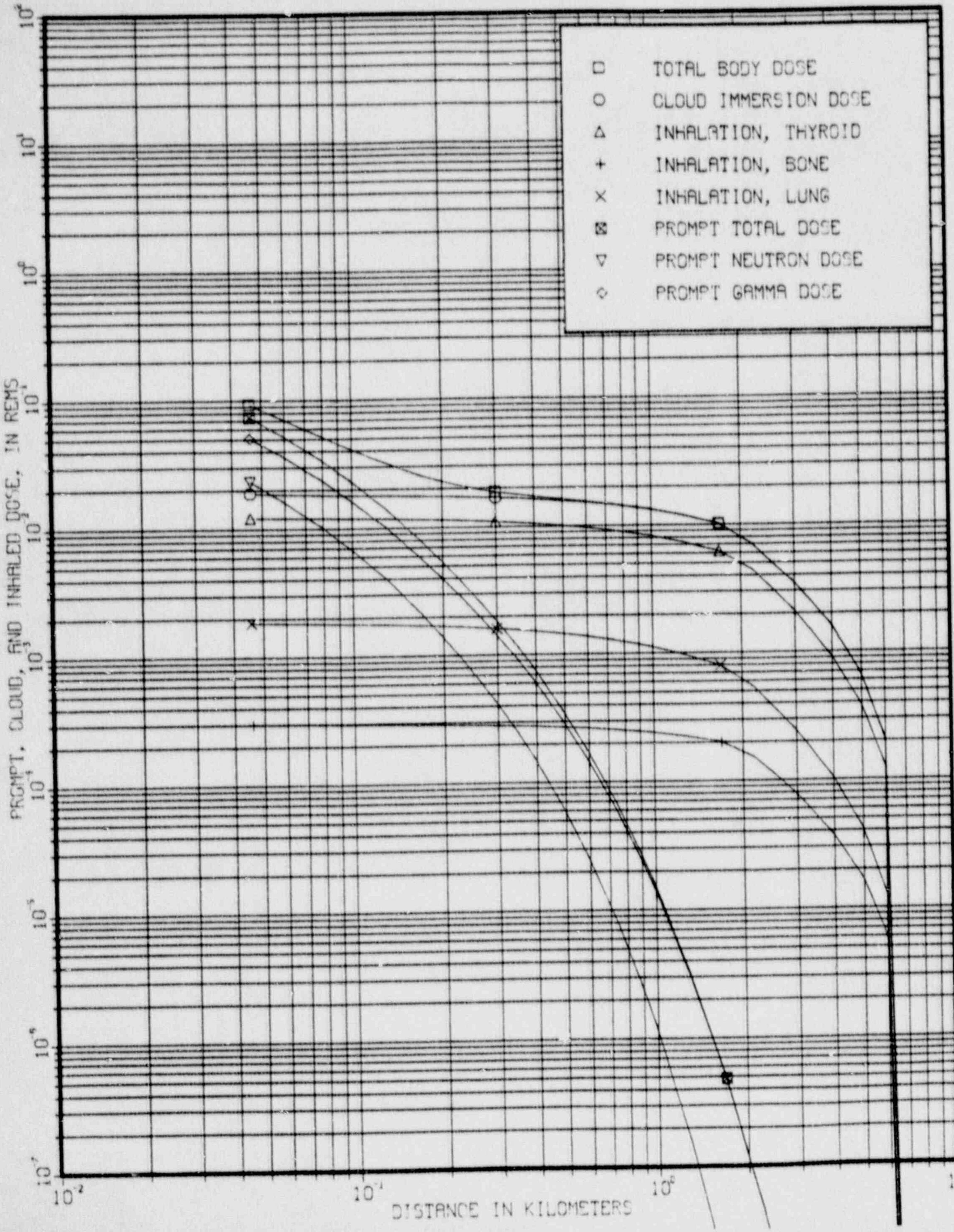


FIG I 7.3-4, 1 HR DOSE, 12 PULSES, 3.0×E18 TOTAL FISSIONS

