ST. LOUIS ORDNANCE PLANT

US Army Corps
of Engineers
HUNTSVILLE DIVISION

30057659
Superfund

Defense Environmental Restoration Program
for
Formerly Used Defense Sites

Ordnance and Explosive Waste
Chemical Warfare Materials

ARCHIVES SEARCH REPORT

APPENDIX C-4

ST. LOUIS ORDNANCE PLANT
AND
ST. LOUIS ORDNANCE CORE PLANT

St. Louis, Missouri

Site Nos. B07MO0010 and B07MO0170

DECEMBER 1993

Prepared by
US ARMY CORPS OF ENGINEERS

ORDNANCE AND EXPLOSIVE WASTE
CHEMICAL WARFARE MATERIALS
ARCHIVES SEARCH REPORT
FOR
ST. LOUIS ORDNANCE PLANT
AND
ST. LOUIS ORDNANCE CORE PLANT
ST. LOUIS, MISSOURI

DERP-FUDS SITE NOS. B07MO0010 AND B07MO0170

APPENDIX C-4
TABLE OF CONTENTS

ADDITIONAL REPORTS, STUDIES, LETTERS, AND MEMORANDUMS
NOT OFFICIALLY INCLUDED IN THE BODY OF THE REPORT

1955. Report from Ordnance Corps, subject: Ordnance Corps Historical Summary (Part I only), St. Louis Ordnance Plant, dated 1 July - 31 December 1955.

1961. Attorney's Report from L. Sissel, Attorney, Corps of Engineers, subject: Disposal of 77.79 Acres of Land Located at Tyson Valley Powder Farm, St. Louis County, Missouri, dated 18 July 1961.

1962. Memorandum from J. W. Harrop, Chief, Property Division, General Services Administration, Kansas City, Missouri, to "File", subject: Tyson Valley Powder Farm, dated July 2, 1962.

1963. Letter from E. Lyle Knight, Regional Representative, Division of Surplus Property Utilization, Department of Health, Education and Welfare to J. Wayne Harrop, Chief, Real Property Division, GSA, concerning transfer of Tyson Valley Powder Farm property (deed attached), dated October 11, 1963.

1960. Lease Agreement between Secretary of the Army and Indianapolis Grain Warehouse Corp., dated October 1960.

1992. Newspaper clipping from St. Louis Post-Dispatch, concerning brief history of Lone Elk Park, titled: Lone Elk's Story Blends Luck, Lore, Compassion, dated December 21, 1992.

UNK. Report from Washington University, subject: Application for Acquisition of Tyson Valley Powder Farm in St. Louis County, Missouri.

ORDNANCE AND EXPLOSIVE WASTE
CHEMICAL WARFARE MATERIALS
ARCHIVES SEARCH REPORT
FOR
ST. LOUIS ORDNANCE PLANT
AND
ST. LOUIS ORDNANCE CORE PLANT
ST. LOUIS, MISSOURI

DERP-FUDS SITE NOS. B07MO0010 AND B07MO0170

APPENDIX C-4
TABLE OF CONTENTS (CONTINUED)

ADDITIONAL REPORTS, STUDIES, LETTERS, AND MEMORANDUMS
NOT OFFICIALLY INCLUDED IN THE BODY OF THE REPORT

1985. Report, prepared by Woodward-Clyde Consultants, Walnut Creek, California, subject: Archeological Overview and Management Plan for the St. Louis Army Ammunition Plant, St. Louis County, Missouri, dated 1 April 1985.

UNK. Report titled: Armor Piercing Core Plant, St. Louis, Missouri (Availability and Disposal Information Through Reconstruction Finance Corporation).

UNK. Report (portion of), titled: Small Arms Ammunition Plant, Industrial Development Master Plan.

ALL COMMUNICATIONS SHOULD BE ACCOMPANIED BY CARBON COPY AND ADDRESSED TO FCS:tk

WAR DEPARTMENT

OFFICE OF THE CHIEF OF ORDNANCE

WASHINGTON

October 9, 1940

MEMORANDUM FOR: Col. H. K. Rutherford
Chairman, Site Board
Office of the Assistant Secretary of War

Subject: Proposed Small Arms Ammunition Plant: St. Louis, Illinois, and environs. This is a revision of the site letter dated Sept. 11, 1940, due to change in Small Arms Ammunition program.

1. It is desired to acquire real estate; to construct and equip a plant and to have this plant operated by the Western Cartridge Company, East Alton, Illinois, for the manufacture of caliber .30 and caliber .50 ammunition of all types.

2. The following detailed information is submitted.

(a) Type of plant - Plant for manufacturing of .30 cal. and .50 cal. SAA all types.

(b) Capacity - 2,000,000 cal. .30 rounds per day.
1,200,000 cal. 50 rounds per day.

(c) Area - a. One parcel in the City of St. Louis for manufacture of metal components and loading of ammunition as per the attached map, containing approximately 132 acres owned by the General Electric Company. This land is now being quoted at $5000 per acre, but it is believed that through Condemnation proceedings it can be procured for $3000/acre since the City of St. Louis, it is understood, recently condemned part of the whole former parcel for a city park at this price. $3000 x 132 = $396,000.

b. One parcel in the environs of St. Louis for use as a powder farm; to accommodate approximately thirty days' supply of powder ahead of manufacture, this site to be within reasonable trucking distance of the manufacturing plant in the City. This parcel should contain approximately 500 acres and will cost about $200.00 per acre.

REPRODUCED AT THE NATIONAL ARCHIVES

Memo. to Col. Rutherford 10/9/40
Subject: Proposed Small Arms Ammunition Plant,
St. Louis, and environs of Ill.

(d) Estimated cost of installation - $28,504,000.
(exclusive of real estate).

(e) Number of skilled and unskilled laborers - Total 10,000.

Professional and skilled	2500
Unskilled operators and labor	7500

The manufacturing plant in the City of St. Louis will be in the midst of an urban population of 890,000. The powder farm will be in the suburbs of St. Louis from which area it can draw its relatively small proportion of the total amount of labor required to operate the whole plant.

(f) Transportation facilities.

(1) The Belt Line Terminal R. R. forms the South-eastern boundary of the St. Louis property for a distance of approximately 550 feet. Streets and city transportation are ample.

(2) The powder farm site will be chosen so that it lies on the Chicago, Burlington and Quincy R.R.

(g) Power supply is ample at both sites - to be furnished by Commercial Companies.

(h) Water - Drinking and process water is available for the manufacturing plant from local sources. A river water plant would have to be installed for fire protection of the powder farm.

(i) Fuel - ample.

(j) Auxiliary and service facilities ample from the St. Louis area.

(k) Plant fairly well located with respect to supply of metals - shipment of Cartridge Brass from eastern suppliers being the longest haul. Powder to be supplied from either Charlestown, Indiana Ordnance Works, or from Radford Ordnance Works, Virginia. Packaging, boxing, chemical and other materials available within reasonable commercial shipping distances.

(l) Buildings:

REPRODUCED AT THE NATIONAL ARCHIVES

Memo. to Col. Rutherford 10/9/40
Subject: Proposed Small Arms Ammunition Plant,
St. Louis, and environs of Ill.

(1) Manufacturing - a few multi-story buildings; balance, single story.
Construction - steel and concrete.

(2) Magazines - standard Ordnance design - hollow tile and steel.

(m) Estimated cost.

(1)	Land, environs of St. Louis 500 x 200	$ 100,000
	Land in St. Louis 132 x 3000	396,000
(2)	Construction	8,250,000
(3)	Equipment	20,254,000
		$29,000,000

3. It is desired to locate this major activity near the plant of the Western Cartridge Company in order to take full advantage of the skill and know how of the Western Cartridge Company's personnel.

L. H. CAMPBELL, Jr.
Brig. Gen., Ord. Dept.
Ass't Chief of Industrial Service, Facilities

REPRODUCED AT THE NATIONAL ARCHIVES

O.O. 602.3/8 (c)
Attn: SPOIP-Facilities
CE 602.2 (General) SPEKL-Land M 3rd Ind. Smith/igd/6341

Ordnance Office, Industrial Division, Production Service Branch 6 Jan 1944

To: Commanding General, Army Service Forces
Attention Production Division

1. Milwaukee Ordnance Plant has been declared excess to the needs of the Ordnance Department with the provision that Buildings 101 and 11 be made available for storage of Ordnance equipment now at the plant or in other nearby points. It is understood that use of substantial space by the Signal Corps contractor is contemplated. In connection with paragraph 2 of 2nd Indorsement, it is desired to point out that storage of production equipment is far from dead storage. In many cases it is necessary to move equipment into storage prior to determination of disposition of the equipment in order to release production space in plants. Production equipment in storage is always subject to removal for use elsewhere, for disposition to other Government agencies or to private purchasers and for other reasons.

2. Eau Claire Ordnance Plant and Gopher Ordnance Works have been declared excess to the needs of the Ordnance Department. Disposition of these plants is entirely within the province of the Corps of Engineers and your office.

3. It is presumed that Kings Mill Ordnance Depot is intended to refer to the Kings Mill Ordnance Plant. This is the old Peters Cartridge Plant which was expanded with Government funds. The facility is part privately owned and part Government owned. In any case, it is anticipated that it will be fully utilized for the production of carbine ammunition.

4. Reference is made in teletype to St. Louis Ordnance Depot. The Depot now occupies leased space, the amount of which is insufficient for present needs. There is also the St. Louis Ordnance Plant to which the Army Air Forces may refer. The St. Louis Ordnance Depot, in order to take care of its overflow, is now using the available space in the St. Louis Ordnance Plant. Should production at the Ordnance Plant permit release of any more space, immediate use of such space will be made by the Ordnance Department either by Field Service Division for its depot operations or by Industrial Division for storage of production equipment. The Industrial Division has recently made request for additional storage space in St. Louis for this purpose.

5. The Ordnance Department is making a continuous effort to consolidate operations and to release any space for which it does not have an urgent current need. In each instance, formal declaration of excess is made after determination of availability.

For the Chief of Ordnance:

E. F. SAFFORD
Brigadier General, United States Army
Chief, Production Service Branch

1 Incl. n/c

REPRODUCED AT THE NATIONAL ARCHIVES

ALL COMMUNICATIONS SHOULD BE ACCOMPANIED BY CARBON COPY AND ADDRESSED TO

OOSmith/mit/6341

INSURE PROMPT ATTENTION
IN REPLYING REFER TO:

_____ NO. _____

SPOTT - Facilities

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ORDNANCE
WASHINGTON, D. C.

21 August 1945

SUBJECT: Declaration of Excess, St. Louis Ordnance Plant

TO: Office of the Chief of Engineers

1. It is desired to declare as excess to the needs of the Ordnance Department the land, buildings, and equipment other than production equipment, of the St. Louis Ordnance Plant with the exception of (a) the area occupied by Chevrolet Shell Division, General Motors Corporation, which must be held in standby; (b) the area occupied by McQuay Norris Manufacturing Company, which must be used for the production of 90 Cal. cases; (c) Tyson Valley storage area which must be held pending disposition of explosives stored therein.

2. The installation was used for the manufacture of small arms ammunition. Production has ceased. Portions of the plant are available, and the remainder will be available as rapidly as equipment can be cleared.

3. To the knowledge of this office there are no contractual obligations affecting disposition.

4. By memorandum of 17 July 1945 from the Acting Director, Plans and Operations Division, Headquarters, Army Service Forces, it has been directed that the plant be made available for utilization by the Adjutant General, the Office of the Fiscal Director, Army Service Forces, and the General Accounting Office.

5. It is contemplated that effective 15 September 1945, general administration of the plant will be assumed by the Seventh Service Command. It is intended that on that date accountability will be transferred from the Ordnance Department to the Service Command for all real property except those buildings in which production equipment is located. There will also be transferred all equipment other than production equipment except such non production equipment as may be permanently located in the production buildings. As of that date it is intended that the Service Command will assume operation of the utilities, cafeteria, power house, and other

REPRODUCED AT THE NATIONAL ARCHIVES

administrative services, and will take over general plant maintenance and guarding.

6. The present operator of the plant, United States Cartridge Company, will remain in possession of buildings in which production equipment is located, until these buildings can be cleared of the production equipment, at which time accountability for the buildings will be transferred to the Service Command. It is intended that buildings 204 and 105 will be cleared first. Equipment from these buildings will be moved into building 205 temporarily in order to facilitate clearance and prompt disposition by disposal authorities, and by the Ordnance Department. It is hoped that clearance of 204 and 205 can be completed by 15 September. Following clearance of 204 and 105, buildings 203 and 106 will be cleared.

7. Rehabilitation work to be performed by the Corps of Engineers and occupancy of any portion of a single production building can not be undertaken until clearance of that particular building is completed by the Ordnance contractor.

8. It is contemplated that the McQuay Norris area will be declared excess as soon as other arrangements can be made for the production of 60 Cal. cores. With respect to the Chevrolet shell operation, it is contemplated that after performance of the necessary work to place the plant in standby condition, the Chevrolet contract will be terminated, and the Service Command will be requested to exercise guarding and maintenance functions in the area. It will be necessary for arrangements to be made for supply of utilities to McQuay Norris and to Chevrolet subsequent to 15 September.

9. It is requested that local arrangements to carry out the foregoing be made with the Commanding Officer, St. Louis Ordnance Plant and with the Ordnance contractors located at the plant.

FOR THE CHIEF OF ORDNANCE:

G. G. SMITH
Lt Col, Ord Dept
Assistant

cc: Production Div., ASF
Readjustment Div., ASF
Industrial Equipment
Redistribution Bd., RFC
Small Arms Div.
Ammunition Div.
Adjutant General, Attn: Col. White
Records Div.
Office of the Fiscal Director
Attn: Col. A. C. Harten
C. O., St. Louis Ord. Plant
Major Patterson, Demobilization Div.

MICROFILMED AT THE NATIONAL ARCHIVES

Office Memorandum • UNITED STATES GOVERNMENT

TO : CHIEF, PROD SERV DIV - IND SERV - OCO DATE: 11 September 1945

FROM : CHIEF, AMMUN DIV - IND SERV - OCO

SUBJECT: Standby at St. Louis Ordnance Plant

1. This is to advise that the St. Louis Ordnance Plant is now classified as a standby facility. In compliance with para. 7-a-200.2 of Procurement Regulation 7-A, as outlined in ASF Circular 272 dated 14 July 1945, the following information is set forth:

a. St. Louis Ordnance Plant is located at St. Louis, Mo. It consists of 2,918 acres of land, however only that portion occupied by Chevrolet Division, G.M.C., plus the essential utilities in which other portions of the plant are involved and which would be shared with other government agencies, are to be put in standby for complete operation and production for medium artillery shell.

b. The installation was classified as a standby facility on 15 August 1945.

c. This installation will be retained in standby condition for an indefinite period. This plant is a part of the peacetime War Reserve for the production of future possible requirements of medium artillery shell. Justification for the retention of this facility is based on the need for production capacity of medium artillery shell which can start producing with the least possible delay in the event of another emergency.

d. At the present time that portion of the installation now occupied by Chevrolet Division, G.M.C. is required by this office in performing duties incident to close-down, except lands which have been declared available for leasing for agricultural or grazing purposes, details of which may be found in the office of the appropriate Division Engineer. Advice concerning other portions of this installation which might be made available for temporary use by other agencies will be furnished at a later date.

e. It is estimated that 90-120 days will be required to put the installation into production on a substantial scale.

R. E. Hardy

R. E. HARDY
Brigadier General, Ord Dept
Chief, Ammunition Division
Industrial Service

REPRODUCED AT THE NATIONAL ARCHIVES

REPRODUCED AT THE NATIONAL ARCHIVES

[illegible] GOVERNMENT

[illegible] 13 September 1945

Keegan/kw
4120

SPOIF
Facilities

14 September 1945

SUBJECT: Standby Classification - Chevrolet Shell Area of St. Louis Ordnance Plant

TO: Commanding General, ASF
Attn: Production Division

TO: Office, Chief of Engineers

1. It is desired to classify subject facility as standby. The following information is submitted in accordance with FR 7-1-200.2:

a. St. Louis Ordnance Plant is located at St. Louis, Missouri. That portion of the plant occupied by Chevrolet Division, General Motors Corporation, plus the essential utilities used jointly by other portions of the plant and which would be shared with other Government agencies, are to be put in standby for complete operation and production of medium artillery shells.

b. The installation was classified as a standby facility on 15 August 1945.

c. This installation will be retained in standby condition for an indefinite period. This plant is a part of the peacetime War Reserve for the production of future possible requirements of medium artillery shell. Justification for the retention of this facility is based on the need for production capacity of medium artillery shell which can start producing with the least possible delay in the event of another emergency.

d. At the present time that portion of the installation now occupied by Chevrolet Division, G.M.C. is required by this office in performing duties incident to close-down, except lands which have been declared available for leasing for agricultural or grazing purposes, details of which may be found in the office of the appropriate Division Engineer. Advice concerning other portions of this installation which might be made available for temporary use by other agencies will be furnished at a later date.

e. It is estimated that 90-120 days will be required to put the installation into production on a substantial scale.

FOR THE CHIEF OF ORDNANCE:

G. C. SMITH
Lt. Col., Ord. Dept.
Assistant

cc Ammunition Div. 3 copies

APPRAISAL OF

ST. LOUIS ORDNANCE PLANT

(for that portion occupied by
(the McQuay-Norris Mfg. Co.)

THIS DOCKET IS NOT TO
BE REMOVED FROM
YOUR CUSTODY

PLEASE RETURN PROMPTLY!
RECORDS UNIT • ROOM ~~874~~ 4411

APPRAISAL OF

ST. LOUIS ORDNANCE PLANT

(for that portion occupied by)
(the McQuay-Norris Mfg. Co.)

Prepared by

Nelson Cunliff

January 10, 1946.

St. Louis, Missouri
January 10, 1946

The Reconstruction Finance Corporation
407 North Eighth Street
St. Louis, Missouri

Gentlemen:

In Re: That part of the St. Louis Ordnance Plant that was occupied by the McQuay-Norris Manufacturing Company

Herewith is my appraisal of the normal replacement cost of the land, land improvements, buildings and building structures of that part of the St. Louis Ordnance Plant, known as The Armour Piercing Core Plant, formerly operated by the McQuay-Norris Manufacturing Company.

The normal replacement new cost is figured on the basis of the cost of labor and materials as of December 1945. The plant was erected during 1941 and 1942. T he records show that a portion of the plant was completed in August 1941 and additional construction and installation was completed in September 1942. While the parking area was completed in July 1943.

The plant was erected for the production of war materials and was erected during the time when many other war plants were in process of erection and the work was performed at a time when the prices of material and labor were effected by premium wages, priorities, overtime compensation, increased cost of materials due to scarcity of the materials or accelerated deliveries.

The work was performed by the Fruco Construction Company, which was a temporary consolidation of the executive direction on the part of a leading construction firm in St. Louis and a strong, experienced

construction firm from Kansas City. These were the Fruin-Colnon Construction Company of St. Louis and the Hassman Construction Company of Kansas City. Both companies were recognized for their skill, integrity and ability in all forms of construction.

The architectural and engineering services were by Mauran, Russell, Crowell & Mullgardt of St. Louis and an associated firm, Giffels-Ballet of Detroit, Michigan. The operator of the plant was the McQuay-Norris Manufacturing Company, a Delaware Corporation, located in St. Louis, who have a large plant of their own in this community, producing automotive piston rings.

The appraised plant was built to supplement the work of the St. Louis Small Arms Plant which is located immediately north of the appraised property, and upon which was located for this particular plant, the railroad switching facilities, power plant and government fire fighting facilities.

The Small Arms Plant, as well as the Armour Piercing Core Plant were operated on contiguous properties under the direction of the Ordnance Department of the United States Army. The address of the Armour Piercing Core Plant was 4014 Siemers Lane, St. Louis, Missouri.

The engineers, architects and contractors were limited in their use of materials by the regulations of the War Production Board.

The best building in this plant was the Main Building, which is a one and two story building of brick, concrete and structural steel construction. This building is known as #113; it included the core plant, screw machine room, tool and die shop, inspection room and kindred facilities. Building #113C is the warehouse building, it was

a one story and mezzanine warehouse building with railroad tracks inside and outside of the building. The finished product was inspected, packed and packaged in this building. The building, itself, was entirely of frame construction with structural steel columns, structural steel roof beams and concrete foundation. The floor was of concrete.

Building #113-D was a one story and mezzanine furnace building. It included a large annealing furnace room with steel tempering facilities. The building had an interior loading dock but no direct railroad facilities.

Building #113-E was a laboratory building that had been reconstructed from an old building that was on this original site. There were two guard houses, a steel storage shed and a liquid storage shed. All of which will be described in detail herein.

There were no unusual construction problems in connection with this work. The plant was centrally located with adequate railroad facilities. Most of the ground was virgin soil and the terrain is fairly rolling. The plant has ready access to city streets, sewers, lights, electric power and bus transportation.

It is located in what is known as the Northwest industrial area and there are many plants in this area, due to the accessibility to the homes of workers who were employed herein. There were no unusual strikes or labor disorders that seriously interfered with the progress of the construction work. There were the usual jurisdictional labor disputes but nothing that seriously interfered with the early completion of construction work.

It is assumed:

That the buildings were all started in 1941 and completed about the middle of 1942.

In figuring the Replacement New Cost it would be based on the work being performed by Union Labor, members of the American Federation of Labor and in accord with labor rates and rules of the St. Louis Building Trades Council. No overtime payments are required.

That five 8 hour days constitute a week and no premiums are to be paid for labor or materials.

That car load quantity prices F.O.B. job site prevail.

That job costs for general contractors and sub-contractors are to be figured on a competive basis. No prices are to be in excess of the War Production Board ceiling and no penalty added for the scarcity of labor or its inefficiency, or substitution of materials other than the standard materials or those used on this job. The prices are based on the prevailing schedules as of December, 1945.

All measurements are based on War Department plans included in their Industrial Facilities Inventory.

Land and Land Improvements:

The land comprising the McQuay-Norris Plant or the Armour Piercing Core Plant is made up of two tracts, mainly the plant area proper, which is located on the East of Siemmers Lane, and the other is a parking area which lies entirely west of Siemmers Lane.

The plant area proper is described as follows:

Beginning at a point in the East line of a private road 30 feet wide, which East line is the West line of U.S. Survey 3331, said beginning point being 20 feet northerly along said East line from the

North line of a right-of-way easement, said easement being described in deed recorded in Book 2956, Page 13, in the records of the Recorder of Deeds for the City of St. Louis, Missouri; thence North 29 degrees 11 minutes East along the West line of said U. S. Survey 3331 to a point, said point being at the intersection of said West line with the South line of a sidewalk along the North side of Elward Avenue between Goodfellow Boulevard and Siemmer's Lane if said line were projected eastward; thence eastwardly along the existing McQuay-Norris boundary fence to a point approximately 10 feet from the center line of the Government owned spur track which serves the St. Louis Ordnance Plant; thence along the boundary fence which is parallel to and approximately 10 feet distant from the center line of said spur track and of a "Hole" track which ends near the southeast corner of the Core Plant Building, excepting, however, the fence-inclosed Gas Meter House area; thence southward along the boundary fence to a point in the Northerly line of a switch track easement, described in Deed Book 2956, Page 13, City of St. Louis Recorder's Office; thence along said northerly line to a point in said line 125 feet easterly from the west line of U.S. Survey 3331 which is the East line of Siemer's Lane, a private road 30 feet wide; thence North 29 degrees 11 minutes East, a distance of 20 feet; thence North 60 degrees 52 minutes West 125 feet to the point of beginning.

The parking area is described as follows:

Lots 1 to 28, inclusive, Block 1, Dougherty's Goodfellow Avenue Subdivision, in City Block 4347, of the City of St. Louis, Missouri, together with abutting alleys and streets to be vacated. This area is further described by meets and bounds as follows: Beginning at the point of intersection of the North line of Elward Avenue and the easterly line

of Goodfellow Boulevard as widened; thence eastwardly along the northerly line of Elward Avenue to the westerly line of a private road known as Siemer's Lane; thence southwardly along the westerly line of said Siemer's Lane 180 feet 4 inches to the line of a private alley along Block 1, Dougherty's Goodfellow Avenue Subdivision; thence westwardly along the line of said alley to a point of intersection with the easterly line of Goodfellow Boulevard as widened; thence northwardly along the easterly line of Goodfellow Boulevard as widened to the northerly line of Elward Avenue, the point of beginning, all in the City of St. Louis, Missouri.

The acreage on the plat in that portion of the ground designated to be in the plant area proper is reported to be 11.465 acres which excludes the portion of public highway which was formerly the property of the City of St. Louis.

The acreage in the parking lot, which fronts on Elward Avenue is 2.302 acres. This parking lot or plot of ground west of Siemer's Lane, was acquired by the government in 1942 and in 1943. Before the government condemned it and acquired it, it was a regular street in the City of St. Louis with about 23 small lots, most of which had small 4, 5 and 6 room bungalows located thereon. These homes had sewers, water, sidewalks, electric and gas facilities, as would be used on the average city street, nearly all of these homes were occupied by owners. It was necessary for the government to file a declaration of taking in most instances and acquire this property that has since been used, as an automobile parking lot for those employees who drove their cars. The parking lot was surfaced with macadam, bumpers and stall markers were installed. Driveways, inside flood lights were provided and the entire area was enclosed within a non-climable fence. Guards and watchmen

who were housed in a guard house just within the parking lot, supervised its use. At the present time this parking lot is not in use but it does adjoin an industrial plant on the South.