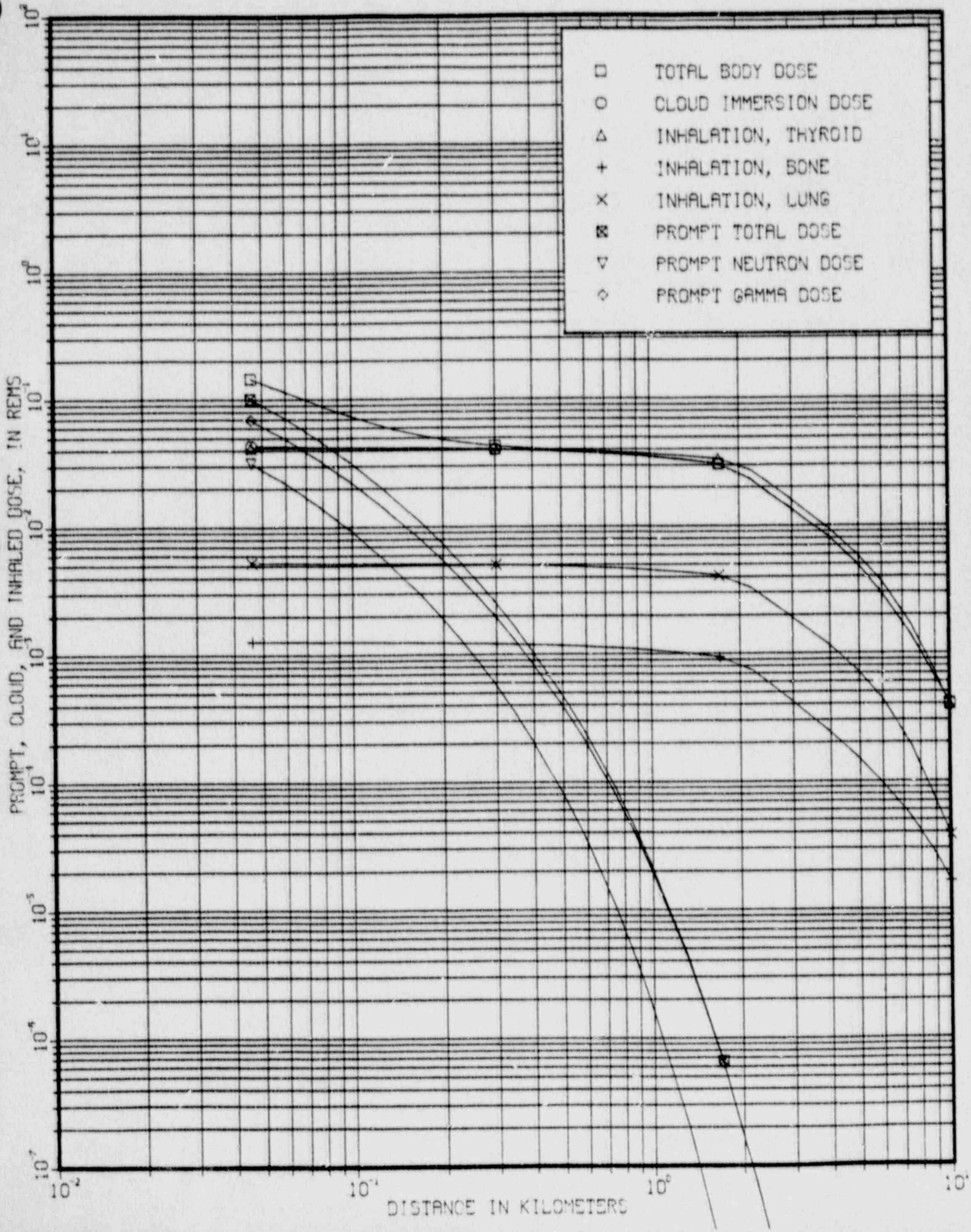


FIG I 7.3-5, 3 HR DOSE, 12 PULSES, 3.0*E18 TOTAL FISSIONS