The property is zoned unrestricted. It does not have railroad facilities but is accessible to bus service and all public utilities.

Similar property is available at the price of $37.50 per front foot and this is the value at which I will appraise this parking lot. This would be for the entire frontage on Elward Avenue.

I recognize the fact that when the government acquired these lots they were individual lots, improved with individual houses, which houses have been removed. These houses certainly added considerable value to the property that is not there today. I also recognize the fact that the government spent between 18 and 19,000 dollars in making improvements that would allow them to satisfactorily use this property as a parking lot and enclose it with fences, build drives, install lights, etc. The replacement new cost in this appraisal for the work this ground use required is $15,000, but in my opinion it does not add anything to the value of this lot today, over and above the value of $37.50 per front foot. This valuation in my opinion, establishes the value of the parking lot of 851' 03/4" front foot at $37.50.....$31,912.50. * * * The ground in the main plant was owned and used by industry prior to the present occupancy. It had railroad facilities and was zoned for industrial uses.

The buildings referred to in the Core Plant above are located closely together and that portion of the land area not occupied by buildings is used for parking lots, railroad facilities or landscape.

This plant, as it is at present laid out, is dependent upon

**** See Page 11a

many facilities that originate in the Small Arms Munitions Plant.

Steam:

Steam is provided for the Main Core Plant building by a 190 pound high pressure line from the distribution system of the Small Arms Power Plant, and from there it is distributed throughout the Armour Piercing Core Plant by a 40 pound pressure line. If this property is to be sold, arrangements must be made for either a new source of heat and steam power or for the metering of services for the new owners.

Water:

Water is now supplied by means of a distribution system in the Small Arms Plant. If this plant is sold, arrangements would either have to be made for a new source of supply or have a meter service through the Small Arms Plant.

Electricity:

Electricity is supplied from the Small Arms Power Plant. This comes into the main building in the Core Plant and from there it is distributed to the other buildings of the Armour Piercing Core Plant.

Natural Gas:

Natural Gas is now supplied from the distribution system of the Small Arms Plant into the main building of the Armour Piercing Core Plant, from this point it is distributed to the other buildings. If this plant is sold for private use, arrangements will have to be made for service from the Small Arms Plant or arrangements would have to be made for the use of artificial gas that would come from the gas company mains in this vicinity.

Railroad:

Railroad connections are served to the Armour Piercing Core Plant from the railroad facilities in the Small Arms Plant, and all switching of cars in the appraised property is now handled by army locomotives. It is true that all the tracks on the appraised property, as well as in the St. Louis Ordnance Plant, connect up with the ample facilities of the St. Louis Terminal Railroad Association, and whose right of way touches the appraised property on the East. However, it has not been governmental policy to allow the engines of the St. Louis Terminal Railroad Association to traverse the rails of the St. Louis Ordnance Plant or the Armour Piercing Plant, nor is it practical or possible, at the present time, to make a direct connection from the Armour Piercing Core Plant switches or rails directly to the facilities of the St. Louis Terminal Railroad Association.

Your appraiser understands that consideration is being given to adding additional ground to that which has already been established as belonging to the Core Plant, in order that proper turnouts might be made from the Terminal Railroad Association to the rails on the Core plant.

Telephones:

The present telephone facilities are owned and were installed by the Army. Telephones in the Core Plant are connected to the switchboard of the Small Arms Munitions Plant. However, there are public telephone facilities nearby so that direct connections could be made with the lines of the Southwestern Bell Telephone Company system.

Most of the facilities coming from the Small Arms Plant, such as steam, telephone, gas power, etc., comes through a tunnel from the Power Plant of the Small Arms Plant. While your appraiser has given consideration to the replacement new values of these facilities in another portion of this report, he feels that a frank statement at this point as to the limited facilities of the Core Plant is necessary for anyone considering purchasing these facilities. He will have the problem of the government giving a clear title to the land under the foregoing circumstances, or will be faced with providing them himself through private or public services.

Your appraiser has considered numerous tracts of ground in the Northwest industrial district and has appraised property within a radius of 1/2 mile of the Armour Piercing Core Plant. Land similar to that of the appraised property is available today and the market value thereof is $0.30 per square foot.

In this main plant area of the Core Plant, the Army records show that there are 499,415 square feet (11.465 acres), and on the basis of 30¢ per sq.ft.,it would have a total market value today of. .$149,824.00

Your appraiser understands that approximately $50,000.00 was spent by the Army on what is ordinarily considered land improvements which included, grading, shaping the terrain, i.e., preparing it for its present use.

Approximately $31,000.00 of this money was spent on the main plant site. In determining the foregoing values your appraiser has given consideration to these improvements in the values of the ground that he has used. This value of 30 cents per square foot,

includes land improvements other than those listed in "Leasehold Improvements" hereinafter.

T OTAL OF SCHEDULE I $181,736.50

* * *

Army records do not show the distance along Elwood Avenue between the now existing lines of Goodfellow and Siemers Lane. City Hall records show this distance to be 851'03/4". This distance is the one that is used in this appraisal.

Should any future survey not confirm this figure, then the price of $37.50 per front foot should be maintained, together with any revision in this total distance.

The same condition applies as to the property east of Siemers Lane and is herein designated as the Main Plant Area.

Army records show this acreage to be 11.465 acres which is the equivalent of 499,415 square feet. Should this total area be proven incorrect on any future survey the price of 30¢ per square foot should be applied to any corrected total.

SCHEDULE II

BUILDINGS, STRUCTURES, ETC.

All values herein shown for Reproduction New Cost includes all job costs, contractors fees, architectural and engineering fees, cost of structural steel, heating, plumbing, electric lighting, etc., in each building.

The tunnels, railroads, fences, walks, etc., outside of the buildings are considered under the subject Leasehold Improvements.

BUILDING #113 - GORE BUILDING

This building consists of:

1 - Screw machine room

2 - Tool and die shops

3 - Inspection Room

4 - Basement

There are first, second and third floors. There is a cafeteria, toilets and locker facilities for colored and white men, and colored and white women. The building has an outside dimension of 158' 9" by 309' 3". The floor areas are as follows:

29,520	Square feet -	Basement
148,634	Square feet -	1st floor
17,315	Square feet -	2nd floor
5,978	Square feet -	3rd floor
5,368	Square feet -	Covered storage area

A total of...206,815 Square feet

The basement story height is 11' while on the first floor, the story heighth of the east part is 35', the middle 23' and the west part 11'.

The second floor story height is 13'3", and the third floor height is 12'. The total number of cubic feet is 4,965,834.

In the basement there is a reinforced concrete slab on the

ground; on the first floor 88% of the floor area consists of concrete slab on the ground or on a sand fill especially prepared for this purpose. The second and third floors are reinforced concrete slabs with concrete beams.

The floors finish in the basement is of cement; on the first floor over 2/3 of the area is covered with wood blocks. The balance is cement and steel plate grating and asphalt tile.

Foundations are of reinforced concrete spread footing under the columns with reinforced concrete spandrel walls from column to column.

The structural frame for this building is of steel columns and truss, the exterior wall is of brick unfinished on the inside, except that the walls in the toilets, locker and cafeteria have structural glazed tile walls.

The designed floor loads in the basement are 1,000 pounds per square foot, while the first floor is designed for 2,000 pounds per square foot. The second floor is designed for 150 pounds, and the third floor for 60 pounds, and the roof for 40 pounds.

Unit heaters with radiators operate on steam furnished by heat from the central heating unit from the Small Arms Plant.

The lights are all flourescent.

The roof deck is precast concrete slab on steel purlins, while the roof is a 20 year guaranteed tar and gravel roof with no insulation.

There is a 1½ Ton Cleveland Tram Rail that travels overhead along the center of the screw machine room. There is a 3 Ton hoist in the machine repair department in the Southeast corner of the building and a 5 Ton crane over the loading dock in the Northeast corner of the building.

The Core building was used for the production of Armour Piercing Cores which are made largely with screw machines and the main portion of this building was devoted to hundreds of screw machines which were fed by means of the overhead crane which brought large supplies of rods to each machine.

The Normal Replacement New Value of this building is $1,815,000.00

BUILDING #113A - GUARD HOUSE

These buildings were reinforced concrete structures designed as an operating point for the guards in charge of the premises. There were turnstiles and inspection facilities typical of the facilities required by the Auxiliary Police service in the various munition plants.

Generally the buildings were about 9' high, on concrete foundations, concrete roof, brick walls about 3' high and above that glass all around so that the guard would have a clear view in any direction. There was a toilet, office and waiting room in the principle guard house at this plant.

In Building #113A there were 1,665 square feet and contained 15,766 cubic feet.

It has a Replacement New Cost of . . . . . $ 12,000.00

BUILDING 113B

Building #113B was of similar design and construction to that of Building #113A, except that it lacked the administrative facilities. It contains 118 square feet and 1,694 cubic feet and had a Normal Replacement New Cost of . . . . . $ 3,100.00

BUILDING #113C - WAREHOUSE

This is a frame building on structural steel columns and trusses. The total floor area is 155'7" by 155'7". On the first floor there are 50,113 square feet, on the mezzanine, 4,296' and on the third floor a guard house with 59 square feet, making a total of 54,568 square feet.

The story heights on the first floor are 27'4" and 11'3", on the mezzanine the story height is 16', while in the guard house it is 8'6". The cubical content is 1,659,528 cubic feet. The building contains a small cafeteria, locker facilities, toilets for colored and white men, and colored and white women. The floor construction on the first floor is reinforced concrete slab on the ground. There is railroad ballast and rails on the switch track that comes into the building. The mezzanine has tongue and groove flooring on wood joists. The first floor is of small amounts of cement and bituminous topping, with 84% of the area being covered with wood blocks. The structural frame of this building is steel columns and steel truss. The foundations are of reinforced concrete with spread footings. The spandrel walls are of reinforced concrete while the exterior of the building consists of wood studs with sheathing and siding on the exterior and shiplaps on the inside. There is no insulation in the exterior walls. There is structural tile in the walls of the toilet rooms and prestwood and plaster board in the locker rooms, entry, etc.

The designed floor loads for the first floor is, approximately 75% will take care of 1,000 pounds per square foot, the balance 2,000 pounds per square foot, the mezzanine 60 pounds and the guard house 60 pounds per square foot. The heating is through steam radiators and unit

radiators with steam from the central power plant from the St. Louis Ordnance Plant. The lights are all flourescent. The roof deck construction is of 2" tongue and groove yellow pine on steel purlins covered with a 15 year guaranteed tar and gravel roof. There is no roof insulation. This structure was provided with crane rails and a conveyer that extends the full length of the building.

The Normal Replacement New Cost is $154,000.00

BUILDING 113D - FURNACE BUILDING

This building is similar in design to that of the Warehouse Building. This building is 263'7" by 117'6". It has a basement that contains 14,816 square feet. The first floor contains 30,973 square feet, and the second floor contains 4,050 square feet. This makes a total of 49,839 square feet.

The story height in the basement is 13', on the first floor on the north elevation it is 10'5", the middle 27' and on the west 19'0". On the second floor it is 9'6". The total cubical content is 961,997 cubic feet. There is a small cafeteria in this building. It has toilet facilities which include showers, sink, lavatories, etc., for white and colored men and for white and colored women, and it also has lockers for same.

Floor construction in the basement is reinforced concrete slab on the ground. The first floor is reinforced concrete slab, half of which is on sand fill brought in by the government, and half on spans of reinforced concrete slabs from the beam to wall.

The second floor is entirely of wood joists and wood floor. The floor finish in the basement is cement while 88% of the area on the

first floor is wood block and the balance of asphalt.

The wall construction in the basement is reinforced concrete spandrel wall bearing on concrete footings.

The first story consists of wood studs with sheathing on the inside and drop siding on the exterior. No insulation is used in this wall construction.

The floors are designed to carry 1,000 pounds in the basement, 500 pounds on the first floor and 50 pounds on the second floor and 30 pounds on the roof.

Heat is through unit heaters, pipe coils and ordinary radiators. Steam is from the central plant on the Ordnance property.

Flourescent lighting fixtures throughout.

Roof deck of steel I beams and channel purlins with 2" wood sheathing, while the roof is a guaranteed 20 year tar and gravel roof with no insulation.

There is a 1300 pound capacity elevator that operates from the basement to the first floor in the East half of the building. There are numerous cranes, 9 of which have 2,000 pound capacity, 4 which have 1,000 pound capacity, and 12 which have 500 pound capacity.

The Normal Replacement New Cost of this building is . . . . . $ 175,000.00

BUILDING #113E - LABORATORY BUILDING

This is a building that existed on the site when the government bought the property and has been made over to a laboratory building and there

are very few indications of its original use.

The building contains 4,578 square feet on the ground floor area, the small area in the basement contains 153 square feet.

The first floor story height is 14'9" and the building contains 102,246 cubic feet. There are toilets for white men and women with locker facilities.

The first floor is reinforced concrete slab on a fill, and the finish of this floor in the general area, is of asphalt tile. There are concrete foundations and walls with brick above. This brick is painted on the inside of the first floor.

The heating is furnished through radiators and unit heaters with steam from the central plant.

Flourescent lighting throughout.

The roof deck construction is reinforced concrete slab and is covered with a 20 year guaranteed tar and gravel roof, with no insulation.

The Normal Replacement New Cost of this building is . . . . . $ 27,500.00

BUILDING #113F - STEEL STORAGE SHED:

This building is 30' by 122', and contains 3,660 square feet.

It has a height of 10' and contains 36,100 cubic feet. This is used as a steel shed with most of the floor being on the earth; the frame is of wood columns on concrete piers. The structural frame is wood siding on studs. There are incandescent lights. The roof deck is of wood joists and sheathing with a guaranteed 10 year roofing.

The Normal Replacement New Cost of this building is . . . . . $ 1,600.00

BUILDING #[illegible] - LIQUID STORAGE SHED:

This building is 11'3" x 12' and contains 135 square feet. The ceiling height is 9' and has a cubical content of 1,215'. The floor is reinforced concrete slab on the ground with a cement finish. The structural frame is of wood studs and wood siding. The roof deck is of wood rafters and sheathing covered with asbestos shingles, with a 10 year guarantee.

The Normal Replacement New Cost of this building is . . . . . $ 300.00

LEASEHOLD IMPROVEMENTS:

These consist of facilities shown on photostats and plans in the Industrial Facilities Report prepared by the War Department.

They were studied by your appraiser on the grounds, and from the above data and observation he finds the Replacement New Cost to be as follows:

Tunnel	$ 22,000.00
Manhole Closure	1,200.00
Sewer Lines	41,500.00
Concrete pipe culvert	300.00
Parking Area	39,000.00
Walks	6,000.00
Roads and Roadways	40,000.00
Fences	2,300.00
Railroad Switches	32,000.00
Intercommunications System	2,500.00
Heating Pipe Lines	11,500.00
Fire Alarm System	9,200.00
Telephone Lines	100.00
Gas Mains	5,400.00
Electric Lines	7,100.00
Water Mains	27,300.00
Manholes	1,100.00
	$248,500.00

The architectural fees and engineer's cost are included in the above figures.

Total of Schedule II $2,437,000.00

A total Normal Replacement New Cost of the items listed above including market value of the ground as of December 1945, is . . .$2,618,736.50

Your appraiser is a civil engineer and general contractor and has been in business in the St. Louis district for over thirty years. He is familiar with building costs and has used the same kinds of building materials, employed the same sub-contractors that were used in the erection of these buildings. He is familiar with the cost of labor and materials and conditions that might be expected under the present day building conditions. In making this Normal Replacement New appraisal he has studied the "War Department Facilities Inventory" on the Armour Piercing Core Plant and has inspected the premises and has discussed this matter with those in a position who have knowledge of the plant. This appraisal is based on his observations of the structures as they exist today, and he has visualized them when they were built.

This is to certify that I, Nelson Cunliff, have examined the above described property, and certify to values shown herein.

Nelson Cunliff

Nelson Cunliff.

DEPRECIATION

Most of the plant was completed in 1942. Various parts of this were put into operation at different times. The west parking lot was completed in 1943. Depreciation in this case may not be measured by years and it will be necessary to apply the result of observation and study on each particular building.

#113 Core Plant is a brick, steel concrete structure that under normal conditions would have a long life. It was used 24 hours a day, 6 days a week for several years. It does not show much wear but because of this heavy design and the heavy use it was put to in the short span of time and for the further reason that its use is limited by its dependency upon the particular plant facilities of the St. Louis Ordnance Plant, it should be charged with a rate of depreciation in the amount of 10% and the depreciated value of Building #113, is .....$1,433,500.00.

On the guard house, #113-A and B - they are single purpose buildings, their original design was of concrete, steel and they show no wear or excessive use. In my opinion the rate of depreciation would be 10%. The depreciated value of

Guard House #113A is . . . . . $ 10,800.00 and

Guard House #113B is . . . . . $ 2,790.00

On Building #113C Warehouse Building. This building was completed in 1942 and has been used to handle steel cores and bulk steel that was made into these cores. The walls of the building are 1" boards on 2 x 4 studs. There is no insulation or special treatment to keep out the rain or the cold. It is true that the shiplap on the building will need additional painting and the maintenance cost of this building will be higher than on a similar building of brick. This type of building cannot

be built by a private individual for an industrial plant under the building code of the City of St. Louis. It was the privilege enjoyed by the U. S. Government that permitted them to erect this non-fireproof type of building in this area. In the opinion of your appraiser the rate of depreciation should be 20%. The depreciated value of this building is . . . $ 123,200.00

On building #113D The Furnace Building - It is the same type of design as the warehouse. It is approximately in the same condition and the same rate of depreciation should apply. Therefore the depreciated value of this building would be . . . . . .$ 140,000.00

Building #113E - Laboratory - The outside structure of this building was a building that was on the site when this property was acquired by the Government. This building was fire-proofed by the Government, although on the inside the offices and most of the layout is set up with compo boards. The building itself would require some renovation for permanent use. In the opinion of your appraiser it should be depreciated 1/3 which would establish a depreciated value on this building of . . . . . $ 18,334.00

Building #113F - Steel Storage Shed - This is a frame building which has seen hard usage and it should be depreciated 50%. Therefore, the depreciated value of this building would be . . . . . $ 800.00

Building #113G - Liquid Storage Shed - This building is also a frame building and needs maintenance work. Your appraiser has established a rate of 50%, which would make a depreciated value of . . . . . $ 150.00

The Leasehold Improvements consist of water mains, electric lines, tunnels, walks, roads, etc. Most of the walks and roads show the result of frost action and breakage. The water mains, public utilities and railroad facilities all have been used hard but do not show any abuse.

In the opinion of your appraiser, an average rate of depreciation of 15% on all of the Leasehold Improvements would be fair, and the depreciated value of Leasehold Improvements would be . . . .$ 211,225.00

Total Depreciated Values $2,140,799.00

RECAPITULATION

	Normal R. N. C.	After Depreciation
Schedule I		
Land&Land Improvements		
East of Siemers Lane 11.465A $149,824.00		
West of Siemers Lane (851'0-3/4") (front ft.) 31,912.50	$ 181,736.50	$ 181,736.50
Total Schedule I	$ 181,736.50	$ 181,736.50
Schedule II		
Building, Structures, etc.		
113 Core Plant	$1,815,000.00	$1,633,500.00
113-a Guard House	12,000.00	10,800.00
b Guard House	3,100.00	2,790.00
113-c Warehouse	154,000.00	123,200.00
113-d Furnace Building	175,000.00	140,000.00
113-e Laboratory	27,500.00	18,334.00
113-f Steel Storage Shed	1,600.00	800.00
113-g Liquid Storage Shed	300.00	150.00
Leasehold Improvements	248,500.00	211,225.00
Total Schedule II	$2,437,000.00	$2,140,799.00
Total Schedules I & II	$2,618,736.50	$2,322,535.50

SUMMARY

Code No.		Item	Square Feet	Cubic Feet	CostPer Sq.Ft.	Cost Per Cu.Ft.	Normal R. N. C.
		Land and Land Improvements					$ 181,736.50
113		Core Plant	216,815	4,965,834	$ 8.37	$0.365	$1,815,000.00
"	(a)	Guard House	1,665	15,766	7.20	.76	12,000.00
	(b)	Guard House	118	1,694	26.27	1.82	3,100.00
	(c)	Warehouse	54,568	1,659,523	2.82	.092	154,000.00
	(d)	Furnace Building	49,839	961,997	3.51	.18	175,000.00
	(e)	Laboratory	7,669	102,246	3.58	.28	27,500.00
	(f)	Steel Storage Shed	3,327	36,600	.48	.045	1,600.00
	(g)	Liquid Storage Shed	155	1,215	2.32	.24	300.00
		Leasehold Improvements	-	-	-	-	211,225.00

The above figures include Building Installations not mechanical and architectural and engineering cost.

NELSON CUNLIFF

Your appraiser is a civil engineer, specializing in construction from 1905 up to the present time. Your appraiser has at all times been in contact with construction work in the St. Louis district. This work has included the design and erection of public and private buildings, roads, bridges, commercial buildings, apartment buildings, industrial buildings and hotels. During the last twenty years he has served in various capacities of city officials, and a member of the city planning commission. He has had occasion to buy and sell land and buildings for his own account or for others, and has erected many industrial and commercial plants. During this time he has participated in the making of appraisals which appraisals are made in his own name or in the name of the firm William H. & Nelson Cunliff Company. He served as one of the real estate consultants for the United States Department of the Interior, National Park Service, and appraised 482 parcels of land and about 681 buildings. H e has testified in the Federal and Circuit Courts in St. Louis.

William H. & Nelson Cunliff Company
3320 Lindell Boulevard
St. Louis 3, Missouri

STANDARD FORM 118
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION
REGULATION 2-IV-201.00

REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

DATE RECEIVED (GSA use only) 11/6/61

2. DATE OF REPORT 27 October 1961

GSA CONTROL NO. (GSA use only) D-Mo-460-A

3. TO (Furnish address of GSA regional offices)
General Services Administration
2306 East Bannister Road
Kansas City 31, Missouri

4. FROM (Name and address of holding agency)
Dist Engr, U. S. Army Engr District
Kansas City, CE, 1800 Federal Office Bldg.
Kansas City 6, Missouri

5. NAME AND ADDRESS OF REPRESENTATIVE TO BE CONTACTED
Same as 4

6. NAME AND ADDRESS OF CUSTODIAN
Commander's Representative, SLOP
4300 Goodfellow Boulevard
St. Louis, Missouri

7. PROPERTY IDENTIFICATION
St. Louis Ordnance Plant
St. Louis County & City, Missouri

8. PROPERTY ADDRESS (Give full location)
St. Louis Ordnance District

9. SPACE DATA

USE	NUMBER OF BUILDINGS (1)	FLOOR AREA (Sq. ft.) (2)	NUMBER OF FLOORS (3)	FLOOR LOAD CAPACITY (4)	CLEAR HEADROOM (5)
A. OFFICE	6	155,306	4	100#	8' - 10'
B. STORAGE					
C. OTHER (See 9 F)	* 230	3,886,531	1 - 3	100# 300#	7' - 20'
D. TOTAL (From SF 118a)	236	4,041,837			
E. GOV'T INTEREST: (1) OWNER					
(2) TENANT					

F. SPECIFY "OTHER" USE ENTERED IN C ABOVE
* These buildings are classified as other because they were built for a specific use.

10. LAND

(From SF 118b)	ACRE OR SQUARE FEET
A. FEE	227.056
B. LEASED	
C. OTHER	.0021
D. TOTAL	227.0581

11. COST TO GOVERNMENT

ITEM	SCHEDULE	COST
A. BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES	A (Col d)	$61,898,650
B. LAND	B (Col. f)	1,144,775
C. RELATED PERSONAL PROPERTY	C (Col. h)	
D. TOTAL (Sum of 11A, 11B, and 11C)		$63,043,425

E. ANNUAL PROTECTION AND MAINTENANCE COST (Government-owned or leased) $740,000

12. LEASEHOLD(S) DATA (Use separate sheet if necessary)

A. TOTAL ANNUAL RENTAL	$
B. ANNUAL RENT PER SQ. FT. OR ACRE	$
C. DATE LEASE EXPIRES	
D. NOTICE REQUIRED FOR RENEWAL	
E. TERMINAL DATE OF RENEWAL RIGHTS	
F. ANNUAL RENEWAL RENT PER SQ FT. OR ACRE	$

G. TERMINATION RIGHTS (in days)
LESSOR GOVERNMENT

13. DISPOSITION OF PROCEEDS
212629 Miscellaneous Receipts

14. TYPE OF CONSTRUCTION
Reinforced concrete, steel and brick construction in a high state of repair.

15. HOLDING AGENCY USE
Small Arms Ammunition Factory

16. RANGE OF POSSIBLE USES
Specifically designed for small arms ammunition factory; Industrial site or commercial property.

17. NAMES AND ADDRESSES OF INTERESTED FEDERAL AGENCIES AND OTHER INTERESTED PARTIES
Fifth U. S. Army and St. Louis Ordnance District is interested in parts of the property. However, such requests were not favorably considered at Assistant Secretary of Army's level.

18. REMARKS This property has been screened against the known defense needs of the Department of Defense. The property was also submitted to Armed Services Committees of Congress on 1 September 1961, and the 30-day waiting period expired on 2 October 1961.