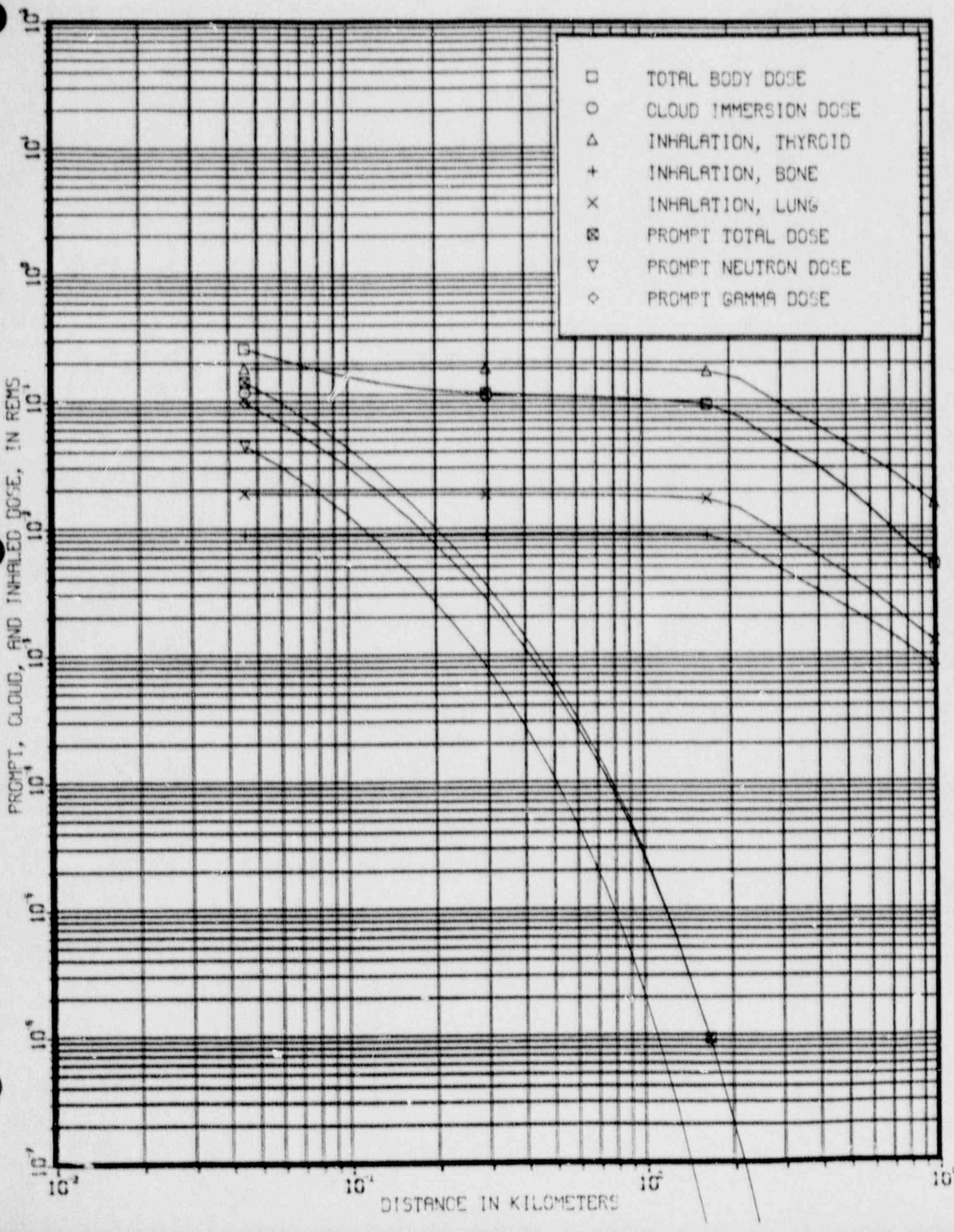
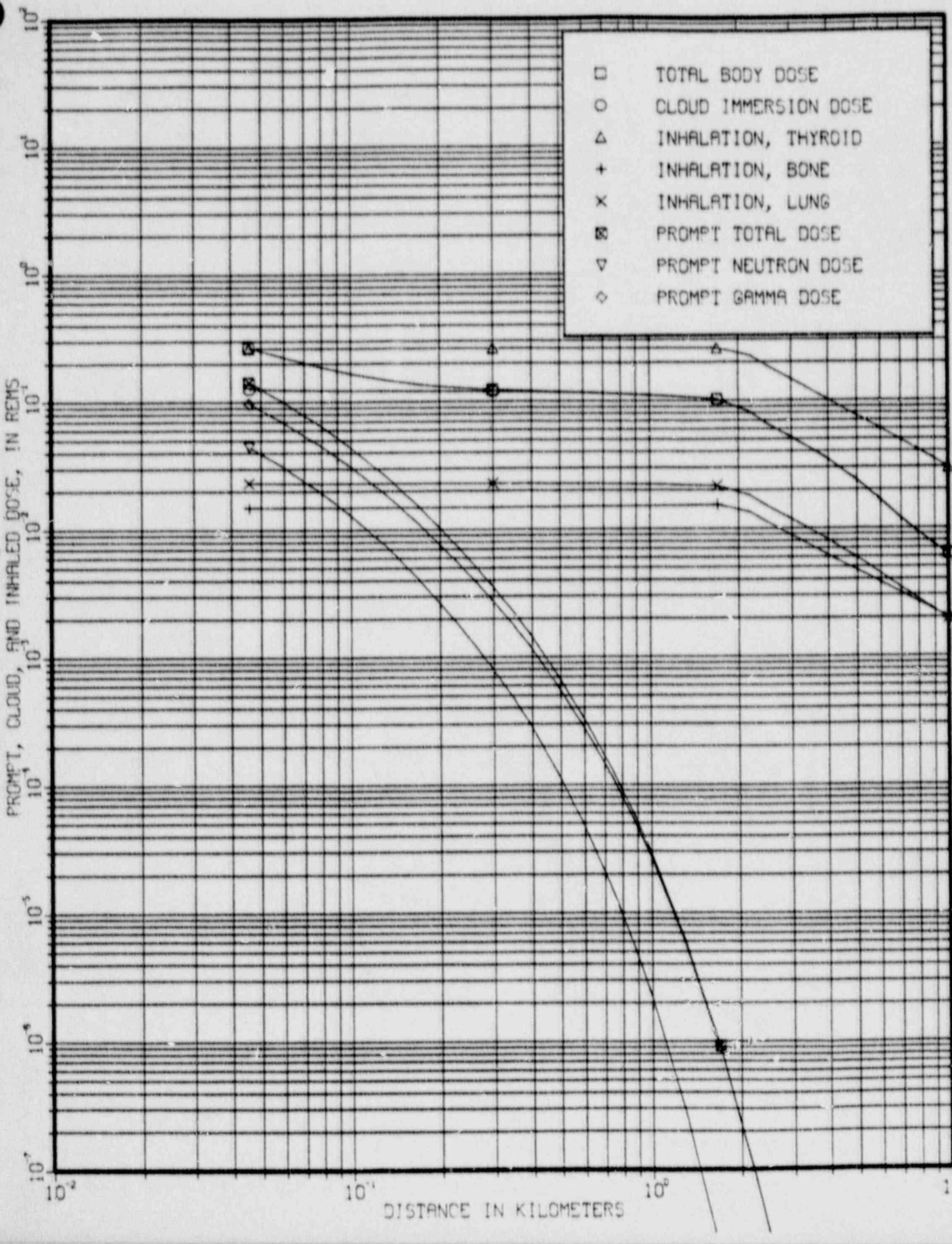