19. REPORT AUTHORIZED BY

NAME
CHARLES M. McDONNELL

TITLE
Chief, Management & Disposal Branch
Real Estate Division

SIGNATURE
Charles M. McDonnell

U. S. GOVERNMENT PRINTING OFFICE 16—69840-1

ST. LOUIS ORDNANCE PLANT

Buildings Considered as Office

Bldg. No.		Square Feet
101		106,813
107		29,723
116J		190
138		433
222B		14,131
307		4,016
	6 Buildings Total -	155,306

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 2 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	101	Administration Bldg., Brick & Tile							
2		1942	1,308,428	IR	106,813	4B	8-10'	100#	Permitted to U. S.
3	102ABC	.30 Cal. Production, Brick & Tile							Ordnance District
4		1942	2,819,779	764x141'	252,060	3B	6-15'	500#	
5	102D	Loading, Brick & Tile, 1942	198,214	177x41'	16,840	3	9-12'	300#	
6	102E	Primer Insert, Brick & Tile, 1942	164,879	161x41'	13,982	3	9-12'	300#	
7	102F	Ammunition Storage-Powder Canning,							
8		Brick & Tile, 1942	8,200	32x23'	759	1	12'	600#	
9	102H	Ammunition Storage-Powder Storage,							
10		Brick & Tile, 1942	4,594	22x16'	355	1	12'	2000#	
11	102J	Solvent & Lacquer Storage, Brick,							
12		1942	600	6x13'	78	1	7'	3000#	
13	102K	Solvent & Lacquer Storage, Brick,							
14		1942	600	6x13'	78	1	7'	3000#	
15	103ABC	.30 Caliber Production, Brick &							
16		Tile, 1942	2,779,013	764x141'	254,638	3B	7-12'	500#	
17	103D	Loading, Brick & Tile, 1942	192,589	177x41'	16,842	3	9-12'	300#	
18	103E	Primer Insert, Brick & Tile, 1942	163,632	161x41'	13,964	3	9-12'	300#	
19	103F	Ammunition Storage-Powder Storage							
20		Brick & Tile, 1942	8,720	22x16'	355	1	12'	700#	
21	103H	Ammunition Storage-Powder Canning							
22		Brick & Tile, 1942	4,887	32x23'	759	1	12'	3000#	
23	103J	Storage-covered, Solvent & Lacquer,							
24		Brick, 1942	600	13x6'	78	1	7'	3000#	
25	103K	Storage-Covered, Solvent & Lacquer,							
26		Brick, 1942	992	13x6'	78	1	7'	3000#	
27	104ABCD	.30 Caliber Production, Brick &							
28		Tile, 1942	3,651,384	1045x141'	314,794	3	7-12'	900#	
29	104E	Loading, Brick & Tile, 1942	209,919	221x41'	18,558	3	9-12'	300#	
30	104F	Primer Insert, Brick & Tile, 1942	193,269	181x41'	16,040	3	9-12'	300#	
31	104G	Ammunition Storage-Powder Canning,							
32		Reinforced Concrete & Tile, 1942	7,380	32x23'	759	1	12'	700#	
		TOTAL							

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 3 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	104J	Ammunition Storage-Powder Storage							
2		Tile, 1942	4,135	22x16'	355	1	12'	3000#	
3	104K	Vehicle Maintenance, Brick, 1942	55,592	60x36'	2,167	2	7-13'	1000#	
4	104L	Acid Storage, Brick, 1942	23,174	30x28'	1,886	2B	8-13'	350#	
5	104M	Storage-Covered, Solvent & Lacquer,							
6		Brick, 1942	600	13x6'	78	1	7'	3000#	
7	104N	Storage-Covered-Solvent & Lacquer,							
8		Brick, 1942	600	13x6'	78	1	7'	3000#	
9	105ABCD	.30 Caliber Production, Brick &							
10		Tile, 1942	3,872,414	1049x141'	326,843	3B	7-12'	1000#	
11	105E	Loading, Brick & Tile, 1942	233,081	221x41'	18,558	2	10-15'	300#	
12	105F	Primer Insert, Brick & Tile, 1942	178,677	181x41'	16,040	2	10-15'	300#	
13	105G	Ammunition Storage-Powder Canning,							
14		Reinforced Conc. & Tile, 1942	7,840	32x23'	759	1	12'	600#	
15	105J	Ammunition Storage-Powder Storage,							
16		Tile, 1942	4,135	22x16'	355	1	12'	3000#	
17	105L	Warehouse, Brick, 1942	219,176	470x80'	37,641	1	7-15'	1000#	
18	105M	Solvent & Lacquer Storage, Brick,							
19		1942	600	6x13'	78	1	7'	3000#	
20	105N	Solvent & Lacquer & Storage, Brick,							
21		1942	600	6x13'	78	1	7'	3000#	
22	107	Personnel Building & Guard Head-							
23		quarters, Brick & Reinforced Con-							
24		crete, 1942	452,737	261x50'	29,723	3B	9'	100#	
25	108A	South Primary Substation, Brick,							
26		1942	384,120	120x28'	3,374	1	11-20'	500#	
27	108B	North Primary Substation, Brick,							
28		1942	245,892	94x28'	2,644	1	20'	250#	
29	108C	Distribution Substation, Brick,							
30		1942	90,790	57x28'	1,604	1	12'	500#	
31	108D	Distribution Substation, Brick,							
32		1942	81,988	57x28'	1,604	1	12'	500#	
		TOTAL	5,554,51						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—69841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 4 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	110	Tool & Gage Shop & Extension,							
2		Brick, 1942	2,150,354	IR	210,780	3B	6-32'	300#	
3	111	Boiler House, Reinforced Concrete,							
4		& Brick, 1942	1,864,302	162x76'	26,076	4B	7-37'	300#	
5	112	Lead Shop, Brick & Tile, 1942	341,783	201x81'	16,515	1	14'	800#	
6	114A	Powder Magazine, Tile Sand Filled,							
7		1942	27,340	60x40'	2,400	1	10'	1000#	Outleased - Lease #4349
8	114C	Powder Magazine, Structural tile,							
9		sand filled, 1942	27,340	60x40'	2,400	1	10'	1000#	" " "
10	114E	Powder Magazine, Tile Sand Filled,							
11		1942	27,340	60x40'	2,400	1	10'	1000#	" " "
12	115	Vehicle Garage, Brick, 1942	127,275	141x71'	10,133	1	12-14'	250#	
13	116A	Scrap & Salvage, Brick & Tile 1942	23,874	23x23'	544	1	8'	500#	
14	116B	Primer Popping Furnace Bldg.							
15		Reinforced Concrete & Brick, 1942	52,404	52x29'	1,512	1	8-15'	300#	
16	116C	Explosive Scrap Burning, Reinforced							
17		Concrete & Brick, 1942	50,192	57x11'	655	1	8'	500#	
18	116D	Chemical Bullet Burning, Reinforced							
19		Concrete & Brick, 1942	5,088	51x28'	1,779	1	8'	500#	
20	116F	Incinerator, Reinforced concrete,							
21		Brick, Corr. side, 1942	53,992	45x42'	2,584	1	13-17'	1000#	
22	116G	Explosive Scrap Storage, Reinforced							
23		Concrete, 1942	655	9x9'	87	1	7'	300#	
24	116H	Explosive Scrap Storage, Reinforced							
25		Concrete, 1942	655	9x9'	87	1	7'	300#	
26	116J	Office, WF W/roll roofing, 1942	640	16x10'	190	1	-	-	
27	116K	Explosive Scrap Storage, wood, 1952	500	12x2'	34	1	-	-	
28	116L	Explosive Scrap Storage, screened,							
29		1952	996	12x2'	34	1	-	-	
30	116M	Explosive Scrap Storage, wood, 1952	500	12x2'	34	1	-	-	
31	116N	Explosive Scrap Storage, wood, 1952	500	12x2'	34	1	-	-	
32	116P	Solvent & Lacquer Storage, drop	932	34x8'	272	1	-	-	
		siding, 1955							
		TOTAL	[illegible]						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—60851-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 3 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	116R	Garbage Dock, sheet metal, 1957	996	18x10'	180	1	-	-	
2	117	Proof House, Reinforced Concrete,							
3		Brick & Tile, 1942	1,271,216	IR	71,531	1	9-11'	1000#	
4	118A	Tracer & Incendiary Preparation							
5		Mix, Brick & Tile, 1942	295,331	IR	13,620	2B	7-12'	500#	
6	118B	Tracer & Incendiary Preparation							
7		Mix, Brick & Tile, 1942	295,489	IR	13,620	2B	7-12'	500#	
8	118C	Hot Scrap Storage, Reinforced							
9		Concrete 12" thick, 1942	1,910	13x10'	146	1	-	-	
10	119A	Machine Shop, Brick & Tile, 1942	87,303	100x40'	4,000	1	8-9'	300#	
11	119B	Tracer & Ignitor Storage, Brick &							
12		Tile, 1942	4,250	20x20'	400	1	8'	1000#	
13	119C	Tracer & Ignitor Storage, Brick &							
14		Tile, 1942	4,250	20x20'	400	1	8'	1000#	
15	119D	Chemical Warehouse, Brick & Tile,							
16		1942	86,932	100x40'	4,000	1	8-9'	300#	Outleased - Lease #4770
17	119E	Tracer & Ignitor Storage, Brick							
18		& Tile, 1942	4,250	20x20'	400	1	8'	1000#	
19	119F	Tracer & Ignitor Storage, Brick							
20		& Tile, 1942	4,250	20x20'	400	1	8'	1000#	
21	120	Laboratory, Brick & Tile, 1942	90,984	91x39'	3,662	1	10'	100#	Outleased - Lease #49[illegible]
22	122A	Service Bldg. - Cafeteria, Brick							
23		& Tile, 1942	785,935	174x47'	13,036	2	9'	100#	
24	122B	Ordnance Inspection & Service Bldg							
25		Brick & Tile, 1942	159,503	162x62'	13,872	2	13'	500#	
26	123	Tracer Charge Bullet Manufacturing							
27		Brick & Tile, 1942	486,178	302x80'	29,980	2	17'	150#	
28	123A	Compressor Bldg., Brick, 1952	126,146	63x29'	1,827	1	-	-	
29	123B	Cooling Tower, Wood, 1952	17,825	45x27'	1,238	1	-	-	
30	123C	Scrap House, Wood, 1952	1,778	31x2'	92	1	-	-	
31	123E	Inspection & Storage, Brick siding,							
32		1956	45,726	82x32'	2,633	1	-	-	
		TOTAL	3,770,752						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—69841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 6 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	124A	Transfer of Igniting explosives,							
2		W/F, w/roll roofing, 1942	2,123	12x10'	120	1	8'	1000#	
3	124B	Underground Storage, Reinforced							
4		Concrete, 1941	7,360	10x10'	250	1	8'	1000#	
5	124C	Transfer of Igniting explosives,							
6		W/F, roll roofing, 1942	2,123	10x10'	100	1	8'	1000#	
7	125A	Incendiary Mix Storage,wood,roll							
8		roofing, 1942	1,944	6x2'	30	1	5'	60#	
9	125B	Incendiary Mix storage, wood, roll							
10		roofing, 1942	1,500	6x2'	30	1	5'	60#	
11	125C	Incendiary Mix Storage, wood, roll							
12		roofing, 1942	1,500	6x2'	30	1	5'	60#	
13	125D	Incendiary Mix Storage, wood, roll							
14		roofing, 1942	1,500	6x2'	30	1	5'	60#	
15	126A	Primer Storage, Frame-wood, 1942	1,450	14x12'	168	1	8'	1000#	
16	126B	Primer Storage, Frame-wood, 1942	1,450	14x12'	168	1	8'	1000#	
17	126C	Primer Storage, Wood-frame, 1942	1,450	14x12'	168	1	8'	1000#	
18	126D	Primer Storage, Wood-frame, 1942	1,450	14x12'	168	1	8'	1000#	
19	126E	Primer Storage, Wood-frame, 1942	1,450	14x12'	168	1	8'	1000#	
20	126F	Primer Storage, Wood-frame, 1942	1,450	14x12'	168	1	8'	1000#	
21	126G	Primer Storage, Wood-frame, 1942	1,450	14x12'	168	1	8'	1000#	
22	126H	Primer Storage, Wood-frame, 1942	1,450	14x12'	168	1	8'	1000#	
23	127A	Primer Storage, Wood-frame, 1942	1,365	14x12'	168	1	8'	1000#	
24	127B	Primer Storage, Wood-frame, 1942	1,365	14x12'	168	1	8'	1000#	
25	127C	Primer Storage, Wood-frame, 1942	1,365	14x12'	168	1	8'	1000#	
26	127D	Primer Storage, Wood-frame, 1942	1,401	14x12'	168	1	8'	1000#	
27	127E	Primer Storage, Wood-frame, 1942	1,809	14x12'	168	1	8'	1000#	
28	127F	Primer Storage, Wood-frame, 1942	1,365	14x12'	168	1	8'	1000#	
29	127G	Primer Storage, Wood-frame, 1942	1,365	14x12'	168	1	8'	1000#	
30	127H	Primer Storage, Wood-frame, 1942	1,365	14x12'	168	1	8'	1000#	
31	128B	Infra Red Primer Dryer, Wood frame,							
32		Asbestos Shingle, 1953	6,685	53x10'	930	2	10'	100#	
		TOTAL							

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—69841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 3 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	128C	Infra Red Primer Dryer, Wood Frame,							
2		Asbestos Shingle, 1953	6,275	53x10'	930	2B	10'	100#	
3	128E	Storage, Brick & Tile, 1942	8,975	20x20'	800	2B	10'	100#	
4	128F	A.P.I. Peletizing, Brick & Tile,							
5		1942	8,975	20x20'	800	2B	10'	100#	
6	128G	A.P.I. Peletizing, Brick & Tile,							
7		1953	23,561	20x20'	800	2B	10'	100#	
8	128K	Infra Red Primer Dryer, Wood Frame,							
9		Asbestos shingle, 1953	6,777	53x10'	930	2B	10'	100#	
10	128L	Infra Red Primer Dryer, Wood Frame,							
11		Asbestos Shingle, 1953	6,275	53x10'	930	2B	10'	100#	
12	128M	Explosive Weighing, Brick & Tile,							
13		1942	8,975	20x20'	800	2B	10'	100#	
14	128N	Explosive Weighing, Brick & Tile,							
15		1942	8,975	20x20'	800	2B	10'	100#	
16	128O	Explosive Weighting, Brick & Tile,							
17		1942	8,975	20x20'	800	2B	10'	100#	
18	128P	Inspection Office, Roll roofing,							
19		1957	2,500	16x10'	160	1	-	-	
20	128Q	Infra Red Primer Dryer, Asbestos							
21		Siding, 1942	16,201	53x10'	930	2B	-	-	
22	128R	Infra Red Primer Dryer, Asbestos							
23		Siding, 1942	5,830	53x10'	930	2B	-	-	
24	129A	Explosive Storage, wood-frame,							
25		w/roll roofing, 1942	2,000	10x10'	100	1	6'	-	
26	129B	Explosive Storage, wood-frame,							
27		w/roll roofing, 1942	2,000	10x10'	100	1	6'	-	
28	129C	Explosive Storage, wood-frame,							
29		w/roll roofing, 1942	2,000	10x10'	100	1	6'	-	
30	129D	Explosive Storage, wood-frame,							
31		w/roll roofing, 1942	2,000	10x10'	100	1	6'	-	
32	130	Toilet, Brick & Tile, 1942	24,555	21x21'	596	2B	10'	50#	
		TOTAL	[illegible]						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—69841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. RC-173

2. PAGE 8 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	131A	Primer Mix, Frame-wood, 1942	3,045	17x6'	136	1	9'	1000#	
2	131C	Primer Pre-Mix, Brick & Tile, 1942	9,250	30x20'	600	1	10'	1000#	
3	131D	Storage, Brick & Tile, 1942	3,624	10x10'	100	1	10'	1000#	
4	131G	Primer Mix, Frame-wood, 1942	2,893	17x7'	136	1	9'	1000#	
5	131J	Primer Pre-Mix, Brick & Tile, 1942	9,250	30x20'	600	1	10'	1000#	
6	131K	Storage, Brick & Tile, 1942	3,624	10x10'	100	1	10'	1000#	
7	132A	Primer Mix, Frame-wood, 1942	2,969	17x7'	136	1	9'	1000#	
8	132C	Primer Pre-Mix, Brick & Tile, 1942	9,326	30x20'	600	1	10'	1000#	
9	132D	Scrap Pick Up, Brick & Tile, 1942	3,624	10x10'	100	1	10'	1000#	
10	132G	Primer Mix, Frame-wood, 1942	2,969	17x7'	136	1	9'	1000#	
11	132J	Primer Pre-Mix, Brick & Tile, 1942	9,250	30x20'	600	1	10'	1000#	
12	132K	Storage, Brick & Tile, 1942	3,624	10x10'	100	1	10'	1000#	
13	132N	Primer Mix, Frame-wood, 1942	2,893	17x7'	136	1	9'	1000#	
14	132P	Primer Pre-Mix, Brick & Tile, 1942	9,250	30x20'	600	1	10'	1000#	
15	132Q	Storage, Brick & Tile, 1942	3,624	10x10'	100	1	10'	1000#	
16	133A	Underground Primer Mix Storage,							
17		Reinforced Concrete, 1941	7,621	10x10'	279	1	8'	500#	
18	133B	Underground Primer Mix Storage,							
19		Reinforced Concrete, 1941	7,621	10x10'	279	1	8'	500#	
20	133C	Underground Primer Mix Storage,							
21		Reinforced Concrete, 1941	7,621	10x10'	279	1	8'	500#	
22	133D	Underground Primer Mix Storage,							
23		Reinforced Concrete, 1941	7,621	10x10'	279	1	8'	500#	
24	134A-G	Primer Mfg., Brick & Tile, 1942	990,897	IR	44,085	2B	8-12'	150#	
25	134H	Refrigerator Unit, Brick, 1952	114,306	59x29'	1,725	1	-	-	
26	134J	Cooling Tower, Wood, 1952	12,216	28x21'	614	1	-	-	
27	134K	Scrap House, Wood, 1953	775	12x2'	33	1	-	-	
28	134L	Scrap House, Wood, 1953	1,179	12x2'	33	1	-	-	
29	135	Gas Meter & Guard Hse, Brick, 1942	7,344	18x13'	239	1	9'	500#	
30	136A	Storage, Brick, 1941	2,349	14x14'	200	1	8'	500#	
31	136B	Storage, Brick, 1941	2,349	14x14'	200	1	8'	500#	
32	136C	Storage, Brick, 1941	2,349	14x14'	200	1	8'	500#	Outleased - Lease #4930
		TOTAL	[illegible]						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—69841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 9 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	136D	Storage, Brick, 1941	2,349	14x14'	200	1	8'	500#	
2	136E	Storage, Brick, 1941	2,349	14x14'	200	1	8'	500#	
3	136F	Storage, Brick, 1941	2,349	14x14'	200	1	8'	500#	
4	137A	Paint & Lacquer Mix, Brick, 1942	8,338	32x16'	522	1	9'	500#	
5	137B	Solvent & Lacquer Storage, Brick,							
6		1942	3,956	16x13'	217	1	8'	500#	
7	138	Foreman's Office, Brick, 1942	8,029	21x20'	433	1	10'	100#	
8	141	Stand-By Propane Fuel System-							
9		Propane Tanks, (Barricades around							
10		Propane Tanks, Concrete, 1952	299,861	-	-	-	-	-	
11	141A	Vaporizer Building, Concrete Block,							
12		1952	42,847	21x13'	292	1	-	-	
13	141B	Air Compressor House, Concrete							
14		Block, 1952	41,606	21x13'	292	1	-	-	
15	141C	Booster Pump Station, Brick &							
16		Concrete, 1954	22,844	27x22'	602	1	-	-	
17	141D	Gas Detector Equipment Bldg. Wood							
18		Frame, w/roll roofing, 1957	500	6x6'	44	1	-	-	
19	142	Wet Primer Storage, Asbestos Siding							
20		1956	13,040	62x32'	1,364	1	-	-	
21	201	R. R. Car Scale & Bldg., Brick,							
22		1942	33,374	36x13'	575	1	9'	100#	
23	203ABC	.30 Cal. Production, Brick & Tile,							
24		1942	3,326,734	764x181'	323,368	2B	8-12'	500#	Outleased - Lease $4000
25	203D	Loading, Brick & Tile, 1942	247,891	237x41'	22,326	2B	10-14'	300#	" " "
26	203E	Primer Insert, Brick & Tile, 1942	209,463	232x41'	19,648	2B	7-14'	300#	" " "
27	203F	Powder Canning, Tile, 1942	9,430	32x23'	759	1	12'	500#	" " "
28	203H	Powder Storage, Tile, 1942	5,283	22x16'	355	1	12'	3000#	" " "
29	203J	Storage, Brick, 1942	600	6x13'	78	1	7'	3000#	
30	203K	Storage, Brick, 1942	600	6x13'	78	1	7'	3000#	
31	204ABCD	.50 Cal. Production, Brick & Tile,	4,682,626	1045x181'	518,260	3B	8-14'	500#	Outleased - Lease $3823
32		1942							
		TOTAL	[illegible]						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—00841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 10 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	204E	Loading, Brick & Tile, 1942	269,659	261x41'	32,087	3B	11-15'	300#	Outleased - Lease #3959
2	204F	Primer Insert, Brick & Tile, 1942	273,223	261x41'	32,932	3B	11-14'	300#	Outleased - Lease #3973
3	204G	Powder Canning, Tile, 1942	7,954	32x23'	759	1	12'	500#	
4	204J	Powder Storage, Tile, 1942	4,456	22x16'	355	1	12'	3000#	
5	204K	Water Softener, Brick, 1942	105,988	89x36'	9,331	1B	12-15'	2500#	Outleased - Lease #4126
6	204L	Chemical Storage, Brick, 1942	27,038	28x30'	1,938	2B	8-16'	100#	
7	204M	Storage, Brick, 1942	600	13x6'	78	1	7'	3000#	
8	204N	Storage, Brick, 1942	600	13x6'	78	1	7'	3000#	
9	205ABCD	.30 Caliber Production, Brick &							
10		Tile, 1942	4,652,313	1045x181'	517,815	3B	6-14'	500#	
11	205E	Loading, Brick & Tile, 1942	300,648	261x41'	32,720	3B	11-14'	300#	
12	205F	Primer Insert, Brick & Tile, 1942	329,902	281x41'	34,604	3B	11-14'	300#	
13	205G	Powder Canning, Tile, 1942	9,430	32x23'	759	1	12'	500#	
14	205J	Powder Storage, Tile, 1942	5,283	22x16'	355	1	12'	3000#	
15	205K	Solvent & Lacquer Storage	600	13x6'	78	1	7'	3000#	
16	205L	Solvent & Lacquer Storage, Brick,							
17		1942	600	13x6'	78	1	7'	3000#	
18	207	Ordnance Proof House, Reinforced							
19		Concrete, Wood frame with asbestos							
20		siding, 1950	295,301	188x88'	22,750	2B	8-11'	50#	Permit - ACIC
21	207A	Storage-Powder Magazine, Frame,							
22		1942	500	8x8'	64	1	-	-	
23	207E	600' Target House, (Sand Bunker)							
24		Brick, superstructure, 1955	10,000	14x18'	1,031	2B	-	-	
25	207F	Incendiary Flash Observation HM178							
26		Reinforced Concrete, 1955	6,250	34x17'	586	1	-	-	
27	207G	Plate Penetration, Reinf. Concrete	3,250	21x12'	258	1	-	-	
28	207H	200' Target House (Sand Bunker)							
29		Reinforced Concrete, 1955	3,500	32x10'	323	1	-	-	
30	207J	150' Target House, Reinforced							
31		Concrete, 1955	500	32x18'	604	1	-	-	
32	208A	West Primary Substation, Reinforced	243,258	94x28'	2,644	1	20'	250#	
		concrete on steel joists, 1942							
		TOTAL	[illegible]						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 11 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	208B	East Primary Substation, Brick,							
2		1942	244,413	94x28'	2,644	1	20'	250#	
3	209B	Guard House & Plant Entrance,							
4		Brick, 1942	20,531	14x14'	198	1	7'	100#	
5	209C	Guard House & Plant Entrance,							
6		Brick, 1942	8,165	11x11'	121	1	9'	500#	Outleased - Lease #4000
7	211	Boiler House, Reinforced Concrete,							
8		& Brick, 1942	3,147,676	240x87'	38,549	2B	8-37'	150#	
9	214A	Powder Magazine, str'l Tile-Sand							
10		filled, 1942	24,660	60x40'	2,400	1	10'	1000#	
11	214C	Powder Magazine, str'l Tile-Sand							
12		filled, 1942	24,660	60x40'	2,400	1	10'	1000#	
13	214E	Powder Magazine, str'l Tile-Sand							
14		filled, 1942	24,660	60x40'	2,400	1	10'	1000#	Outleased - Lease #4583
15	215	Transfer Dock, Frame-wood, asbestos							
16		shingle, 1942	30,516	32x21'	676	1	11'	300#	
17	216	Salvage, Frame-wood, asbestos							
18		shingle, 1942	71,969	181x90'	16,290	1	12'	500#	Outleased - Lease #4196
19	217	Hang Fire Test House, Reinforced							
20		Concrete w/pitch & gravel, 1942	13,461	42x17'	748	1	10'	1000#	
21	217A	Powder Magazine, Frame-wood, 1945	700	8x8'	64	1	-	-	
22	222B	Office, Brick & Tile, 1942	173,422	122x62'	14,131	2B	10-13'	125#	Outleased - Lease #4625
23	236A	Storage House, Brick, 1942	2,288	20x14'	292	1	8'	500#	
24	236B	Storage House, Brick, 1942	2,288	20x14'	292	1	8'	500#	
25	236C	Storage House, Brick, 1942	2,288	20x14'	292	1	8'	500#	
26	236E	Storage House, Brick, 1942	2,288	20x14'	292	1	8'	500#	
27	237 A	Storage, Brick, 1942	6,741	32x16'	522	1	9'	500#	
28	238	Motor Truck Scale & Scale House,							
29		Brick, 1942	7,603	11x11'	130	1	8'	60#	
30	241	Water Booster Pump Sta.Reinforced							
31		concrete, 1953	9,949	24x13'	370	1	-	-	
32	242	Warehouse, Brick w/concrete block	835,088	420x70'	100,800	2	-	-	Permit - USA Support Ctr.
		back, 1954							
		TOTAL							

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—00841-1 U. S. GOVERNMENT PRINTING OFFICE

AMMUNITION DIVISION

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 12 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	230T	Gas Meter Shelter, Wood, 1952	500	10x7'	70	1			
2	307	Family Housing, Sheetrock,							
3		Asbestos Shingle, 1948	37,069	75x23'	4,016	2B			
4	209K	Guard House & Plant Entrance,							
5		Wood-frame Siding, 1942	3,066	12x9'	112	1			
6		Guard House, Gate #2 on Goodfellow							
7		Blvd., Wood, 1957	500	6x6'	36	1			
8		Guard House, Gate #1A N. of Bldg.							
9		101, Wood, 1957	325	7x6'	45	1			
10		Guard House, Gate #1, Restricted							
11		Area #1, Wood	952	8x8'	64	1			
12		Guard House, Gate #2, Restricted							
13		Area #1, Wood	500	6x6'	36	1			
14		Guard House, Gate #3, Restricted							
15		Area #1, Wood	500	6x6'	36	1			
16		Guard House, Gate #4, Restricted							
17		Area #1, Wood	1,614	8x8'	64	1			
18		Guard House, Gate #5, Restricted							
19		Area #1, Wood	952	8x8'	64	1			
20		Guard House, Gate 25A	500	6x4'	26	1			
21	109A	Guard House, Brick, 1942	7,317	11x11'	121	1			
22	109B	Guard House, Plant Entrance,							
23		Brick, 1942	9,235	11x11'	121	1			
24	109C	Guard House, Brick, 1942	1,077	6x6'	42	1			
25	209H	Guard House & Plant Entrance,							
26		Brick, 1942	8,754	14x14'	200	1			
27									
28									
29									
30									
31									
32									
		TOTAL							

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—69841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 13 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1		BARRICADES:							
2									
3	102G	Protective Construction-Barricade,							
4		Concrete, 1942	73,738	485 LF					
5	103G	Protective Construction-Barricade,							
6		Concrete, 1942	73,738	485 LF					
7	104H	Protective Construction-Barricade,							
8		Concrete, 1942	73,738	485 LF					
9	105H	Protective Construction-Barricade,							
10		Concrete, 1942	73,738	485 LF					
11	114B	Protective Construction-Barricade,							
12		Concrete, 1942	59,997	383 LF					
13	114D	Protective Construction-Barricade,							
14		Concrete, 1942	59,986	383 LF					
15	114F	Protective Construction-Barricade,							
16		Concrete, 1942	59,986	383 LF					
17	119G	Protective Construction-Barricade,							
18		Concrete, 1957	60,000	268 LF					
19	119H	Protective Construction-Barricade,							
20		Concrete, 1957	60,000	268 LF					
21	124D	Protective Construction-Barricade,							
22		Concrete, 1942	42,411	342 LF					
23	124E	Protective Construction-Barricade,							
24		Concrete, 1942	32,875	401 LF					
25	126J	Protective Construction-Barricade,							
26		Concrete, 1942	101,328	841 LF					
27	127J	Protective Construction-Barricade,							
28		Concrete, 1942	101,328	841 LF					
29	128D	Protective Construction-Barricade,							
30		Concrete, 1942	85,416	674 LF					
31	128H	Protective Construction-Barricade,							
32		Concrete, 1942	85,416	794 LF					
		TOTAL	[illegible]						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—60841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 14 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	129E	Protective Construction-Barricade,							
2		Concrete, 1942	8,595	413 LF					
3	131B	Protective Construction-Barricade,							
4		Concrete, 1942	17,832	160 LF					
5	131E	Protective Construction-Barricade,							
6		Concrete, 1942	2,409	20 LF					
7	131F	Protective Construction-Barricade,							
8		Concrete, 1942	2,409	20 LF					
9	131 H	Protective Construction-Barricade,							
10		Concrete, 1942	17,832	160 LF					
11	131 L	Protective Construction-Barricade,							
12		Concrete, 1942	2,409	20 LF					
13	131M	Protective Construction-Barricade,							
14		Concrete, 1942	2,409	20 LF					
15	131N	Protective Construction-Barricade,							
16		Concrete, 1942	2,409	20 LF					
17	132B	Protective Construction-Barricade,							
18		Concrete, 1942	17,832	148 LF					
19	132E	Protective Construction-Barricade,							
20		Concrete, 1942	2,409	20 LF					
21	132F	Protective Construction-Barricade,							
22		Concrete, 1942	2,409	20 LF					
23	132H	Protective Construction-Barricade,							
24		Concrete, 1942	17,832	148 LF					
25	132L	Protective Construction-Barricade,							
26		Concrete, 1942	2,409	20 LF					
27	132M	Protective Construction-Barricade,							
28		Concrete, 1942	2,409	20 LF					
29	132O	Protective Construction-Barricade,							
30		Concrete, 1942	17,832	148 LF					
31	132R	Protective Construction-Barricade,							
32		Concrete, 1942	2,409	20 LF					
		TOTAL	121,[illegible]						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

10—69841-1 U. S. GOVERNMENT PRINTING OFFICE

AMMUNITION DIVISION

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 15 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1	132B	Protective Construction-Barricade,							
2		Concrete, 1942	2,409	20 LF					
3	132T	Protective Construction-Barricade,							
4		Concrete, 1942	2,409	20 LF					
5	142A	Protective Construction-Barricade,							
6		Concrete, 1956	25,000	278 LF					
7	203G	Protective Construction-Barricade,							
8		Concrete, 1942	73,738	485 LF					Outleased - Lease $4000
9	204H	Protective Construction-Barricade,							
10		Concrete, 1942	73,738	485 LF					
11	205H	Protective Construction-Barricade,							
12		Concrete, 1942	73,738	485 LF					
13	207B	Protective Construction-Barricade,							
14		Concrete, 1942	10,618	146 LF					
15	214B	Protective Construction-Barricade,							
16		Concrete, 1942	60,173	383 LF					
17	214D	Protective Construction-Barricade,							
18		Concrete, 1942	60,173	383 LF					
19	214F	Protective Construction-Barricade,							
20		Concrete, 1942	60,173	383 LF					
21	217B	Protective Construction-Barricade,							
22		Concrete, 1945	7,527	45 LF					
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
		TOTAL							

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—68841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 16 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1		CORE DIVISION							
2	113	Core Building, Brick, 1942	2,741,341	458x309'	173,725	3B	8-34'	500#	
3	113A	Guard House, Brick, 1942	16,512	17x24'	418	1	9'	500#	Outleased - Lease #4637
4	113B	Guard House, Brick, 1942	4,861	11x10'	119	1	9'	500#	" " "
5	113C	Inspection & Packing, Wood siding							
6		covered with asbestos shingle 1942	247,196	321x155'	50,031	1	26-7'	1000#	Outleased - Lease #4025
7	113D	Furnace Building, wood siding,							
8		asbestos shingles, 1942	282,360	263x117'	47,742	2B	8-18'	500#	
9	113E	Laboratory Building, Brick, 1942	29,136	99x42'	4,341	1	11-14'	500#	
10	113G	Volatile Storage Bldg. Wood, 1942	1,500	12x11'	141	1	7'	500#	
11	113H	Volatile Storage Bldg. Concrete							
12		Block, 1954	4,722	20x30'	600	1			
13	113J	Pump House, Galvanized Sheet Metal							
14		1956	20,090	18x16'	305	1			
15	113K	Guard House, portable, wood, 1953	1,134	8x8'	64	1			
16	113L	Guard House, portable, wood, 1953	864	8x8'	64	1			
17		Tank, gasoline storage, Underground,							
18		1,000 Gal. Capacity	1,500						
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
		TOTAL	[illegible]						

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—68841-1 U. S. GOVERNMENT PRINTING OFFICE

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 17 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1		MISC. STRUCTURES, UTILITIES, GROUND							
2		IMPROVEMENTS:							
3		Underground Gas Tanks (3)	5,670						
4		Open Storage, 5623 SY	6,089						
5		Flagpole, 82' H (1)	1,331						
6		ELECTRICITY-DISTRIB. & TRANSM.:							
7		Overhead Trans. Lines, 8,189 LF	12,804						
8		Underground Conduit, 1,127 LF	2,357						
9		Underground Cable, 347,709 LF	1,415,142						
10		Fence Lights (54)	2,863						
11		Street Lights (129)	9,325						
12		Floodlights (26)	9,635						
13		HEAT & STEAM TRANSMISSION:							
14		Distribution Lines, 50,589 LF	373,456						
15		SEWAGE & INDUSTRIAL WASTE:							
16		Sanitary Sewer Mains, 29,030 LF	681,760						
17		House Laterals, 102,534 LF	1,754,001						
18		WATER DISTRIBUTION SYSTEM:							
19		Mains, 42,878 LF	1,012,840						
20		Service Lines, 10,079 LF	164,647						
21		ROADS - 178,906 SY or 10.6197 Mi	1,013,562						
22	210	Vehicle Overpass, 1,596 SY/.06 Mi	235,869						
23		SIDEWALKS, PARKING, OTHER PAVEMENT							
24		Walks, 42,156 SY	250,275						
25	139	Pedestrian Overpass, 495 SY	66,730						
26		PARKING AREAS - 130,450 SY	275,299						
27		RAILROADS - 6.8078 Mi.	373,261						
28		GROUNDS, DRAINAGE & SITE IMPROVE.:							
29		Storm Sewers, 464 LF	3,300						
30		Retaining Walls, 892 LF	21,815						
31		FENCING & GATES, 29,058 LF	139,041						
32		FIRE ALARM SYSTEMS - 508 Bxs	136,760						
		TOTAL	[illegible]						

*Prefix letters with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—09841-1 U. S. GOVERNMENT PRINTING OFFICE

AMMUNITION & CORE DIVISIONS

STANDARD FORM 118a
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201.00

BUILDINGS, STRUCTURES, UTILITIES, AND MISCELLANEOUS FACILITIES

SCHEDULE A—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 18 OF 21 PAGES OF THIS SCHEDULE

GSA CONTROL NO. (GSA use only)

3. ANNUAL RENTAL

LINE NO. (a)	HOLDING AGENCY BUILDING NO. (b)	DESCRIPTION (c)	COST (d)	OUTSIDE DIMENSIONS (e)	FLOOR AREA (Sq. ft.) (f)*	NO. OF FLOORS (g)*	CLEAR HEAD-ROOM (h)*	FLOOR LOAD RANGE (i)*	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (j)
1		TUNNELS - 12,081 LF	845,931						
2		GAS DISTRIBUTION LINES - 21,620 LF	252,478						
3		~~COMPRESSED AIR LINES-14,779 LF~~	73,987						
4		RUBBISH BIN	1,212		231				
5									
6		The following improvements were constructed on SLOP (0.40 acres near Bldg. 307)							
7		while the property was permitted to Air Force, Detachment 6, 10th RBS Squadron.							
8									
9									
10	307A	Squadron Operations	7,827.24		631 SF				
11	1000	Elec Distri Line OH	2,884.10		440 Pole Ft.				
12	1005	Gas Mains	213.08		502 LF				
13	1010	Sidewalk	76.00		10 SY				
14	1015	Fence, Security	1,500.00		373 LF				
15	1018	Fire Alarm System	117.98		1 Box				
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
		TOTAL	$ 61,898,650		4,041,837				

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

16—69841-1 U. S. GOVERNMENT PRINTING OFFICE

ST. LOUIS ORDNANCE PLANT

STANDARD FORM 118b
DECEMBER 1953
PRESCRIBED BY GENERAL
SERVICES ADMINISTRATION
REGULATION 2-IV-201.00

LAND

SCHEDULE B—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 19 OF 21 PAGES OF THIS SCHEDULE

3. GOVERNMENT INTEREST: [ ] LEASE [ ] LICENSE [ ] PERMIT [X] EASEMENT [X] FEE [ ] INFORMAL AGREEMENT

GSA CONTROL NO. (GSA use only)

LINE NO. (a)	TRACT NO. (b)	NAME OF FORMER OWNER OR LESSOR AND ADDRESS (c)	TRACT ACQUIRED (Acres or sq. ft.) (d)	EXCESS REAL PROPERTY: ACRES OR SQUARE FEET (e)	COST (f)	ANNUAL RENTAL (g)	TYPE OF ACQUISITION (h)	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (i)
1	543E	The Pullman Co.	0.0021	0.0021	Donation		Donation	Easement dated 7-28-42 for
2								sewer line
3			*	227.0560	1,144,775		D/T of Purchase	
4								
5	*The above 227.0560 acres includes 10.5800 acres added to cover Government-owned							
6	fee underlying streets as follows:							
7		Riverview Boulevard		2.40 acres				
8		Thrush Avenue		0.10 "				
9		Goodfellow Boulevard		6.50 "				
10		Derby Avenue		0.21 "				
11		Penrose Street		0.37 "				
12		Glenmore Avenue		0.35 "				
13		Hamilton Avenue		0.40 "				
14		Alley thru Block 5580		0.25 "				
15				10.58 "				
16								
17	The Shell Division is to be retained and made a self sustaining plant. Establishment of facilities to							
18	provide required utilities and services such as steam, electricity, water, gas, sewage disposal, and rail will							
19	be required. Should such action become impracticable due to cost or other obstacles, the retention of ease-							
20	ments for use of certain existing facilities that supply these utilities must be considered. Ordnance Ammuniti							
21	Command, Joliet, Illinois, must be contacted prior to final decision to release the land areas described herein							
22	to ascertain what easements might be required.							
23								
24	Certain buildings and equipment are contaminated to varying degrees with propellant powder, primer composi-							
25	tion, and tracer mix. Kind and cost of neutralization work to be performed will be determined by a special							
26	survey of Ordnance. Restrictions and conditions pertaining to neutralization and decontamination, as determined							
27	by the special survey, should be a part of the conditions of sale or transfer.							
28								
29	The boundary between the Shell Division, which is being retained, and the remainder of the installation,							
30	which is recommended as excess, should be located 30 feet southwest and parallel to the existing security fence							
31	which divides these areas.							
32								
		TOTAL			$1,144,775			

U. S. GOVERNMENT PRINTING OFFICE 16—60842-1

ST. LOUIS ORDNANCE PLANT

STANDARD FORM 118b
DECEMBER 1953
PRESCRIBED BY GENERAL
SERVICES ADMINISTRATION
REGULATION 2-IV-201.00

LAND

SCHEDULE B—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 20 OF 21 PAGES OF THIS SCHEDULE

3. GOVERNMENT INTEREST
- [ ] LEASE
- [ ] LICENSE
- [ ] PERMIT
- [ ] EASEMENT
- [ ] FEE
- [ ] INFORMAL AGREEMENT

GSA CONTROL NO. (GSA use only)

LINE NO. (a)	TRACT NO. (b)	NAME OF FORMER OWNER OR LESSOR AND ADDRESS (c)	TRACT ACQUIRED (Acres or sq. ft.) (d)	EXCESS REAL PROPERTY: ACRES OR SQUARE FEET (e)	EXCESS REAL PROPERTY: COST (f)	EXCESS REAL PROPERTY: ANNUAL RENTAL (g)	TYPE OF ACQUISITION (h)	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST (i)
1								
2		The St. Louis Ordnance Plant is made excess with the provision that the St. Louis Ordnance District Office						
3		should remain at SLOP until a satisfactory alternate facility is assigned by General Services Administration						
4		on a non-reimbursable basis. They are presently occupying approximately 50,000 square feet of space in						
5		building 101.						
6								
7		A 50-year easement, No. DA-23-075-ENG-398 from 3 November 1949 thru 2 November 1999, has been granted						
8		to the Union Electric Company of Missouri, for aerial rights only, to construct and maintain a 13.2 and 34.5						
9		KV transmission line on the property.						
10								
11		The acreage shown in this report is the best available information until a survey can be made of the area.						
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
		TOTAL						

U. S. GOVERNMENT PRINTING OFFICE 16—69842-1

STANDARD FORM 118c
DECEMBER 1953
PRESCRIBED BY GENERAL SERVICES ADMINISTRATION REGULATION 2-IV-201 00

RELATED PERSONAL PROPERTY

SCHEDULE C—SUPPLEMENT TO REPORT OF EXCESS REAL PROPERTY

1. HOLDING AGENCY NO. KC-173

2. PAGE 21 OF 21 PAGES OF THIS SCHEDULE

3. SCC GROUP (2 digits)

GSA CONTROL NO. (GSA use only)

ITEM NO. (a)	DESCRIPTION (b)	STANDARD COMMODITY CLASSIFICATION (c)	CON-DITION (d)	UNIT (e)	NUMBER OF UNITS (f)	UNIT COST (g)	TOTAL COST (h)	DO NOT USE THIS SPACE (i)
	ST. LOUIS ORDNANCE PLANT NEGATIVE REPORT							
	At a predisposal conference on 5 and 6 October 1961, it was the opinion of Ordnance that all personal property would be removed from the St. Louis Ordnance Plant prior to vacating the property.							
	TOTAL							

U. S. GOVERNMENT PRINTING OFFICE 16—68835-1

000087

USATHAMA
TECH INFO CTR

Report DRXTH-FS-TR-81106

Circulation Copy

Copy 2

SURVEY OF HAZARDOUS/CHEMICAL AREA NO. 2 OF THE FORMER ST. LOUIS ORDNANCE PLANT

VOLUME II

William R. Colvin
Joseph H. Zarzycki

June 1981

FINAL REPORT

Distribution limited to US Government Agencies:
Evaluation of Another Command: June 1981
Requests for this document must be referred to:
Commander, USATHAMA, ATTN: DRXTH-ES, APG-EA, MD 21010

US Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, MD 21010

DISCLAIMER

The views, opinions and/or findings contained in this report are those of the authors and should not be constructed as an official Department of the Army position, policy, or decision, unless so designated by other documents.

000087

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
Report DRXTH-FS-TR-81106

2. GOVT ACCESSION NO.
—

3. RECIPIENT'S CATALOG NUMBER
—

4. TITLE (and Subtitle)
Survey of Hazardous/Chemical Area No. 2 of the Former St. Louis Ordnance Plant

Volume II

5. TYPE OF REPORT & PERIOD COVERED
Final Report

6. PERFORMING ORG. REPORT NUMBER
—

7. AUTHOR(s)
William R. Colvin
Joseph H. Zarzycki

8. CONTRACT OR GRANT NUMBER(s)
—

9. PERFORMING ORGANIZATION NAME AND ADDRESS
US Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, MD 21010

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
—

11. CONTROLLING OFFICE NAME AND ADDRESS
US Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, MD 21010

12. REPORT DATE
June 1981

13. NUMBER OF PAGES
272

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Distribution limited to US Government Agencies:
Evaluation of Another Command: June 1981
Requests for this document must be referred to:
Commander, USATHAMA, ATTN: DRXTH-ES, APG-EA, MD 21010

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
—

18. SUPPLEMENTARY NOTES
Volume II contains only the appendices for the Survey Report (Volume I)

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Volume II
St. Louis Ordnance Plant
Goodfellow US Army Reserve Center
Hanley Industries
US Army Toxic and Hazardous Materials Agency

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This volume contains the following appendices to Volume I of the survey report:

Appendix A: Authority
Appendix B: Archives Search
Appendix C: Description of Buildings in the GUSARC and Hanley areas.
Appendix D: Tables of Complete Analytical Results

(Continued on next page)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Continued from Block 20:

Appendix E: Analytical methods and Quality Assurance Data for the Goodfellow US Army Reserve Center Survey

Appendix F: Analytical Methods and Quality Assurance Data for the Hanley Area Survey

Appendix G: Sample Standard Operating Procedure. "Demolition Plan for the 400 Area (Explosives Manufacturing Area) of the Frankford Arsenal" ? what is this

000087

Survey of Hazardous/Chemical Area No. 2

of the Former St. Louis Ordnance Plant

VOLUME II

APPENDIX A

AUTHORITY

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO
ATTENTION OF:

DAEN-REM-C

18 December 1978

SUBJECT: Installation Restoration, Goodfellow U. S. Army Reserve Center (Portion of Former St. Louis Ordnance Plant), Missouri

Commander
U. S. Army Materiel Development
and Readiness Command
ATTN: DRCDMR
5001 Eisenhower Avenue
Alexandria, Virginia 22333

1. A 27.88 acre parcel of property which was part of the former St. Louis Ordnance Plant has been determined excess to the needs of the Army. The Department of Labor (DOL) is interested in acquiring the property for the establishment of a Job Corps Training Center. DOL has requested authorization to immediately initiate modification of certain of the buildings.

2. Approximately 13.20 acres of the area was last used as a Reserve Training Center with a 14.68 acre portion being leased to Hanley Industries, Inc., for the manufacturing of detonators and other explosive devices. Since DOL will use the property on an unrestricted use basis, certification that it is free from hazardous materials and/or contamination is required. Certification falls within the purview of the Installation Restoration Program.

3. Request expeditious actions be taken to determine the status of the property with respect to contamination and that a schedule for the determination be provided this office.

4. Because of DOL need for earliest possible use of the 13.20 acre area, a separate certification should be provided thereon, and, certification relative to the remaining 14.68 acre area should be provided at an early date thereafter.

DAEN-REM-C 18 December 1978

SUBJECT: Installation Restoration, Goodfellow U. S. Army Reserve Center (Portion of Former St. Louis Ordnance Plant), Missouri

5. Coordination of the transfer of property with DOL will be the responsibility of Mr. W. Jaster of this office, Autovon Telephone No. 223-6175.

FOR THE CHIEF OF ENGINEERS:

JAMES E. UELMEN
Acting Chief, Military Branch
Management & Disposal Division
Directorate of Real Estate

001123

S: 10 Jan 78

DRCIS-EP (18 Dec 78) 1st Ind
SUBJECT: Installation Restoration, Goodfellow U. S. Army Reserve Center (Portion of Former St. Louis Ordnance Plant), Missouri

HQ, US Army Materiel Development & Readiness Command, Alex, VA 22333 26 Dec 1978

TO: Project Manager for Chemical Demilitarization and Installation Restoration, ATTN: DRCPM-DRR, Aberdeen Proving Ground, MD 21010

1. Reference telephone conversation between Mr. Andy Anderson, OPMCDIR, and Mr. Robert Marshall, DRCIS-EP, 26 December 1978.

2. Forwarded for appropriate action and information for a reply in accordance with paragraph 3 of basic correspondence. Request response not later than 10 January 1979.

FOR THE COMMANDER:

Robert G. Marshall
for

ALFRED F. LAWRENCE, JR.
Colonel, GS
Chief, Engineer Division
Directorate for Installations
and Services

APPENDIX B

ARCHIVES SEARCH

ST. LOUIS ORDNANCE PLANT ARCHIVES SEARCH

TABLE OF CONTENTS

		PAGE
I.	General	1
	A. Purpose of the Archives Search	1
	B. Authority	1
	C. Introduction	1
II.	Personnel/Agencies Contacted	1
III.	Findings	2
	A. Installation History 1941-1959	2
	B. Activities in Hazardous Area No. 2, 1941-1945	5
	C. Activities in Hazardous Area No. 2, 1945-1959	6
IV.	Document Sources	6
	A. Files Available at National Personnel Record Center, St. Louis, MO	6
	B. Files Destroyed & Dates Destroyed, National Personnel Record Center, St. Louis, MO	6
	C. Files Available at Washington National Records Center, Suitland, MD	7
V.	Conclusions	7

LIST OF FIGURES

	PAGE
Figure 1 - Site Map of Hanley Area, St. Louis Ordnance Plant, MO	3

FRC - KANSAS CITY
291-69A0768 Box 3 of 4
D-MO-460A St. Louis Ord Plt

THE LOCATION AND EXTENT OF CONTAMINATION
ST. LOUIS ORDNANCE PLANT

The following teletype from Ordnance Ammunition Command is quoted in its entirety indicating the contamination of the plant and the decontamination which is necessary:

Unclas AMFF-07 for ORDSW-AF Mr Russell ORDRF Mr TT Tyler from ORDLY-AMFF Lynn Signed Lt Colonel Latham Ref OCO ltr 16 Jan 62 and Mr T T Tyler's request, following is submitted for decontamination of St. Louis Ordnance Plant: A. All buildings and equipment have been decontaminated to 3K condition, I. E., all visible explosives and powder removed, flushed with steam and/or hot water, and surfaces brushed and or wt vacumed. Sumps and drains cleaned and flushed. Filters burned. Residual explosives or powder might be found under and around machine bases.