FIG I 7.3-6, 8 HR DOSE, 12 PULSES, 3.0×E18 TOTAL FISSIONS



8. SUPPORTING DEMONSTRATION DOCUMENTS

8.1 SNM MATERIAL CONTROL AND ACCOUNTING

10 CFR Part 70 requires that licensees establish an organization and procedures to implement requirements for the measurement, control and accounting of SNM. GA has developed a Fundamental Nuclear Material Control Plan which has been approved by the Commission. The requirements to maintain and follow such an approved plan are contained in the licensee's Specifications Volume.

8.2 SECURITY PLANS

Pursuant to 10 CFR Parts 70 and 73, GA has and maintains an NRC-approved plan for the physical protection of its SNM and SNM facilities. GA's plan entitled "Fixed Site and Transportation Plan for the Protection of Special Nuclear Material of Moderate and Low Strategic Significance" must be maintained and followed as a requirement contained in GA's license Specifications Volume.

8.3 RADIOLOGICAL CONTINGENCY PLAN

GA has and maintains a Radiological Contingency Plan. This plan has been submitted to and approved by the NRC. GA's license Specifications Volume contains the requirement to maintain and implement such a Radiological Contingency Plan.

8.4 DECOMMISSIONING PLAN

GA has developed a plan for decommissioning its licensed facilities at the end of plant life. This Decommissioning Plan dated June 1979 was first submitted to NRC June 15, 1979. GA received NRC approval of this plan January 13,1982. The Decommissioning Plan was updated in July 1986 and the revised plan submitted to NRC by letter dated July 25, 1986 and its supplement dated October 15, 1986. The revised plan was approved December 2, 1986.

The release of facilities and equipment for unrestricted use from GA's plant site or to unrestricted areas onsite shall be in accordance with Annex C of the Specifications Volume, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material", dated July 1982!