B. Further decontamination would consist of spot flushing floors where machines were set and later removed in following buildings:

WD (1) 102E, 103E, 104F, 105-F-Primer insert buildings. Test for presence of primer mix. Flush first floor, mop up after machines removed. No sumps.

WD (2) 102D, 103D, 104E, 105E- Loading buildings. Test for presence of propellant. Flush first floor, mop after machines removed. No sumps.

WD (3) 102F, H; 103F, H; 104G, J; 105G, J; - Powder canning buildings and powder storage magazines. Test for propellant. Flush and mop. No sumps.

(4) 123 - Tracer and Incendiary Charge Building. Test for presence of materials. Flush and drain after machines removed. Three sumps service air handling units.

(5) 124A, C-Transfer buildings for igniting compositions. 124B - Storage for above. Test for presence of igniting compositions, flush with neutralizer solution, and mop.

(6) 119B, C, E, F-Tracer and Igniter Storage. Same as preceding.

(7) 119D - Chemical Warehouse. Neutralize only spilled chemicals not already decomposed or removed.

(8) 125A, B, C, D - Incendiary Mix Storage. Same as for 124 and 119 series.

(9) 126 and 127 series - 16 buildings primer storage. May be contaminated with mix from ruptured primers. Remove equipment shelving; flush and mop.

(10) 128 Series - 12 buildings primer dry, storage, and weighing. Same as above.

(11) 129 Series - 4 buildings explosive storage. Test for presence of explosive, remove shelving, flush and mop.

EXHIBIT "A"

(12) 131 and 132 series - 16 buildings, Primer Mix Buildings, barricades, and control houses. May be contaminated with mix or components of mix. Ten sumps in area. All sumps were stainless steel buckets with filter overflowing into concrete settling basin which drained to sewer. Remove shelving and equipment; remove sump filters and solids for burning.

(13) 133 Series - 4 buildings underground primer mix storage. Wt storage of mix in bulk. Decontaminate as above.

(14) 134 - Primer manufacturing buildings. Manufacturingwings, drains to sumps, and sumps may have some styphnate tetracene mix under or around machine bases. After moving machines, test for contamination; flush floors to remove any contamination, flush drains serving air handling units, floor drains, and sumps.

(15) 142-WT Primer Storage. Used for holding primer before distribution to operating buildings. May contain some undecomposed mix from spilled or ruptured primers. See procedures for building 134 above.

(16) 114A, C, E - Propellant Storage Magazines. May have some propellant grains in cracks or corners. Flush. All are presently leased to private company for furniture storage.

C. All sumps and settling basins should be physically removed and hauled to an inert dumping ground. The holes should be backfilled.

D. Nature of material loaded or prepared is expected to decompose over period of time and upon exposure to atmosphere. Preliminary survey of the facilities would ascertain the degree of contamination, if any, and the extent of decontamination required.

E. Recommended limitations for use by others: Unrestricted use of all facilities, subsequent to removal of equipment and the determination that contamination no longer exists.

F. The estimated cost of decontamination, or the determination of the absence of contamination, should not exceed $25,000 including overhead and supervision. The decontamination work, if required, would be accomplished by the purchaser under supervision of responsible ordnance representative.

BT
31/2202Z RUWMFH

ST. LOUIS ORDNANCE PLANT
ARCHIVES SEARCH

I. General

A. Purpose of the Archives Search: This historical summary was conducted to determine operations at the St. Louis Ordnance Plant (SLOP) during the years 1941-1959. Foremost in the search was historical information relative to the use and subsequent decontamination of the buildings and magazines associated with Hazardous Area No. 2/Chemical Area No. 2.

B. Authority: DF, Chief, Field Systems Division to Chief, Environmental and Safety Division, 25 June 80, subject: Request for Archives Search of the St. Louis Ordnance Plant - Hazardous Area No. 2/Chemical Area No. 2.

C. Introduction: The Hanley Area, a contractor operated portion of the Hazardous Area No. 2, is to soon be acquired by the Department of Labor. It is imperative that the history of this portion, prior to 1959, be known in order to identify those buildings and magazines where explosives and heavy metals were used. A history of the operations conducted in the Hanley Area exists for the period 1959 to present.

II. Personnel/Agencies Contacted

Personnel from the following agencies were contacted to provide information concerning the search:

A. National Personnel Records Center, St. Louis, MO

B. Industrial and Social Division of the National Archives, Washington, D.C.

C. Washington National Records Center, Suitland, MD

D. Environmental Photographic Interpretation Center, Vint Hill Farms Station, Warrenton, VA

E. U.S. Army Corps of Engineers, Kansas City District, MO

F. Retired SLOP Post Engineer, St. Louis, MO

G. Department of Agriculture, ASCS Imagery, Bionetics Corporation, Vint Hill Farms Station, Warrenton, VA

H. Commander's Representative for St. Louis Army Ammunition Plant (SLAAP), St. Louis, MO

I. Retired Commander's Representative for SLAAP, St. Louis, MO

J. Plant Manager for SLAAP, St. Louis, MO

K. Data Processing and Information Management Branch of Administrative Services Division, US Army Environmental Hygiene Agency (USAEHA),APG, MD

L. US Army Armament Materiel Readiness Command (ARRCOM) Historical Office, Rock Island, IL

III. Findings

A. Installation History 1941-1959

The following summary was taken from internal documents of the St. Louis Ordnance Plant files and from Historical Report, 45-55, St. Louis Ordnance Plant, primarily using Chevrolet Motor Division records when plant files were unavailable.

Construction was started during January 1941 and was completed in May 1942. Initial production, however, started as early as December 1941. During the World War II period, the St. Louis Ordnance Plant was constructed and activated as a Government Owned-Contractor Operated (GOCO) plant for the production of small arms ammunition (caliber .30 and .50) and components for the 105 mm shells.

Major contractor operators during the subject period were:

1. The United States Cartridge Company (U.S. Cartridge), a subsidiary of Olin Industries, operated the ammunition plant for manufacture of small arms ammunition and produced 67 million rounds. U.S. Cartridge occupied plants No. 1 and No. 2. Plant No. 1 comprised buildings in the 100 series and Plant No. 2 the 200 series (see Figure 1, page 3). They are both located due east of Bldg 107.

2. The McQuay-Norris Manufacturing Company operated the core plant for manufacture of cores for small arms ammunition and produced 8,500 million cores. McQuay-Norris occupied the 113 building series on the extreme south end, located south of Highway 70 on Goodfellow Boulevard near Natural Bridge Road.

3. The Chevrolet-Shell Division of the General Motors Corporation operated the shell plant for the manufacture of 105 mm shells. This facility began production late in 1945 following the changeover from small arms ammunition manufacture. The number of shells produced is unknown.

Following deactivation of the plant in 1945, all property and buildings were transferred to the Seventh Service Command for use as an administrative center for the Army Service Forces. This included the plants No. 1 and No. 2 areas, but excluded the McQuay-Norris plant.

During the period 1945 to 1951 the Plant was utilized as a record center for maintaining and servicing records of the Adjutant General's Office and the Finance Center, US Army. During this period the Plant was administered by the St. Louis Administration Center, a Class I activity under the jurisdiction of Fifth Army Region.

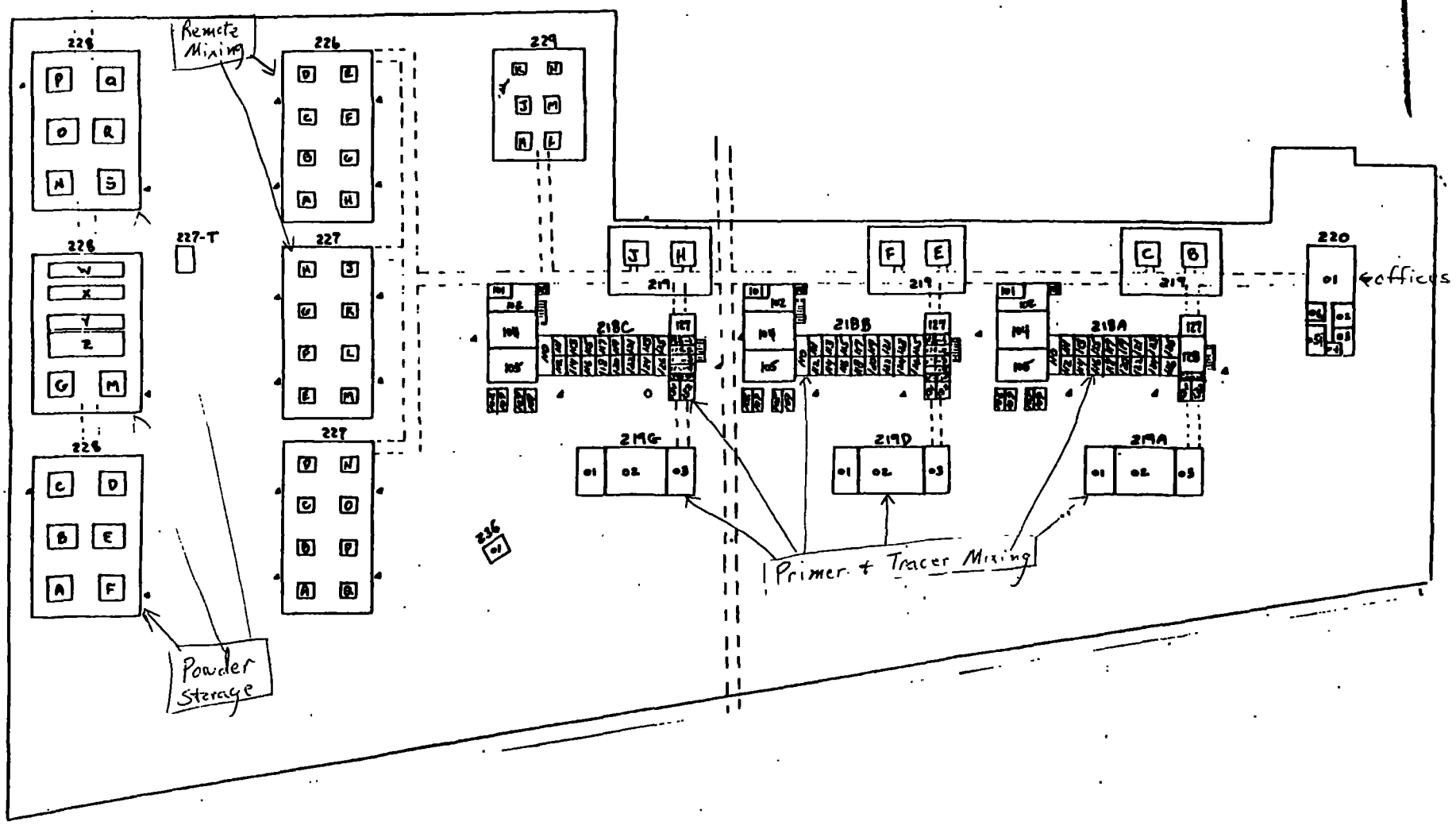


FIGURE 1. SITE PLAN OF THE HANLEY AREA OF THE FORMER ST. LOUIS ORDNANCE PLANT, ST. LOUIS, MISSOURI

Between 1945-51, seven Government housing buildings were constructed, each containing four apartments. In addition, a Wherry Housing Project consisting of 16 buildings containing a total of 120 apartments was completed.

On 1 Aug 1951, the Plant was established as a Class II industrial installation under the jurisdiction of the Chief of Ordnance and placed in an active status under command of the Ordnance Small Arms Ammunition Center. On 1 Sep 1951, the St. Louis Core Plant was redesignated from a Class II industrial installation to a Class II industrial activity at this Plant.

On 1 Feb 1952, the Chevrolet-Shell Plant was discontinued as a Class II industrial installation and its facilities consolidated with and made a part of the St. Louis Ordnance Plant. On the same date the St. Louis Core Plant was discontinued and its facilities were also consolidated with and made a part of the St. Louis Ordnance Plant.

Three divisions of SLOP were established:

1. Ammunition Division - Small arms ammunition manufacturing activities; contractor-operator U.S. Defense Corporation.

2. Core Division - Formerly St. Louis Core Plant; contractor-operator McQuay-Norris Manufacturing Company.

3. Shell Division - Formerly Chevrolet Shell Plant; contrator-operator Chevrolet Shell Division.

On 1 May 1952 the St. Louis Administration Center was discontinued and its function transferred to the St. Louis Ordnance Plant. These functions consisted of Army housekeeping services to Army Finance Center. In view of the Plant mission, efforts were immediately started to eliminate the housekeeping functions and by the end of September 1953, they were eliminated to the extent that the Army Service Unit was discontinued and the services decentralized to other Fifth Army Agencies within the St. Louis area.

As of 1 July 1954, this plant was placed under the command supervision of the US Army Ordnance Ammunition Command vice the US Army Ordnance Small Arms Ammunition Center which was being disbanded.

Facilities formerly operated by Chevrolet Shell Division of General Motors Corporation were placed in standby under power status, 30 Aug 1954. From 1951 through 1954 a cumulative total of 19,094,321 shells were produced. Unlike the shells of WW II era production, these shells were phosphate coated.

Later activities consisted of manufacturing small arms ammunition by the United States Defense Corporation and small arms ammunition cores by the McQuay-Norris Manufacturing Company.

Effective 1 Dec 1957, the St. Louis Ordnance Plant, a Class II industrial installation of the Chief of Ordnance, was placed in an inactive status.

B. Activities in Hazardous Area No. 2, 1941-1945

According to information provided by a former employee, of the 37.35 acres comprising Hazardous Area No. 2, the portion on the north end, specifically Bldgs 223 A and B, used magnesium for tracer bullet manufacture. In Bldg 234, on the extreme south end, lead styphnate and possibly tetrazine were used in the manufacture of primers.

The former employee recalled that areas designated on site map of Hanley Area, page 3, were used prior to 1945 as follows:

AREA	USE
220	Offices
218 A,B,C	Primer & Tracer Mixing
219 A,D,G	Primer & Tracer Mixing
226, 227	Remote Mixing Operation
228	Powder Storage

The following information was taken from documents entitled Disposition of the St. Louis Ordnance Plant and from Chapter I - Major Activities, Mopping Up, a formerly restricted publication of unknown origin found in the plant files.

In 1945, following deactivation procedures, machines having fire and explosive hazards due to collection of powders in hidden parts and/or places on the machines and buildings having explosive hazards were decontaminated by the Army COE in accordance with regulations of the Safety and Security Branch, Office, Chief of Ordnance, Chicago. The decontamination included machines being scrapped as well as those being disposed of through other channels. All special equipment peculiar to the production of small arms ammunition was declared excess and recommended for scrapping. All multipurpose equipment was reported to the Reconstruction Finance Corporation for ultimate disposition. Over 14 million pounds of scrap material were moved from the plant.

The War Department Supply Bulletin, SB 5-52, July 1945, Decontamination Procedures, outlined the procedures for decontamination or discontinuation of operations prior to dismantling, demolition, alteration, or conversion of plants or equipment or areas where explosives or toxic materials have been manufactured, and in other plants and areas where similar hazards exist. A system of markings used to show extent of decontamination ranges from a simple "X" to indicate material only partially decontaminated to five "X" indicating safe. A review of SB 5-52 by an Explosive Ordnance Disposal Officer assigned to Environmental and Safety Division of the US Army Toxic and Hazardous Materials Agency revealed that procedures had changed little from the date of publication to present. Procedures were stringent, including detailed cleaning with water, steam, or

solvents, neutralization of acids, and flashing or burning of contaminated equipment to reach a "XXXXX" level of decontamination. Current procedures are listed in ARRCOM 385-5, dated 26 Oct 1979.

The buildings and magazines in the entire Hanley Area were marked "XXXXX" which indicated that the structures had been inspected after decontamination and were considered safe, and that no explosives remained in the structures.

One former government employee, a plant maintenance engineer who often served as Post Engineer, confirmed the specific documentating of decontaminations. However, copies of the COE completion report have not been located and it is assumed that none survived as archival documents. Accordingly, no record of toxic or hazardous activities from 1945 until the Hanley lease of 1959 were uncovered.

C. Activities in Hazardous Area No. 2, 1945-1959

was powder and chemicals restocked at SLCP or Tyson ?

As buildings were available, the Finance Center conducted classes in this area until 1951. In 1951, a rehabilitation program for small arms ammunition manufacture was begun in the area. The machinery was installed but production was never begun. After the Korean Conflict, the machinery was removed and disposed of. It was reported that at various times the area was used for storage and for automotive and equipment maintenance.

IV. Document Sources

A. Files Available at National Personnel Record Center, St. Lousi, MO

<u>File Container No.</u>

05-25-52-7-3 Memos, General Orders, Special Orders, Bulletins, Procedural Standardization Files

06-25-04-2-1 Minutes of Staff Meetings, Minutes of Ind. Planning Board, Memos, Bulletins, Special Orders, SOP's

08-41-10-E-3 Trip Reports, Newspapers, Clippings, Photos

B. Files Destroyed and Dates Destroyed, National Personnel Record Center, St. Louis, MO

1951-1957 Files of Government-Owned, Contractor Operated Industrial... Destroyed 1 July 1964

Unserviceable Scrap... Destroyed 1976

Contract Files Over $25,000. Destroyed 1963

1951-1952 Plant General Administrative Files - Could not be located.

C. Files Available at Washington National Records Center, Suitland, MD

Record Group 156, Entry 646, Box 210 - Decontamination and Equipment Disposition, Newspaper Clippings

Record Group 156, Entry 646, Boxes A560 and 558 - St. Louis Ordnance District History, Volumes I - XIV

V. Conclusions

A. Documents specific to land transfers, buildings and magazines requiring heavy metal use, explosive use, or decontamination reports were not located during the subject search.

B. Information presented from personal interviews may prove useful relative to general locations and recalled plant operations. This information was not corroborated by other sources.

APPENDIX C

Description of Buildings in the

Goodfellow US Army Reserve Center and Hanley Areas

1. Descriptions of Buildings and Bunkers in the Goodfellow US Army Reserve Center Area

a. Building 234

This large "U" shaped building has an east and west wing comprised of red painted cement floors with glazed brick walls. The central part of 234 has a central (northern room) adjoined by (going south) a room with metal cages, a large room with some old shower stalls, a kitchen, mess hall, and some smaller rooms including a toiletroom.

The southwestern part of the building has a floor constructed of wooden blocks. A mezzanine (very small) exists in the western part of the building. There is also a basement which houses the heating system in the north central part of this building.

b. Building 223A

Building 223A is a large rectangular, one-story building whose length runs north-south and its width runs east-west. One large room on the first floor is divided up into 21 sections on the east and 21 sections on the west sides of the building. These sections are referred to as bays in the southern portion of the building. The surface of the first floor is red painted cement. The walls are all glazed brick. Each section has six overhanging fluorescent lights. The basement of the building has five (5) large heating units.

c. Building 223B

Building 223B is characteristically the same as 223A except that it is smaller, having only 13 bays on either side. It also runs north-south lengthwise, parallel to and directly across the street from 223A. The walls are glazed brick. The northern half of the building floor is painted red. The southern half is basically unpainted except for the bays between walls 10C and 11C and 10B and 11B. The floor in the southern half may have been painted at one time--some signs of red paint are indicated. The ceiling is about 25 ft. high, similar to 223A. A basement exists where five heating units similar to those in 223A are housed. This is beneath the northwestern section of the building. Three pollution control systems enclosed in three houses are on top of 223A and 223B.

d. Building 222A

This building is a one-story, irregularly-shaped, rectangular structure with an unpainted floor. Building 222A has many rooms including toiletrooms and shower rooms. Walls are painted white (upper section) and green and blue (lower section). The basement is in the southern section of the building and contains the heating system. Three exhaust systems enclosed in houses are on top of the roof.

e. Building 231 Series

This series consists of 8 small one-room red brick buildings with glazed brick interiors and red painted floors.

f. Building 243 Series

The 243 series consists of 8 small, two-roomed, white buildings constructed of plasterboard and shingles. The floors are red-painted cement. Each building is surrounded by 15 foot high cement blast walls roughly 18 inches thick. The front part of the walk going into 243D is soaked with oil. Some oil barrels are stored in the area.

g. Building 232 Series

Walls ?

The buildings in 232 series are similar to those in the 243 series. Wells are constructed of plasterboard (interior) and green shingle (exterior). The floors are red painted cement. A partition (wall between rooms) is present in several of the buildings. Each building is surrounded by 15 foot high blast walls as is the 243 series. There are 8 buildings in this series.

h. Building 244

This building formerly housed a power plant. It has a basement and first floor consisting of one large room. First floor is contaminated with bird excrement.

i. Underground Bunkers

There are six underground bunkers which are located south of building 234. Each bunker is approximately 4 feet by 6 feet by 8 feet. There are cement steps leading to each bunker. The stairways are enclosed with a concrete canopy.

j. Bunker 224

used for tracer manufacturing. used magnesium

This underground bunker is located Northwest of building 223B. Bunker 224 was accessed by a stairwell. Because the bunker was filled with water, it was not possible to determine its dimensions. However, the walled area above the bunker measured approximately 30 feet by 30 feet and the bunker appeared to be about 20 feet deep.

2. Descriptions of Buildings in the Hanley Industries Inc. Leased Area

a. Building 218 Series — used for primer + tracer manufacturing lead styphnate, tetrazine, magnesium

Series 218 buildings are large T shaped buildings with a red brick exterior and glazed brick interior walls. Floors throughout the buildings are of anti-static composition construction. The south end consists of three large and six smaller rectangular rooms. The center portion contains 17 rooms, a large one on the south end and the smaller ones extending to the north end. The north end of buildings 218B and C contain eight rooms. Four are of poured concrete construction. The north end of building 218A consists of two large and two small rooms. All rooms open to the building exterior. Each room has overhanging fluorescent lights.

what does this mean? what is it made of?

These buildings are interconnected by underground tunnels. Basement rooms are located at each end of the buildings. At the south end are four rooms which open into a foyer. One of these is an equipment room, the others appear to be storage rooms. At the north end is one large basement room connected to the tunnel system.

b. Building 219 Series used for primer & tracer mixing see bld 218 for list of possible contaminates

The buildings in the 219 series are of two types. Those to the east are large, single story, rectangular, brick buildings, whose length runs north-south. These consist of a large control room with smaller rooms at each end. All rooms have orange colored glazed brick interior walls, anti-static composition floors, overhanging fluorescent lights, and wall and ceiling vents. These buildings also have outside loading docks. There are no basements.

The 219-series buildings to the west (B, C, E, F, H, J) are square, one room brick buildings with orange colored glazed tile interior walls and anti-static floors. The ceilings are plasterboard and contain a vent. The roofs are clay tile. All of these buildings are surrounded by 15 foot high concrete blast walls.

c. Building 220

Building 220 is a large rectangular, one-story brick structure whose length runs east-west. This was a laboratory facility. The west end consists of one large room with laboratory benches at the east end and a laboratory hood in the center. The east end consists of a hallway and five rooms, two of which are restrooms. A stairwell at this end leads to the basement. All rooms on the ground floor have orange colored glazed brick interior walls, anti-static composition floors and overhead fluorescent lights.

The basement of building 220 is a single large room which was used as a machine shop. The walls and floors in the basement are concrete.

d. Building 226 and 227 Series - used for remote mixing operation

The 226 and 227 series consists of small one room, white buildings constructed of plasterboard interior walls, asbestos shingle outer walls, and anti-static compound floors. Each building is surrounded by 15 foot high concrete walls approximately 18 inches thick.

e. Building 227T

This is a temporary one story, one room building with plasterboard interior walls, asbestos shingle outer walls, with a solid concrete floor.

f. Building 228 Series — used for powder storage

The buildings in this series are of two types. Those in the east and west groupings are square brick buildings with orange colored glazed brick interior walls and anti-static compound floors. The south central building in each grouping has a stairwell which leads to the underground tunnel network connecting all of the buildings.

The buildings in the center grouping (228W, 228X, 228Y) are long, rectangular structures constructed of plasterboard interior walls and asbestos shingle outer walls. The buildings house drying ovens. Two of the buildings (228G, 228M) in this grouping are square with brick exterior and orange colored glazed brick interior walls.

All of the buildings in this series have anti-static compound floors and are surrounded by 15 foot high blast walls as in the 226 and 227 series.

g. Building 229 Series

Buildings 229H, J, L and M are one room rectangular, underground, poured concrete structures with heavy steel vault doors. Each building has a vent in the center of the ceiling leading to the surface. Access to these buildings is by way of concrete stairways. The stairways and area above each structure are surrounded by thick, 15 foot high poured concrete explosion walls.

Buildings 229K and N are above ground, rectangular, of wood frame construction with exterior asbestos shingles. The interior walls are plasterboard. Each building contains a stainless steel sink with wall to wall drainboards. These buildings are also located within 15 foot high poured concrete explosion walls.

h. Building 236

Building 236 is a one story double garage of brick construction with a concrete floor.

APPENDIX D

TABLES OF COMPLETE ANALYTICAL RESULTS

Table 1. Goodfellow US Army Reserve Center
Results of Heavy Metal Analyses of Surface Samples

Building	Sample #	Concentration, µg/m²			
		Cd	Cr	Pb	Hg
222A	81	58.8	321.6	5775.	< .23
	82	29.8	150.8	3465.	3.02
	83	39.2	110.6	1995.	1.62
	84	29.4	170.8	4515.	2.24
	86	29.8	251.2	4200.	15.9
	87	29.4	130.6	3150.	1.48
	85 (Blank)	< .99	< 2.2	2.1	.23
223A	465	178.2	2575.	13650.	< .23
	500	120.	2678.	3360.	.85
tracers	21	58.8	301.5	966.	.82
	22	5.97	50.2	1365.	.39
	23	5.	50.2	504.	.25
	24	19.6	261.3	4410.	.36
	25	844.2	462.3	3780.	.34
	26	98.	261.3	2625.	.51
	27	88.2	341.7	2594.	.46
	28	49.	1751.	5040.	.37
	29	98.	1648.	5775.	1.70
	40	49.	1009.4	36440.	2.13
	41	117.6	1648.	7875.	< .23
	42	148.5	2060.	13230.	.78
	43	117.6	2091.	5282.	.34
	45	49.8	291.4	2625.	.34
	46	58.8	160.8	2310.	3.47
	47	68.6	597.4	12600.	.34
	48	99.	5562.	2100.	.72
	49	68.6	381.9	2205.	.30
	60	58.8	236.9	2625.	1.59
	44 (blank)	< .99	< 2.2	21.2	< .23
223B	61	39.2	648.9	1890.	.41
	62	5.	20.1	724.5	< .23
tracers	63	68.6	482.4	1470.	.23
	64	19.6	211.0	1029.	.52
	65	29.4	241.2	1470.	.44
	66	9.9	60.3	1575.	.30
	67	78.4	341.7	2205.	< .23
	69	4.98	10.0	474.7	< .23
	79	107.8	462.3	1260.	.44
	80	49.	180.9	2058.	1.17
	68 (blank)	< .99	< 2.2	1.1	< .23

Table 1 (Continued)

Building	Sample #	Cd	Cr	Pb	Hg
234	1	3.5	432.6	598.5	.52
primers	2	49.8	301.5	945.	11.66
Pb styphnate	3	39.8	170.8	865.2	4.14
tetrazine	4	29.8	351.8	2029.	7.62
	5	79.6	221.1	1754.	1.17
	6	783.9	2987.	2940.	13.44
	7	29.4	80.4	861.	1.34
note → consider	8	306.9	587.1	1365.	7.62
Hg	9	168.3	463.5	3570.	6.16
	10	138.6	100.5	2205.	44.8
	12	79.6	1236.	2835.	3.81
	13	217.8	824.	1260.	7.73
	14	844.2	1648.	4515.	5.38
	15	4422.	4120.	14700.	4.7
	16	29.4	367.5	2100.	.34
	17	29.4	231.	1470.	.41
	18	6.0	60.3	1533.	<.23
	19	9.95	66.	903.	<.23
	20	58.8	515.	1680.	.28
	436	58.8	572.8	3360.	1.48
	11(Blank)	9.9	<2.2	52.	.41
244	147	148.5	710.7	6615.	<.23
	148	4.0	150.8	535.3	<.23
	149	29.4	422.1	2730.	.23
	88	148.5	422.1	3360.	<.23
	89	5.0	20.1	3465.	<.23
231A 231C 231E 231G	501 (a)	49.	535.6	3150.	.23
231N 231P 243A 243B	502 (a)	98.	762.2	5985.	<.23
243C 243D 243E	503 (a)	49.	1133.	15750.	<.23

blast walls

Table 1 (Continued)

Building	Sample #	Cd	Cr	Pb	Hg
243F 243G 243H	504[a]	58.8	906.4	7350.	<.23
232A 232A 232B 232C 232D	505[a]	68.6	504.7	18900.	.26
232E 232F 232G 232H	506[a]	178.2	525.3	6720.	.23

Blast units

[a] Composite sample.

Thin Layer Chromatography Results

The results of the TLC analyses of physical and swab samples which gave positive responses are given in Table 2. The levels of TNR, RDX, TNT, NC, and Pb styphnate were all below their TLC detection limits.

In a few cases, PETN and NG were detected, but masked by an interfering material. Subsequent semi-quantitative analysis of these samples by HPLC confirmed the presence of these materials at or about the TLC detection limit. These samples were not rigorously quantitated by HPLC as this effort was beyond the scope of work for this program.

A positive response was obtained in the TLC analysis for tetrazene in several samples. However, these same samples also contained large amounts of interfering materials which contained reducible nitrate groups and masked the TLC visualization of NG and PETN. Bird manure (guano) is composed of a variety of nitrates and guanidine type structures, and it is probable that such compounds would give false-positive responses for PETN, NG and tetrazene. It is, therefore, believed that the positive responses for tetrazene were due to the presence of these interfering compounds and not due to the presence of tetrazene.

NC - nitro cellouse

NG - nitro glycerin

~~PETN - penta-ethyl-tetra-nitrate~~ (primer material - shock sensative)

tetra

PETN Pentaerythritoltetranitrate - primer material

Table 2. Goodfellow US Army Reserve Center
Results of the Analyses of Physical and Swab Samples

Sample No.	Building	TNR	RDX	TNT	NG	PETN	NC	Pb Sty	Tetrazene
160	231P	ND	ND	ND	ND	ND	ND	ND	ND
161	231P	ND	ND	ND	ND	ND	ND	ND	ND
162	231P	ND	ND	ND	ND	ND	ND	ND	ND
163	231N	ND	ND	ND	ND	ND	ND	ND	ND
164	231N	ND	ND	ND	ND	ND	ND	ND	ND
165	231N	ND	ND	ND	ND	ND	ND	ND	ND
169	231J	ND	ND	ND	ND	ND	ND	ND	ND
170	231J	ND	ND	ND	ND	ND	ND	ND	ND
171	231J	ND	ND	ND	ND	ND	ND	ND	ND
172	231G	ND	ND	ND	ND	ND	ND	ND	ND
173	231G	ND	ND	ND	ND	ND	ND	ND	ND
174	231G	ND	ND	ND	ND	ND	ND	ND	ND
175	231E	ND	ND	ND	ND	ND	ND	ND	ND
176	231E	ND	ND	ND	ND	ND	ND	ND	ND
177	231E	ND	ND	ND	ND	ND	ND	ND	ND
178	231C	ND	ND	ND	ND	ND	ND	ND	ND
179	231C	ND	ND	ND	ND	ND	ND	ND	ND
180	231C	ND	ND	ND	ND	ND	ND	ND	ND
181	231A	ND	ND	ND	ND	ND	ND	ND	ND
182	231A	ND	ND	ND	ND	ND	ND	ND	ND
183	231A	ND	ND	ND	ND	ND	ND	ND	ND
184	243H	ND	ND	ND	ND	ND	ND	ND	ND
185	243H	ND	ND	ND	ND	ND	ND	ND	ND
186	243H	ND	ND	ND	ND	ND	ND	ND	ND
187	243G	ND	ND	ND	ND	ND	ND	ND	ND
188	243G	ND	ND	ND	ND	ND	ND	ND	ND
189	243G	ND	ND	ND	ND	ND	ND	ND	ND
190	243F	ND	ND	ND	ND	ND	ND	ND	ND
191	243F	ND	ND	ND	ND	ND	ND	ND	ND
192	243F	ND	ND	ND	ND	ND	ND	ND	ND
193	243E	ND	ND	ND	ND	ND	ND	ND	ND
194	243E	ND	ND	ND	ND	ND	ND	ND	ND
195	243E	ND	ND	ND	ND	ND	ND	ND	ND
196	243D	ND	ND	ND	ND	ND	ND	ND	ND
197	243D	ND	ND	ND	ND	ND	ND	ND	ND
198	243D	ND	ND	ND	ND	ND	ND	ND	ND
199	243C	ND	ND	ND	ND	ND	ND	ND	ND
200	243C	ND	ND	ND	ND	ND	ND	ND	ND
201	243C	ND	ND	ND	ND	ND	ND	ND	ND
202	243B	ND	ND	ND	ND	ND	ND	ND	ND
203	243B	ND	ND	ND	ND	ND	ND	ND	ND
204	243B	ND	ND	ND	ND	ND	ND	ND	ND

Table 2 (Continued)

Sample No.	Building	TNR	RDX	TNT	NG	PETN	NC	Pb Sty	Tetrazene
205	243A	ND	ND	ND	ND	ND	ND	ND	ND
206	243A	ND	ND	ND	ND	ND	ND	ND	ND
207	243A	ND	ND	ND	ND	ND	ND	ND	ND
208	232H	ND	ND	ND	ND	ND	ND	ND	ND
209	232G	ND	ND	ND	+(2)	+	ND	ND	+(3)
210	232F	ND	ND	ND	ND	+	ND	ND	+(3)
211	232E	ND	ND	ND	ND	+	ND	ND	+(3)
212	232D	ND	ND	ND	ND	ND	ND	ND	ND
213	232C	ND	ND	ND	+	+	ND	ND	ND
214	232B	ND	ND	ND	ND	+	ND	ND	ND
215	232A	ND	ND	ND	ND	+	ND	ND	ND
400	222A	ND	ND	ND	ND	ND	ND	ND	ND
401	222A	ND	ND	ND	ND	ND	ND	ND	ND
402	222A	ND	ND	ND	ND	ND	ND	ND	ND
403	222A	ND	ND	ND	ND	ND	ND	ND	ND
404	222A	ND	ND	ND	ND	ND	ND	ND	ND
405	223A	ND	ND	ND	ND	ND	ND	ND	ND
406	223A	ND	ND	ND	ND	ND	ND	ND	ND
407	223B	ND	ND	ND	ND	ND	ND	ND	ND
408	223B	ND	ND	ND	ND	ND	ND	ND	ND
409	234	ND	ND	ND	ND	ND	ND	ND	ND
410	234	ND	ND	ND	ND	ND	ND	ND	ND
411	234	ND	ND	ND	ND	ND	ND	ND	ND
412	234	ND	ND	ND	ND	ND	ND	ND	ND
413	234	ND	ND	ND	ND	ND	ND	ND	ND
414	234	ND	ND	ND	ND	ND	ND	ND	ND
415	223A	ND	ND	ND	ND	ND	ND	ND	ND
416	223A	ND	ND	ND	ND	ND	ND	ND	ND
417	223A	ND	ND	ND	ND	ND	ND	ND	ND
418	223A	ND	ND	ND	ND	ND	ND	ND	ND
419	223A	ND	ND	ND	ND	ND	ND	ND	ND
420	223A	ND	ND	ND	ND	ND	ND	ND	ND
421	223A	ND	ND	ND	ND	ND	ND	ND	ND
422	223A	ND	ND	ND	ND	ND	ND	ND	ND
423	223B	ND	ND	ND	ND	ND	ND	ND	ND
424	223B	ND	ND	ND	ND	ND	ND	ND	ND
425	223B	ND	ND	ND	ND	ND	ND	ND	ND
426	223B	ND	ND	ND	ND	ND	ND	ND	ND
427	222A	ND	ND	ND	ND	ND	ND	ND	ND
428	222A	ND	ND	ND	ND	ND	ND	ND	ND
429	244	ND	ND	ND	ND	ND	ND	ND	ND
430	234	ND	ND	ND	ND	ND	ND	ND	ND

Table 2 (Continued)

Sample No.	Building	TNR	RDX	TNT	NG	PETN	NC	Pb Sty	Tetrazene
431	234	ND	ND	ND	ND	ND	ND	ND	ND
432	234	ND	ND	ND	ND	ND	ND	ND	ND
433	234	ND	ND	ND	ND	ND	ND	ND	ND
434	234	ND	ND	ND	ND	ND	ND	ND	ND
435	234	ND	ND	ND	ND	ND	ND	ND	ND
437	234	ND	ND	ND	ND	ND	ND	ND	ND
438	223A	ND	ND	ND	ND	ND	ND	ND	ND
454	234	ND	ND	ND	ND	ND	ND	ND	ND
455	234	ND	ND	ND	ND	ND	ND	ND	ND
456	234	ND	ND	ND	ND	ND	ND	ND	ND
457	223B	ND	ND	ND	ND	ND	ND	ND	ND
458	223A	ND	ND	ND	ND	ND	ND	ND	ND
459	223B	ND	ND	ND	ND	ND	ND	ND	ND
460	223B	ND	ND	ND	ND	ND	ND	ND	ND
461	223B	ND	ND	ND	ND	ND	ND	ND	ND
462	223B	ND	ND	ND	ND	ND	ND	ND	ND
463	223B	ND	ND	ND	ND	ND	ND	ND	ND
464	223A	ND	ND	ND	ND	ND	ND	ND	ND
466	223A	ND	ND	ND	ND	ND	ND	ND	ND
467	223A	ND	ND	ND	ND	ND	ND	ND	ND
468	223A	ND	ND	ND	ND	ND	ND	ND	ND
469	223B	ND	ND	ND	ND	ND	ND	ND	ND
470	223B	ND	ND	ND	ND	ND	ND	ND	ND
472	223B	ND	ND	ND	ND	ND	ND	ND	ND

(1) ND = not detected.

(2) TLC analysis gave a positive response. However, presence of interference(s) precludes positive identification and quantitation by TLC. HPLC analysis was used to confirm the presence of these materials at or about the TLC detection limit (50–75 ug/g for NG and PETN).

(3) TLC analyses gave positive response. However, presence of interference(s) makes TLC identification and quantitation unreliable.

Table 3. Hanley Area
Positive Spot Spray Results (Buildings)

		Spot Spray Number*				
Building	Room	1	2	3	4	5
218 A	101	+				
	102		+			
	104	+				
	105	+				
	106		+			
	108		+			
	109	+				
	112	+				
	113		+			
	121	+				
	124	+				
	127	+				
218 B	101		+			
	102		+			
	103		+			
	104		+			
	106				+	
	107		+			
	108				+	
	109		+			
	116		+			
	121		+			
	122	+				
	124	+				
	125		+			
	127		+			
	132		+			
	141			+		
	142		+			
	144		+			
	B02	+				
	B05	+				
218 C	102	+				
	104	+				
	106	+				
	108		+			
	111				+	
	115	+				

Table 3 (Continued)

		Spot Spray Number				
Building	Room	1	2	3	4	5
218 C	127		+			
	131		+			
	132		+			
	B02	+				
	B04	+				
	B05	+				
219 A	102		+			
219 D	101	+				
	103		+			
219 G	103		+			
220	101			+ (sill)		
	101			+ (wall)		
	101		+ (shelf)			
	102		+			
	105			+		
	106			+		
	107		+			

*Compounds Identified by Spot Sprays

Spot Spray Number	Compound(s) Detected
1	Nitrocellulose, Nitroglycerine
2	PETN, HMX
3	DNT, TNT, TETRYL
4	Styphnic Acid, Lead Styphnate
5	Tetrayene

Table 4. Hanley Area
Spot Spray Results (Magazines)

		Spot Spray Number				
Magazine	Room	1	2	3	4	5
219 E	101				+	
219 F	101		+			
219 H	101			+		
219 J	101		+			
227 A	101	+				
227 B	101	+				
227 J	101			+		
227 M	101			+		
227 O	101	+				
228 C	101	+				
228 F	101	+				
228 G	101		+			
228 N	101		+			
228 P	101		+			
228 W	101		+			
228 Y	101		+			
228 Y	B01	+				
229 K	101		+			
229 N	101		+			

Table 5. Hanley Area
Physical Sample Results*

Composite Sample #	Building	Analyte									
		2,4 DNT	2,6 DNT	TNT	TETRYL	PETN	NG	NC	Tetrazene	Styphnic Acid	HMX
S62434	218 A	ND	ND	ND	+	ND	ND	ND	ND	ND	<0.0075
S62447	218 B	ND	ND	ND	+	ND	ND	ND	ND	ND	3.8
S62468	218 C	ND	ND	ND	+	ND	ND	ND	ND	ND	<0.0075
S62497	219 A	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.0075
S62424	219 C	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0120
S62500	219 D	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.0075
S62425	219 E	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.0075
S62503	219 G	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.0075
S62428	219 H	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0120
S62481	220	ND	ND	ND	+	ND	ND	ND	ND	ND	<0.0075
S62490	227 (M)	ND	ND	ND	+	ND	ND	ND	ND	ND	2.1
S62493	227 (E)	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.029
S62420	228 (E)	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0083
S62411	228 (M)	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.0075
S62417	228 (W)	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.0075
S62431	229	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.0075
S62504	218 C (B03)	ND	ND	ND	ND	+	ND	ND	ND	ND	0.35
S62505	228 R (B01)	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.0075
S62506	228 Y (B01)	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.0075

* All analyses were performed by TLC methodology except Tetrazene and HMX. Tetrazene analyses were performed by colorimetric spot test. HMX analyses were performed by quantitative HPLC procedure.

LEGEND:
ND = Non-detectable
(M) = Mid
(E) = East
(W) = West
(+) = Positive (Detection Limit 1 $\mu g/cm^2$

Table 6. Hanley Area
Detection Limit, Precision, and Accuracy
of Analytical Methods by Analyte

Analyte	Detection Limit		Accuracy	Precision
Ag (in water)	0.5	ppb	0.85	0.10
Pb " "	10	"	0.89	0.10
Cr " "	5	"	0.92	0.10
Ni " "	10	"	1.03	0.10
Cd " "	0.5	"	0.93	0.10
Hg " "	0.4	"	0.87	0.10
Ag (on filter swipes)	1	$\mu g/m^2$		
Pb " " "	5	"		
Cr " " "	5	"		
Ni " " "	5	"		
Cd " " "	25	"		
Hg " " "	0.2	"		
Styphnic Acid (in water)	50	ppb	0.66	0.08
Tetrazene	500	"	1.01	0.03
HMX (in water)	8.4	"	0.96	0.041
NC (in water & soil)	9700	"	0.976	0.011
NG " " "	9700	"	0.976	0.011
PETN " " "	9700	"	0.976	0.011
TNT (in water)	1.2	"	0.60	0.35
Tetryl "	2.4	"	0.69	0.15
2,4-DNT "	0.5	"	0.83	0.14
2,6-DNT "	0.5	"	0.83	0.14
Explosives by TLC	1	$\mu g/cm^2$		
2,6-DNT by TLC	2.5	"		

Table 7. Hanley Area
Heavy Metal Analysis of Surface Swipes ($\mu g/M^2$)

Bldg./ Magazine	Sample #	Pb	Ag	Ni	Hg	Cr	Cd
218 A	S62311	17300	4.3	61	<0.2	343	102
218 B	S62316	4920	8.6	74	<0.2	310	<25
218 C	S62322	5080	7	147	<0.2	449	<25
219 A	S62360	820	3.7	22	32	64	<25
219 B	S62295	3330	4.6	55	<0.2	126	<25
219 D	S62365	1920	8	64	<0.2	232	100
219 E	S62298	27200	24	30	<0.2	92	<25
219 G	S62370	1900	10	84	1.7	293	<25
219 J	S62301	4220	9.8	147	<0.2	364	28
220	S62329	5850	7.5	100	0.9	434	54
226 (W)	S62334	8140	3.1	34	<0.2	116	<25
227 (E)	S62351	4180	4.2	59	<0.2	170	<25
227 (M)	S62343	2870	3.2	33	<0.2	95	<25
227 T	S62285	800	<1	<5	<0.2	26	<25
228 (E)	S62268	4020	4.7	59	<0.2	300	<25
228 (M)	S62277	2870	3.9	53	<0.2	222	<25
228 (W)	S62286	3880	6.4	95	<0.2	515	40
229	S62304	2670	4.1	49	<0.2	328	<25
236	S62328	6180	5	40	<0.2	172	<25
QUALITY CONTROL DATA* ($\mu g/M^2$)							
Blank	-	<5(0)	<1(0)	<5(0)	<.2(0)	<5(0)	<1(0)
S.L. 1	-	6(2.5)	<1(.5)	<5(2.5)	.2(.2)	<5(2.5)	25(25)
S.L. 2	-	8(5)	1.1(1)	8(5)	.33(.4)	6(5)	50(50)
S.L. 3	-	12(10)	2(2)	14(10)	.79(.8)	11.5(10)	100(100)
S.L. 4	-	27(25)	5.2(5)	27(25)	2.06(2)	26.5(25)	246(250)
S.L. 5	-	53(50)	10.2(10)	55(50)	4.16(4)	56(50)	520(500)

*Expected value in parenthesis

LEGEND: S.L. = Spike Level

Table 8. Hanley Area
Powder Well Sample Results (ppb)

Composite Sample	Location	2,4 DNT	2,6 DNT	TNT	Tetryl	PETN	NG	NC	Tetrazene	Styphnic Acid	HMX
S62407	PW425	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62375	PW0218A	<0.5	<0.5	<1.2	4.0	<9700	<9700	<9700	< 500	<50	<8.4
S62380	PW0218B	<0.5	<0.5	<1.2	4.6	<9700	<9700	<9700	< 500	<50	<8.4
S62384	PW0218C	<0.5	<0.5	<1.5	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62399	PW226 (W)	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62389	PW227 (E)	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62394	PW227 (M)	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62404	PW228 (E)	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62408	PW228 (W)	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
					QUALITY CONTROL DATA* (ppb)						
S63109	Blank	NA	NA	NA	NA	NA	NA	NA	NA	NA	<8.4(0)
S63102	Blank	NA	NA	NA	NA	NA	NA	NA	NA	NA	<8.4(0)
S63099	Spike Level	NA	NA	NA	NA	NA	NA	NA	NA	NA	39(40)
S63100	Spike Level	NA	NA	NA	NA	NA	NA	NA	NA	NA	75(80)
S62514	Duplicate*	NA	NA	NA	NA	NA	NA	NA	< 500(<500	NA	NA
S62515	Spike	NA	NA	NA	NA	NA	NA	NA	2.5(2.5)	NA	NA
S62375	Spike	NA	NA	NA	NA	NA	NA	$(1.6x10^4)$	(10^4)NA	131(200)	NA
S62407	Spike	3.3(5)	3.3(5)	4.5(5)	7.3(5)	NA	NA	NA	NA	NA	NA
S62541	DW Spike	<0.5(0)	<0.5(0)	<0.5	<0.5(0)	NA	NA	NA	NA	NA	NA
S62542	DW Spike	0.42 (0.5)	0.5 (10.5)	0.58 (0.5)	1.5 (0.5)	NA	NA	NA	NA	NA	NA
S62543	DW Spike	0.75(1)	0.80(1)	1.4(1)	2.6(1)	NA	NA	NA	NA	NA	NA
S62544	DW Spike	2.0(2)	2.1(2)	3.5(2)	3.5(2)	NA	NA	NA	NA	NA	NA
S62545	DW Spike	5.1(5)	4.3(5)	6.1(5)	6.6(5)	NA	NA	NA	NA	NA	NA
S62546	DW Spike	8.8(10)	8.8(10)	11.9(10)	11.6(10)	NA	NA	NA	NA	NA	NA

* Expected value in parenthesis

Legend: NA = Not analyzed
#D.W. Spike = Distilled water spike

Table 9. Hanley Area
Sewer Sample Explosive Results (ug/l)

Sample	Sewer Location	2,4 DNT	2,6 DNT	TNT	Tetryl	PETN	NG	NC	Tetrazene	Styphnic Acid	HMX
S62512	428	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62513	430	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62514	432	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62515	434	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4
S62516	436	<0.5	<0.5	<1.2	<2.4	<9700	<9700	<9700	< 500	<50	<8.4

QUALITY CONTROL DATA* (ppb)

S63109	Blank	NA	NA	NA	NA	NA	NA	NA	NA	NA	<8.4(0)
S63102	Blank	NA	NA	NA	NA	NA	NA	NA	NA	NA	<8.4(0)
S63099	Spike Level	NA	NA	NA	NA	NA	NA	NA	NA	NA	39(40)
S63100	Spike Level	NA	NA	NA	NA	NA	NA	NA	NA	NA	75(80)
S62514	Duplicate*	NA	NA	NA	NA	NA	NA	NA	<500(<500)	NA	NA
S62515	Spike	NA	NA	NA	NA	NA	NA	NA	2.5(2.5)	NA	NA
S62375	Spike	NA	NA	NA	NA	NA	NA	$(1.6x10^4)(10^4)$	NA	131(200)	NA
S62407	Spike	3.3(5)	3.3(5)	4.5(5)	7.3(5)	NA	NA	NA	NA	NA	NA
S62541	DW Spike	<0.5(0)	<0.5(0)	<0.5	<0.5(0)	NA	NA	NA	NA	NA	NA
S62542	DW Spike	0.42 (0.5)	0.5 (10.5)	0.58 (0.5)	1.5 (0.5)	NA	NA	NA	NA	NA	NA
S62543	DW Spike	0.75(1)	0.80(1)	1.4(1)	2.6(1)	NA	NA	NA	NA	NA	NA
S62544	DW Spike	2.0(2)	2.1(2)	3.5(2)	3.5(2)	NA	NA	NA	NA	NA	NA
S62545	DW Spike	5.1(5)	4.3(5)	6.1(5)	6.6(5)	NA	NA	NA	NA	NA	NA
S62546	DW Spike	8.8(10)	8.8(10)	11.9(10)	11.6(10)	NA	NA	NA	NA	NA	NA

* Expected value in parenthesis

Legend: NA = Not analyzed
#D.W. Spike = Distilled water spike

Table 10. Hanley Area
Sewer Sample Heavy Metal Results (ug/l)

Sample #	Sewer #	Pb	Ag	Ni	Hg	Cr	Cd
S62507	428	230	<0.5	14	<0.4	<5.0	0.9
S62508	430	18	<0.5	115	<0.4	<5.0	<0.5
S62509	432	270	<0.5	14	<0.4	<5.0	1.2
S62510	434	190	<0.5	<10	<0.4	<5.0	3.3
S62511	436	<10	<0.5	<10	<0.4	<5.0	<0.5
		QUALITY CONTROL DATA* (ppb)					
S62507	Dupli.	220(230)	<.5(.5)	17(14)	<.4(.4)	<5(5)	1.1(.9)
S62510	Spike	330(340)	8.4(10)	49(50)	3.2(4)	96(100)	112(133)
Blank	-	<10(0)	<.5(0)	<10(0)	<.4(0)	<5(0)	<.5(0)
S.L. 1	-	17(5)	<.5(.5)	10(5)	<.4(.2)	5(5)	.7(.5)
S.L. 2	-	10(10)	.8(1)	8(10)	.4(.4)	10(10)	.9(1)
S.L. 3	-	19(20)	1.6(2)	**-(20)	.84(.8)	18(20)	1.9(2)
S.L. 4	-	45(50)	4.2(5)	55(50)	1.96(2)	47(50)	4.7(5)
S.L. 5	-	94(100)	8.5(10)	103(100)	3.36(4)	92(100)	9.4(10)

*Expected values in parentheses

**Sample lost in processing

APPENDIX E

ANALYTICAL METHODS AND QUALITY ASSURANCE DATA FOR THE GOODFELLOW US ARMY RESERVE CENTER SURVEY

1. Analytical Methods

a. Spot Spray Test Methods. Preliminary evaluation of the presence of selected explosives was conducted by spraying building surfaces with reagents which give positive color responses in the presence of certain explosive materials. These tests were conducted using the reagents listed in Table 1. The test for RDX, etc. was performed using two sprays in succession. The first spray reduced the nitrose groups in these explosives to nitrite while the second spray gave a positive response to the liberated nitrite. The second of these sprays was also used to obtain a measure of any background nitrite containing material which would contribute to a flow positive response to this test. Each spray was applied to different spots within a one-meter-square area, with a suitable interval between sprays to prevent mixing of spray materials on the building surface.

Table 1. Spray Tests for Selected Explosives

Munition	Indicating Reagent	Detection Limit $\mu g/cm^2$
TNT	A mixture of 1 percent 1,3 diphenylacetone plus 0.2 percent tetramethylammonium hydroxide in ethanol	0.4
RDX, NC, NG, PETN	(1) 10% Zinc dust in toluene (2) 0.35% each of procaine + N,N_2-dimethyl-napthylamine in 50% acetic acid	0.4
TNR,PbSty*	A mixture of 10% $SnCl_2 \cdot 2H_2O$ in 5% NaOH (filtered)	0.4
Tetrazene	The reaction products from 10%·NaOH, 10% $Na_2[Fe(NO)(CN_5)] \cdot 2H_2O$ and 10% K_3FeCN_6, mixed with an equal volume of acetone.	0.4

*PbSty = lead styphnate

b. Thin Layer Chromatography Methods. The analyses were conducted using Silica Gel plates (LK5DF) with a 15 percent butyl acetate in petroleum ether (bp 30-60C) developer and a series of visualization techniques. A list of the R_f values and visualization procedures is given in Table 2.

Table 2. TLC Parameters for Selected Explosives

Munition	R_f	Visualization Procedure	Detection Limit, µg/gm
TNT	0.92	Spray with 10% KOH in methanol	25
TNR, PbSty	0.0	Visualize in daylight and µv	25
NC NG PETN	0.0 0.76 0.90	Spray with modified Greiss reagent after heating at 105°C for 20 minutes.	50
RDX	0.09	Same as above after visualizing in µv light	50

All physical samples were weighed in 1.0 gram aliquots where sample size permitted and mixed in a sonic bath for 0.5 hour with 2 ml acetone. A 50 µl aliquot of this extract was then spotted on the TLC plate, the solvent allowed to evaporate, and the plate developed in a saturated tank for at least 15 min. The plate was then removed from the tank, air dried, and visualized sequentially according to the tests in Table 2. Quantitation was accomplished by comparison with known standards.

The determination of tetrazene was accomplished using a separate procedure. Because of the low organic solubility, it was not possible to operate sufficient loadings on the TLC plate to permit visualization and identification. Therefore, a swabbing procedure was employed in which the sample, acidified with 0.01 NHCl (to solubilize tetrazene), was allowed to soak into the Q-tip. The Q-tip was then sprayed with the appropriate visualization spray (see Table 1). This test was found to be very selective and sensitive for tetrazene in the presence of the other explosives.

c. HPLC Analysis. All high performance liquid chromatographic (HPLC) analyses were performed using Waters Model 6000A Solvent Delivery System a LDC UNIII Monitor, a DuPont Model 834 Automatic Sampler, and a Hewlett Packard 3385 data system.

Water Sample Preparation and Analysis. Water samples obtained during this study were stored at 4°C in amber-colored bottles fitted with aluminum foil-lined lids. Prior to preparation for analysis, each sample was allowed to warm to ambient temperature. These samples were then filtered in 50 ml aliquot, the residue rinsed with 1 ml acetone and buffered with 1.0 ml (pH = 7) phosphate buffer. A 5 ml aliquot was then withdrawn, spiked with 50 µl of 10.0 ppt m-nitrophenol in acetone (IS), and placed in a screw cap vial for subsequent HPLC analysis. Chromatographic conditions suitable for the separation and quantitation of TNR, RDX, TNT, NG, and PETN are described in Table 3.

Table 3. Operating Parameters for HPLC Analyses

Column	C_{18} reversed phase (Waters Radial System)	Compression Separation
Mobile Phase	40% CH_5CN/60% H_2O	50% CH_3CN/60% H_2O
Flow Rate	1.5 ml/min	1.5 ml/min
Detection Wavelength	254 nm	254 nm
Attenuation	0.128 AUFS	0.016 AUFS
Injection Volume	20 µl	20 µl
Column Pressure	1000 psig	900 psig
Column Temperature	Ambient	Ambient
N_{eff}	5000-7000 plates	5000-7000 plates

2. Quality Assurance

a. Analysis for Heavy Metals

(1) Lead Chromium and Cadmium

The quality assurance aspects of the inductively coupled plasma spectroscopy method used to determine lead, chromium, and cadmium were evaluated by determining the percent recovery of spiked samples. Recoveries from spiked acid swipe samples were Pb-83%, Cr-88%, and Cd-108%.

(2) Mercury

Quality assurance of the atomic adsorption method used for mercury analyses was also evaluated by determining recoveries from spiked samples. A sample was spiked with mercury and carried through the analytical procedure. Recovery from spiked mercury samples was 71 percent. Previous data is presented below.

(a) Precision Data for Lead, Chromium and Cadmium

Spike Mass (Micrograms)	Relative Standard Deviation of Measured Mass ($s/\bar{x}$)		
	Chromium	Cadmium	Lead
10	.113	.031	.107
20	.049	.063	.076
200	.069	.050	.053
1000	.082	.043	.043

(b) Precision Data for Mercury

Spike Mass (Micrograms)	Relative Standard Deviation of Measured Mass (s/x)
0.2	.104
0.4	.063
1.0	.056
3.0	.069

b. Analysis for Organics

(1) Quality Assurance Procedures for Spot Sprays. Each spray test series included a test for background nitrite, which may give false positive response for the NG, PETN, NC, and RDX tests. As no "blank" surface was apparent, no other "blank" samples could be run for these tests. However, at least once each day, the responsiveness of each spray was checked by spraying swabs which had been dipped in 0.012 percent solutions of the respective explosives. Such procedure constituted an analysis of "standard" samples.

(2) Quality Assurance Procedures for TLC Analyses. During the TLC analyses for the selected explosives, a series of blanks, standards, and spiked samples were routinely analyzed. Blank samples consisted of 2 ml acetone. Standard samples consisted of spiking known amounts of each explosive as a mixutre cuts the TLC plate. Also, a series of spiked samples were generated using a physical sample which had been analyzed previously and found to be free of munitions. Four one-gram aliquots were taken, spiked successively at the 25 ug/gm, 100 ug/gm, 500 ug/gm, and 0 ug/gm level, and analyzed by the procedures described above. The results of these snalyses confirmed the validity of our procedures for determining each compound in actual physical samples from SLOP.

(3) Quality Assurance Procedures for HPLC Analysis.

(a) Sample Integrity. All water samples were collected in glass jars equipped with tight-fitting, aluminum-foil-lined lids. All samples were stored at 4°C in separate facility from the analytical lab prior to their preparation for analysis.

(b) Instrument Calibration. The calibration of the LDC UVIII Monitor consisted of following manufacturer's recommended procedures for evaluation of short-term drift and noise. The detection cell was cleaned and rinsed with organic solvents and all mirrors and lenses realigned and cleaned or replaced as appropriate. The instrument was allowed to stabilize for 1 hour with an N_2 purge through the detector cell, and the drift and noise was evaluated. Output noise at 254 nm was less than 3×10^{-4} AU, with an attenuation x 0.0001 AuFS, as per specifications. Drift was less than 0.01 A per 24 hours under these conditions.

(c) Material. All organic solvents used in these analyses were distilled-in-glass grade obtained from Burdick and Jackson Laboratories, Muskegon, Michigan. Table 4 describes the authentic explosive standards used in this study and the sources from which they were obtained. TNT, RDX, and TNR were prepared as 5.0 ppt solutions in acetone while NG and PETN were prepared as their 20.0 ppt acetone solution. These stock solutions were stored at 4C throughout the study. As fresh

standard solution of these explosives were required, they were prepared from these stored stock solutions. Distilled water was used to prepare standard solutions and the chromatographic mobile phase for HPLC analysis. This water was obtained from a Millipore/Milli-Q water purification system.

Table 4. Sources of Explosives Reference Materials

Compound	Source
2,4,6-Trinitrotoluene (TNT)	Edgewood Arsenal, Edgewood, MD
2,4-Dihydroxy-1,2,5-trinitrobenzene (TNR)	Eastman Organic Chemicals, Rochester, NY
1,3,5-Trinitro-1,3,5-triazocyclohexane (RDX)	Edgewood Arsenal, Edgewood, MD
Pentaerythritol tetranitrate (PETN)	Sandia Laboratories, Albuquerque, NM
Trinitroglycerin (NG)	ICI American Inc., Wilmington, DE
m-Nitrophenol	Eastman Organic Chemicals, Rochester, NY
Tetrazene	Olin Corp., East Altan, IL
Lead Styphnate (normal) (PbSty)	Olin Corp., East Altan, IL

These stock solutions were examined by HPLC chromatography for the presence of impurities, by injecting 20 µg of TNT, TNR, and RDX and 100 µg of PETN and NG. In this manner an impurity present at or above the 1 percent level would have been observed assuming any such material had a uv extinction coefficient similar to that of the parent compound. No single such species was observed although several such materials may have been present in trace amounts and whose total percentage in the standard solution could not be determined using these techniques.

Additionally, nuclear magnetic resonance (NMR) and infrared spectroscopy (IR) were used to evaluate these materials for the presence of impurities. These examinations were conducted on 10 mg portions of each standard such that a 1 percent impurity would be present at the 100 µg level. However, such an examination is not suitable for determining any impurities which have similar resonating or absorbing frequencies or extremely small "response factors."

(d) Standard Curves. Standard curves were constructed from solutions of six different concentrations of each explosive in 100 µg/ml m-nitrophenol solution. Each explosive was prepared as a stock solution in acetone from which the standard solutions were generated by combining appropriate amounts of these stock solutions in a single vial. The analytes were divided into two groups corresponding to their common methods of HPLC analysis (i.e., TNT, TNR, and RDX, and NG and PETN). Hence, six separate solutions were prepared containing TNR, RDX, and TNT at each of the six concentrations. Appropriate amounts of each stock solution were combined in a single vessel with 500 µg of m-nitrophenol and the mixture diluted to 5 ml with water. Similarly, PETN and NG standard solutions were prepared in 3 ml acetone containing 500 µg of m-nitrophenol and diluted to 5 ml with water. Each of the above six concentrations were replicated four times.

Standard curves were generated by single injection of each of the 24 vials obtained from the above procedure. Detection limits were determined from such curves using the methods of Hubaux and Vos. The instrumental detection limit for TNR, RDX, and TNT was selected* at 10 µg/ml and at 40 µg/ml for PETN and NG.

(e) Accuracy and Precision. Once each analytical method was selected, the accuracy of these methods was evaluated in the following manner. Spiked water samples were analyzed in replicates of four at each of several concentrations based on the instrumental detection limit for each analyte. These spiked samples were prepared at 1/2 DL, DL, 2DL, 5DL--to the upper limit of reportable data for each method. DL for water samples was taken as the instrumental detection limit since these samples required essentially no dilutions or concentration prior to analysis. For a complete description of the sample preparation and analysis procedures, see the preceding sections of this report.

The accuracy and precision of the HPLC analysis method was determiend at the detection limits of each compound where:

$$\text{Inaccuracy} = \frac{\bar{x} - \text{target}}{\text{target}} = (\text{fraction recovered}) - 100$$

and

$$\text{Imprecision} = \frac{s}{\bar{x}} \quad .$$

The inaccuracy for TNR, RDX, and TNT was less than 0.50 and the imprecision was greater than 0.20 percent at 10 ppm. These values were less than 0.90 and 0.30 for NG and PETN at 40 ppm. The accuracy and precision improved dramatically at concentrations above the detection limits. However, since all samples analyzed contained analyte levels below the detection limit, only the above values are reported for these analyses.

(f) Blanks, Spiked Blanks, and Standard Solutions. Once the accuracy and precision of each of these analytical methods were verified, the continued performance of these sample preparation and analysis procedures was monitored by examining blank and spiked blank samples. Such samples were prepared and analyzed with every group of 10 or less water and soil samples. Blank water samples were generated in the laboratory and consisted of aliquots of distilled water. Blank water samples were spiked by injecting 50 ml blank water with either 50 µl each of 5.0 mg/ml solutions of TNR, RDX, and TNT or with 100 µl each of 20 mg/ml solutions of PETN and NG.

The validity of the standard curves determined for each explosive was monitored regularly by analyzing standard solutions with every set of samples analyzed. The concentration of these standard solutions was determined and if these concentrations deviated by more than 10 percent of their known values, new standard curves were constructed.

---

*Actual method values were slightly less than these values and varied between compounds. A round number to represent detection limits was selected for convenience.

(g) Evaluation of Auto-Sampler. An evaluation was made of the reproducibility of the injections made by the auto-sampler used in these analyses. Seven LC vials were filled from a solution containing 100 µg/ml of TNT and 100 µg/ml IS. These vials were then analyzed with 3 injections per vial to yield a total of 21 injections of this solution. The peak areas of each explosive were then measured and the average and standard deviation obtained. However, because of the known poor reproducibility of injections in HPLC, the method of internal standards was chosen for quantitation of all analytes in this study. Consequently, the peak area ratio of analyte to IS was also determined for these 21 injections and the corresponding average and standard deviation calculated. Similarly, a 400 µg/ml solution of NG was evaluated. The results of these evaluations are given in Table 5, where it is seen that good reproducibility (i.e., precision which equals $S/\bar{x}$) is achieved when peak area ratios are determined.

Table 5. Reproducibility of Automatic Injector

Analyte	Avg. Peak Area	S	$S/\bar{x}$	Avg. Peak Area Ratio	S	$S/\bar{x}$
TNR	54,990	8742.3	0.16	0.50836	0.0153	0.03
RDX	83,657	11844.0	0.14	0.73955	0.0161	0.02
TNT	155,200	24016.0	0.16	1.43610	0.0380	0.03
NG	15,612	1394.9	0.09	0.12490	0.0112	0.09

APPENDIX F

ANALYTICAL METHODS AND QUALITY ASSURANCE DATA FOR THE HANLEY AREA SURVEY

Method No. 1

Revised December 18, 1980

DETERMINATION OF HMX ON BUILDING SURFACES

I. Application: This method is used to semiquantitatively determine the concentration of HMX (1,3,5,7-tetranitro-1,3,5,7-tetracyclo-octane) on building surfaces. It is primarily designed as a screening technique, not a quantitative method.

A. Tested Concentration Range.- The concentration range analyzed is 0.006 $\mu g/cm^2$ to 0.15 $\mu g/cm^2$ on building surface.

B. Sensitivity Limits - The signal to noise ratio was 11:1 for 2 ng injected of HMX.

At the Detection limit,
1 ng of HMX = 1.4×10^{-4} AU

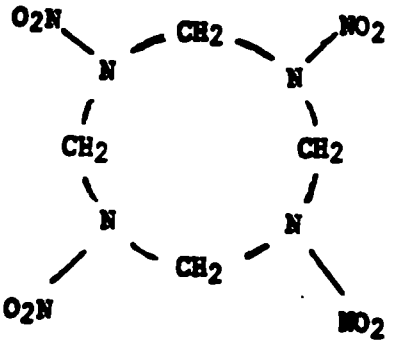
C. Detection Limits - Employing the method of Hubeaux and Vos, the detection limit for HMX in water was determined to be 8.0 $\mu g/\ell$ (lowest level std.) which correspond to 0.0063 $\mu g/cm^2$.

D. Interferences - Components which elute with the same retention time as HMX and absorb UV light (254 nm) will interfere.

E. Analysis Rate - Approximately twenty samples can be analyzed by a worker in an 8 hour day after instrument calibration.

II. Chemistry

Potential explosive, toxic inhalation and skin absorption hazards exist. Chemical structure for HMX:



Alternate nomenclature - cyclotetramethylene tetranitramine; 1,3,5,7-tetranitrol-1,3,5,7-tetracyclooctane; homocyclonite

CAS RN # - 479-45-8

Melting point - 276-7°C

Boiling point - 337°C (explodes)

III. APPARATUS

A. Instrumentation - An Altex Model 100A pump equipped with an Altex Model 420 microprocessor. An LDC UV III Monitor (1203) detector, a Rheodyne Model 7120 injection valve with a 100 µl loop, and a Varian Model 9176 recorder. A Spectra Physics SP 4000 data system.

B. HPLC Parameters -

1. Column: Spherisorb 5 micron ODS, 250x4.6 mm.
2. Mobile Phase: Acetonitrile/water, 40/60, v/v.
3. Flow: 1 ml/min.
4. Temperature: 25°C.
5. Detector wavelength and sensitivity: 254 nm, 0.004 AUFS.
6. Recorder Span: 10 mv/full scale.
7. Injection volume: 100 µl.
8. Retention time for HMX: 9.8 minutes.

C. Hardware/Glassware -

1. Microspatula.
2. 5, 50, 100, 250 ml volumetric flasks.
3. 4 ounce bottles with Teflon lined screw caps.
4. 2 dram vials with Teflon lined screw caps.
5. Pasteur pipets (5 3/4") and bulbs.
6. 5 ml pipet and bulb.
7. Millipore solvent filtering apparatus.
8. Millipore filters, 0.45µ, type HA, 47 mm.
9. 100 µl Hamilton syringe.
10. Refrigerator and freezer.
11. Cotton swabs (Q-tips).

D. Chemicals -

1. Acetone, DIG grade, Burdick and Jackson.
2. Millipore, Milli-Q purified water.

IV. STANDARDS

A. Calibration Standards -

Stock. Ten milligrams of HMX are transferred to a 50 ml volumetric flask. The flask is diluted to the mark with acetone and mixed well.

V. PROCEDURE

A. Sample Collection and Preparation - Place 1.5 milliliters of acetone in a 2 dram vial. Mark a one meter square area on the surface to be sampled. Using cotton swabs (Q-tips) wetted with

acetone to swab five 20 square centimeter areas within the marked area. Place the swabs in the vial, cap tightly, and return to the laboratory for analysis.

Place 100 µl of the acetone extract in a five milliliter volumetric flask and dilute to volume with distilled water. Mix well, place in a screw capped 2-dram vial and store refrigerated until analyzed.

B. Calibration - Inject 100 µl of each standard two times onto the chromatographic system. A solvent blank, represented by distilled water, is also analyzed. Record the concentration, retention time and peak height for HMX. Average the peak heights for the duplicate injections of each standard.

C. Analysis - Inject 100 µl of each diluted sample onto the chromatographic system. Record the retention time and peak height for peaks eluting at the same time as HMX (within 0.1 minute of the HMX standard).

VI. CALCULATIONS

A linear regression curve (concentration vs. peak height) is generated from the HMX calibration data. The diluted sample concentrations are interpolated using the curve.

The relationship between diluted extract concentration and concentration on building surface is:

$$\mu g/cm^2 = \frac{\mu g/l \text{ in diluted extract}}{1330}$$

VII. REFERENCE

1. Battelle method "Determination of HMX in Water".

Spiked Recovery Data for Water (from reference 1)

HMX in Water

N	Target Value ng/ml	Found Value ng/ml			
4	8.0	7.5	7.5	7.5	7.5
4	20	19	19	20	20
4	40	41	39	47	37
4	80	79	76	80	76
4	200	193	193	191	191

DETERMINATION OF Hg, Cd, Ag, Ni, Cr AND Pb BY ATOMIC ABSORPTION SPECTROMETRY

I. Application

The method is used for the determination of Hg, Cd, Ag, Ni, Cr, and Pb in water and on filter papers.

A. Tested Concentration Range:

The concentration range for each metal is:

	In Solutions (ppb)	In Filter Mixes ($\mu g/m^2$)
Hg	0.2 - 4.0	0.2 - 4.0
Cd	0.5 - 10.0	25 - 500
Ag	0.5 - 10.0	0.5 - 10.0
Ni	5.0 - 100	2.5 - 50
Cr	5.0 - 100	2.5 - 50
Pb	5.0 - 100	2.5 - 50

B. Sensitivities: N/A

C. Detection Limits:

	In Solutions (μg/ℓ)	In Filters (μg/m^2)
Hg	0.90	0.20 (lowest std)
Cd	0.54	27.
Ag	0.50 (lowest std)	1.1
Ni	17.	10.
Cr	5.0 (lowest std)	6.1
Pb	7.2	6.3

D. Interferences: Possible interference of sulfide or sulfite with the Hg determination avoided by oxidation of the samples and the use of a silver wool collector. The use of a background corrector for the determination of the other metals is effective for most interferences.

E. Analysis Rate:

Flame Excitation--35 determinations per day including sample preparation.

Graphite Furnace Excitation--25 determinations per day including sample preparation.

Mercury--15 determinations per day including sample preparation.

II. Chemistry

In direct aspiration atomic absorption spectroscopy a sample solution containing the metals in ionic form is aspirated and atomized in a flame. Free unexcited ground state atoms are formed in the flame and absorb light energy from a hollow cathode lamp whose cathode is made of the element being determined. Since the wavelength of the light beam is characteristic of only the metal being determined, the light energy absorbed is a measure of the concentration of that metal in the sample.

The principle involved in the furnace technique is essentially the same as with direct aspiration except a furnace, rather than a flame, is used to atomize the sample. As a greater percentage of available analyte atoms are vaporized and dissociated for absorption in the tube than in the flame, the use of small volumes or detection of low concentrations of elements is possible.

To determine mercury all forms of mercury are converted to mercuric ions by proper digestion. The mercuric ions in the sample solution are reduced to the elemental state, purged from the solution and passed through an optical absorption cell positioned in the light path of an atomic absorption spectrometer. The absorption of radiation at 253.7 nm from a mercury vapor lamp is measured, providing a measure of mercury concentration in the sample.

III. Apparatus

A. Instrumentation:

Mercury

- Perkin-Elmer Model 305B atomic absorption spectrophotometer equipped with a mercury hollow cathode lamp.
- Absorption cell. A cylindrical tube with quartz windows approximately 25 mm ID and 150 mm long with an inlet and outlet sidearms, the inlet having a 12/5 female ball joint. The cell is mounted in the optical path of the atomic absorption spectrophotometer.
- Collector tubes constructed of 7 mm Pyrex tubing, 10 cm long with 12/5 male and female ball joints on each end, respectively. Each is wound with 100 cm of 22-gage chromel A wire and loaded with 0.7 gram of silver wool.
- Mercury reduction apparatus. The reaction vessel is a 150 ml gas-washing bottle with a fritted glass bubbler tube. The outlet tube is fitted with a 12/5 male ball joint. Nitrogen is used as the purging gas and it flows through an activated charcoal trap, a flowmeter, and on into the inlet tube of the reaction vessel. A by-pass circuit for the nitrogen is provided to by-pass the reaction vessel after the mercury has been released from solution and collected on the silver wool.
- Strip-chart recorder.
- Variac controller - 5 amp.
- Compressed nitrogen gas.

Cadmium, Silver, Nickel, Chromium, and Lead

- Perkin-Elmer Model 5000 atomic abosrption spectrophotometer equipped with the proper hollow cathode lamp, background corrector, automated sample injector, HGA 500 graphite furnace and stripchart recorder.

B. Atomic Absorption Parameters:

	Hg	Cd	Ag	Ni	Cr	Pb
Wavelength (nm)	253.7	228.8	328.1	232.0	357.9	283.3
Slit Width (nm)	0.7	0.7	0.7	0.2	0.7	0.7
Light Source	←Hollow Cathode Lamps→					
Excitation	--	A/A	A/A	A/A	N/A	A/A

A/A = Air/acetylene

N/A = Nitrous oxide/acetylene

HGA Excitation Parameters

	Cd	Ag	Ni	Cr	Pb
Drying Temp °C	100	100	100	100	100
Char Temp. °C	400	400	1000	1100	700
Atomization Temp. °C	2200	2600	2700	2700	2300
Internal Flow (ml/min)	80	80	40	200	100

C. Hardware/Glassware

500-ml beakers with cover glasses

250-ml beakers with cover glasses

250-ml Erlenmeyer flasks with cover glasses

10-ml volumetric flasks

25-ml volumetric flasks

100-ml volumetric flasks

1-liter volumetric flasks

Eppendorf pipets

Glass pipets

D. Chemicals:

- Sulfuric acid, concentrated--reagent grade.
- Perchloric acid (60 percent)--reagent grade.
- Nitric acid, concentrated--special reagent grade of low Hg content.
- Hydrochloric acid, concentrated--reagent grade.
- Stannous Chloride--dissolve 20 g of $SnCl_2 \cdot 2 H_2O$ in 20 ml of concentrated HCl and dilute to 100 ml with deionized water.
- Hydroxlamine Hydrochloride (10 percent)--dissolve 10 g of hydroxylamine hydrochloride in water and dilute to 100 ml.
- Potassium Permanganate (5 percent)--dissolve 50 g of $KMnO_4$ in water and dilute to 1 liter.
- Potassium Persulfate (5 percent)--dissolve 5 g of potassium persulfate in 100 ml of water.
- Stock Solutions--Fisher Scientific Certified Standards--1000 µg/ml for each metal.
- Iodine Monochloride Solution (1 M Stock)--add 444 ml concentrated HCl to 444 ml of a 25 percent (W/v) potassium iodide solution, cool and add 75 g of potassium iodate with stirring. Cool and dilute to 1 liter with water.
- Iodine Monochloride Solution (0.1 M)--dilute 100 ml of the stock solution to 1 liter with water and mix well.
- Sodium Hydroxide Solution (20 percent)--dissolve 20 g of NaOH in 100 ml water.
- Hydrogen Peroxide (30 percent)--reagent grade.

E. Reagents: None

IV. Standards

A. Calibration Standards:

1. Stock. Fisher Scientific Certified standard solutions containing 1000 µg metal/ml.

2. Working:

10 ppm solution - 1.0 ml of stock solution diluted to 100 ml.

1.0 ppm solution - 10 ml of 10 ppm solution diluted to 100 ml.

0.1 ppm solution - 10 ml of 1.0 ppm solution diluted to 100 ml.

Blank - 5 ml conc. HNO_3 diluted to 100 ml.

B. Control Spikes:

Spiked solutions of Pb, Ni, and Cr were prepared by adding 0.05, 0.1, 0.2, 0.5 and 1.0 ml of their 10 ppm solutions to 100 ml of water to provide concentrations of 5, 10, 20, 50, and 100 ppb. Spiked solutions of Ag and Cd were prepared by adding 0.05, 0.1, 0.2, 0.5 and 1.0 ml of their 1.0 ppm solutions to 100 ml to provide concentrations of 0.5, 1.0, 2.0, 5.0, and 10 ppb. Spiked solutions of Hg were prepared by adding 0.05, 0.1, 0.2, 0.5, and 1.0 ml of the 0.1 ppm Hg solution to 25 ml providing concentrations of 0.2, 0.4, 0.8, 2.0 and 4.0 ppb.

Spiked filter samples of Pb, Ni, and Cr were prepared by adding 0.25, 0.5, 1.0, 2.5 and 5.0 ml of the 10 ppm solutions to a filter paper to provide concentrations of 2.5, 5.0, 10, 25, and 50 µg/square meter. Spiked filter samples of Ag were prepared by adding 0.5, 1.0, 2.0, 5.0, and 10.0 ml of the 1 ppm solution to a filter paper to provide concentration of 0.5, 1.0, 2.0, 5.0, and 10.0 µg/square meter. Concentration of 25, 50, 100, 250, and 500 µg Cd/square meter were obtained by adding 2.5, 5.0, 10.0, 25.0, and 50.0 ml of the 10 ppm standard solution to a filter paper. Mercury standards of 0.2, 0.4, 0.8, 2.0, and 4.0 µg/square meter were prepared by adding 1.0, 2.0, 4.0, 10.0, and 20.0 ml of the 0.1 ppm standard solution to one half of a filter paper.

V. Procedures:

A. Sample Preparation:

Mercury

Aqueous Samples

Transfer 25 ml of liquid sample to a 250 ml Erlenmeyer flask. Add 2.5 ml of concentrated H_2SO_4 and 1.3 ml of concentrated HNO_3, mixing after each addition. Add 7.5 ml of potassium permanganate solution, stir

and add additional solution if the permanganate color does not persist. Prepare a blank solution using the same amount of reagent. Add 4.0 ml of potassium persulfate solution after about 15 minutes and heat on a steam bath for two hours. Remove from the steam bath and allow the solution to cool.

Filters

Transfer the filter sample to a 250 ml beaker, add 50 ml of 0.1 M iodine monochloride solution and allow to stand for at least two hours with occasional stirring.

Silver, Lead, Chromium, Nickel and Cadmium

Aqueous Samples

Transfer 100 ml of sample to a 150 ml beaker. Add 3.0 ml of concentrated HNO_3 and 5.0 ml of H_2O_2 (30%). Digest on the hot plate until the volume is reduced to about 40 ml. Cool, transfer to a 50 ml volumetric flask and dilute to volume with water.

Filters

Transfer the composited filter sample to a 500 ml beaker, add 70 ml of concentrated HNO_3 and digest on the hot plate for about two hours. Add 5 ml of perchloric acid (60%) and evaporate to fumes. Fume for about 5 minutes, cool and dilute with water to 50 ml in a volumetric flask.

B. Calibration:

Mercury

Standardize the mercury system by carrying aliquots of the working standard solution containing 0.05, 0.10, 0.15 and 0.20 µg of mercury through the procedure. This is accomplished by adding 0.50, 1.0, 1.5, and 2.0 ml of the working standard solution directly to the reaction flask, diluting to 125 ml with water and proceeding with the reduction, aeration and atomic absorption measurement. (Note: The range of standardization may be extended to 0.30 µg of mercury if necessary). Prepare a calibration curve by plotting peak height versus µg of mercury.

Silver, Lead, Chromium, Nickel, Cadmium

The working calibration standards in Section 4.a. are introduced manually into the flame or by the automatic sample injector into the graphite

furnace. By proper programming the calibration data are stored in the minicomputer system of the atomic absorption spectrometer.

C. Analysis:

Mercury

Attach a collector tube to the outlet tube of the mercury reduction apparatus (reaction flash) and adjust the stop cock to direct the carrier gas flow through the reduction apparatus. Attach the tube from the nitrogen gas supply to the inlet tube.

Add hydroxylamine hydrochloride solution with a medicine dropper to the sample solution until the pink color disappears and then add 1 ml excess. Transfer the solution (which contains 25 ml of the original liquid sample) to the reaction vessel, washing out the Erlenmeyer flask with deionized water and adding the washings to the solution. Dilute the solution to 100-125 ml with deionized water, add 10 ml of stannous chloride solution, and attach to the scrubbing system. Pass nitrogen gas through the system at about 700 ml per minute for two minutes. Adjust the stopcock to the by-pass position, attach the collector tube to the absorption cell and flush with nitrogen gas for one minute.

Plug the Variac controller into the 110 volt line, adjust the Variac setting to 19-20, and attach the leads from the Variac controller to the resistance wiring on the collector tube. Turn on the current, and thermally release the amalgamated mercury until the recorded peak on the strip recorder returns to the base line (usually 15-20 seconds). Turn off the current, remove the collector tube from the absorption cell, and prepare for the next run.

Measure the peak height response obtained from the sample and determine the amount of mercury present by referring to the calibration curve. Correct this result by subtracting the amount of Hg found in a reagent blank carried through the whole procedure.

For the reagent blank, transfer 10.0 ml of the iodine monochloride solution used to prepare filter samples to the reaction vessel. Dilute to about 100 ml with water, and 5 ml of sodium hydroxide solution (20%), reduce with hydroxylamine hydrochloride and proceed as described for water solutions.

Silver, Lead Chromium, Nickel and Cadmium

Aspirate the sample solutions contained in the 50 ml volumetric flasks into the flame of the Perkin-Elmer Model 5000 atomic absorption spectrometer. Use the automatic sample injector to introduce samples into the graphite furnace if this mode of excitation is being used. The

instrument will automatically compare the response obtained from samples with the stored calibration data and will provide a measurement of concentration on a print-out tape.

VI. Calculations:

Mercury

$$\text{Concentration in Water (ppb)} = \frac{(A-B)}{V \times 1000}$$

where

A = µg found in sample aliquot

B = µg found in blank sample

V = volume of sample analyzed (ml) - 25 ml for Hg

$$\text{Filters } (\mu g/m^2) = \frac{(A - B) \times V_1}{V_2 \times F \times S}$$

where

A = µg found in the aliquot portion of the sample solution analyzed

B = µg found in the blank sample aliquot

V_1 = volume of sample solution (ml) - normally 50 ml

V_2 = volume of aliquot analyzed (ml) - normally 25 ml

F = fraction of one whole filter used as sample (normally 0.5)

S = area swiped (m^2) - normally 1

Other Metals

$$\text{Concentration in water } (\mu g/\ell) = \frac{(C_A - C_B)}{2} \times 1000$$

$$\text{Amount on filter } (\mu g/m^2) = \frac{(C_A - C_B) \times 50}{F \times A}$$

where

C_A = Concentration (μg/ml) in digested sample

C_B = Concentration (μg/ml) in blank

F = Fraction of filter analyzed (normally 0.5)

A = area swiped (m^2) - normally 1.

VII. References:

Long, Scott, and Thompson, "Atomic Absorption Determination of Elemental Mercury Collected from Ambient Air on Silver Wool", Anal. Chem. 45, 2227 (1973).

D. L. Chase, D. L. Sgontz, E. R. Blosser, and W. M. Henry, "Summary Report on Development and Evaluation of an Analytical Method for the Determination of Total Atmospheric Mercury", NTIS No. PB-210822, 59 (1972).

Methods for Chemical Analysis of Water and Wastes, Environmental Monitoring and Support Laboratory, Office of Research and Development, EPA Cincinnati, Ohio, March 1979 Edition, Method 245.1.

Analytical Methods for Atomic Absorption Spectrophotometry, Perkin-Elmer, September 1976.

Analytical Methods Using the HGA Graphite Furnace, Perkin-Elmer, March 1977.

Spike Recovery Data

A. Water

Concentration (µg/liter)											
Ag		Pb		Cr		Ni		Cd		Hg	
Spiked	Found	Spiked	Found	Spiked	Found	Spiked	Found	Spiked	Found	Spiked	Found
0	ND	0	ND	0	ND	0	ND	0	ND	0	ND
0.5	0.3	5	7	5	5	5	10	0.5	0.7	0.2	ND
1.0	0.8	10	10	10	10	10	8	1.0	0.9	0.4	0.3
2.0	1.6	20	19	20	18	20	(lost)	2.0	1.9	0.8	0.8
5.0	4.2	50	45	50	47	50	55	5.0	4.7	2.0	2.0
10	8.5	100	94	100	92	100	103	10	9.4	4.0	3.4

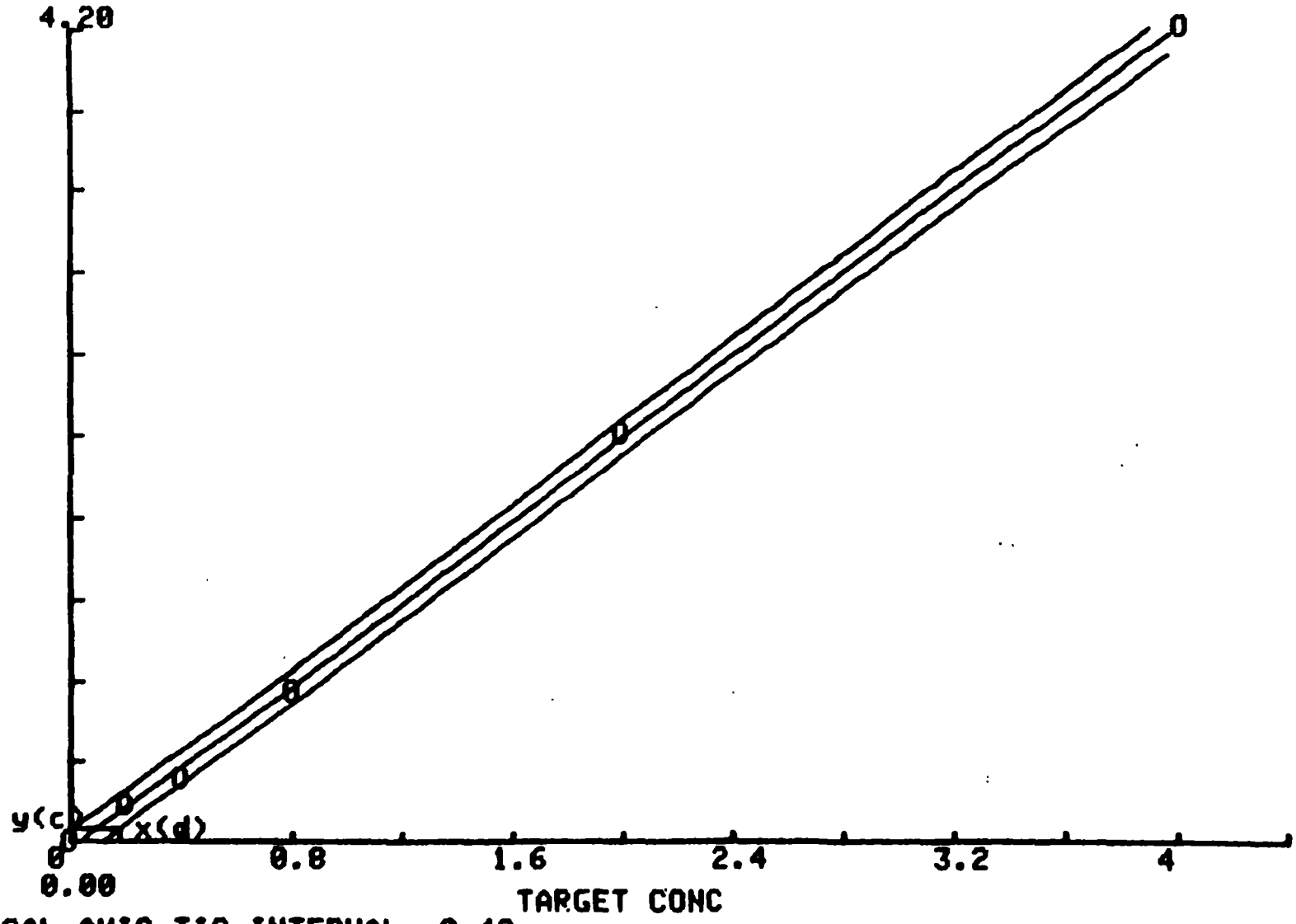
B. Filters

Concentration (µg/liter)											
Ag		Pb		Cr		Ni		Cd		Hg	
Spiked	Found	Spiked	Found	Spiked	Found	Spiked	Found	Spiked	Found	Spiked	Found
0	ND	0	ND	0	ND	0	ND	0	ND	0	ND
0.5	ND	2.5	6	2.5	ND	2.5	ND	25	25	0.2	0.19
1.0	1.1	5	8	5	6	5	8	50	50	0.4	0.33
2.0	2.0	10	12	10	12	10	14	100	100	0.8	0.79
5.0	5.2	25	27	25	27	25	27	250	246	2.0	2.1
10	10.2	50	53	50	56	50	55	500	520	4.0	4.2

MERCURY ON FILTERS
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/M2	Day 1 Found Conc. UG/M2	Day 2 Found Conc. UG/M2	Day 3 Found Conc. UG/M2	Day 4 Found Conc. UG/M2
0.00	0.00			
0.20	0.19			
0.40	0.33			
0.80	0.79			
2.00	2.10			
4.00	4.20			

MERCURY ON FILTERS
1
FOUND CONC



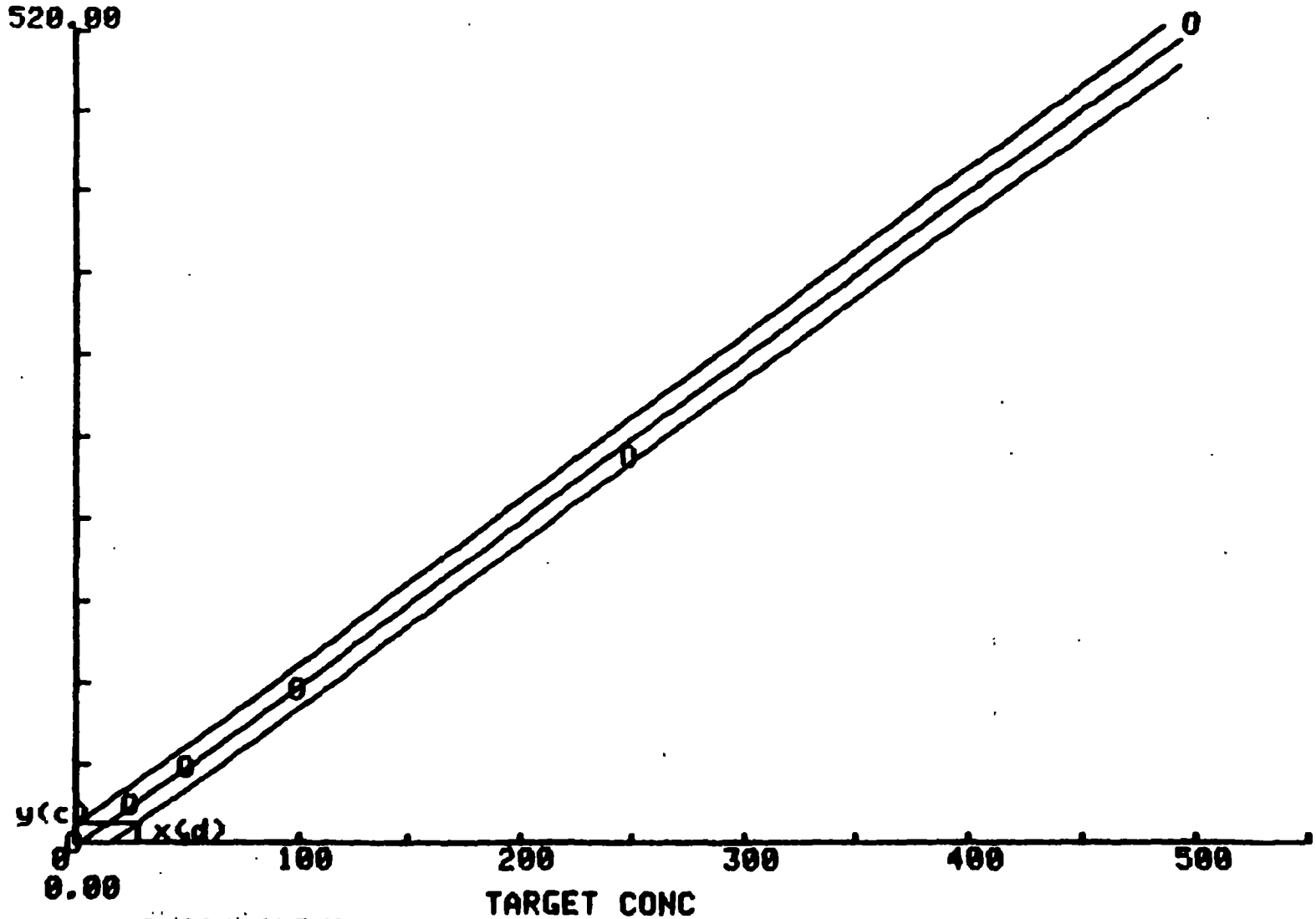
VERTICAL AXIS TIC INTERVAL= 0.42

```
MERCURY ON FILTERS
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 1.23333333333  SD= 1.53057723316

FOUND CONC
MEAN= 1.26833333333  SD= 1.62278053558

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.0390210586227
SLOPE= 1.06001707456
R= 0.99978892124
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.00138949914636
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.0514634962259
x(d)= 0.169620741708
```

CADMIUM ON FILTERS
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/M2	Day 1 Found Conc. UG/M2	Day 2 Found Conc. UG/M2	Day 3 Found Conc. UG/M2	Day 4 Found Conc. UG/M2
0.00	0.00			
25.00	25.00			
50.00	50.00			
100.00	100.00			
250.00	246.00			
500.00	520.00			

CADMIUM ON FILTERS
1
FOUND CONC



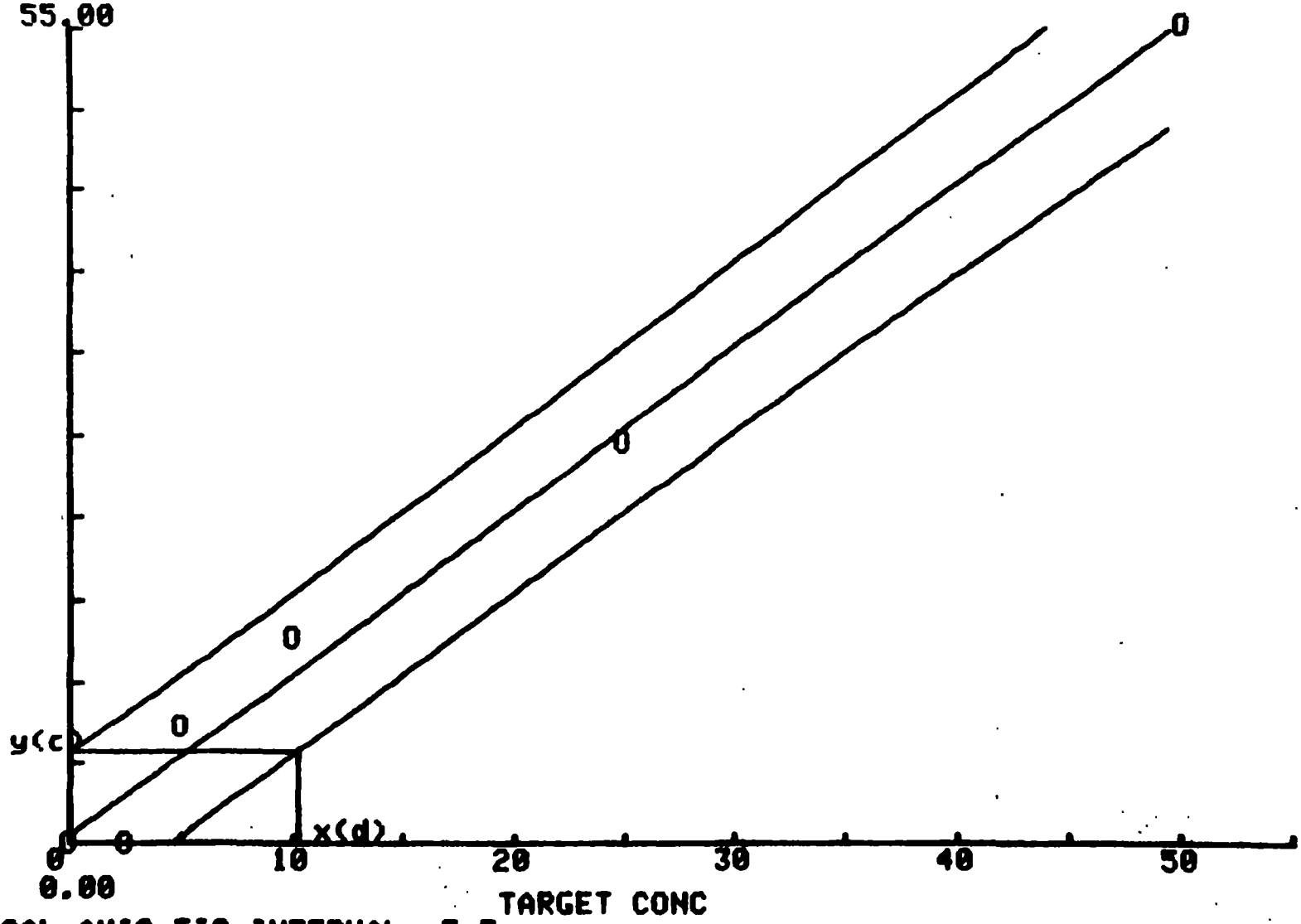
VERTICAL AXIS TIC INTERVAL= 52

```
CADMIUM ON FILTERS
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 154.166666667  SD= 191.322154145

FOUND CONC
MEAN= 156.833333333  SD= 198.222518062

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -2.83665338645
SLOPE= 1.03569721116
R= 0.999643347375
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 35.0278884472
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 11.5298900739
x(d)= 27.5150511892
```

NICKEL ON FILTERS
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/M2	Day 1 Found Conc. UG/M2	Day 2 Found Conc. UG/M2	Day 3 Found Conc. UG/M2	Day 4 Found Conc. UG/M2
0.00	0.00			
2.50	0.00			
5.00	8.00			
10.00	14.00			
25.00	27.00			
50.00	55.00			

NICKEL ON FILTERS
1
FOUND CONC



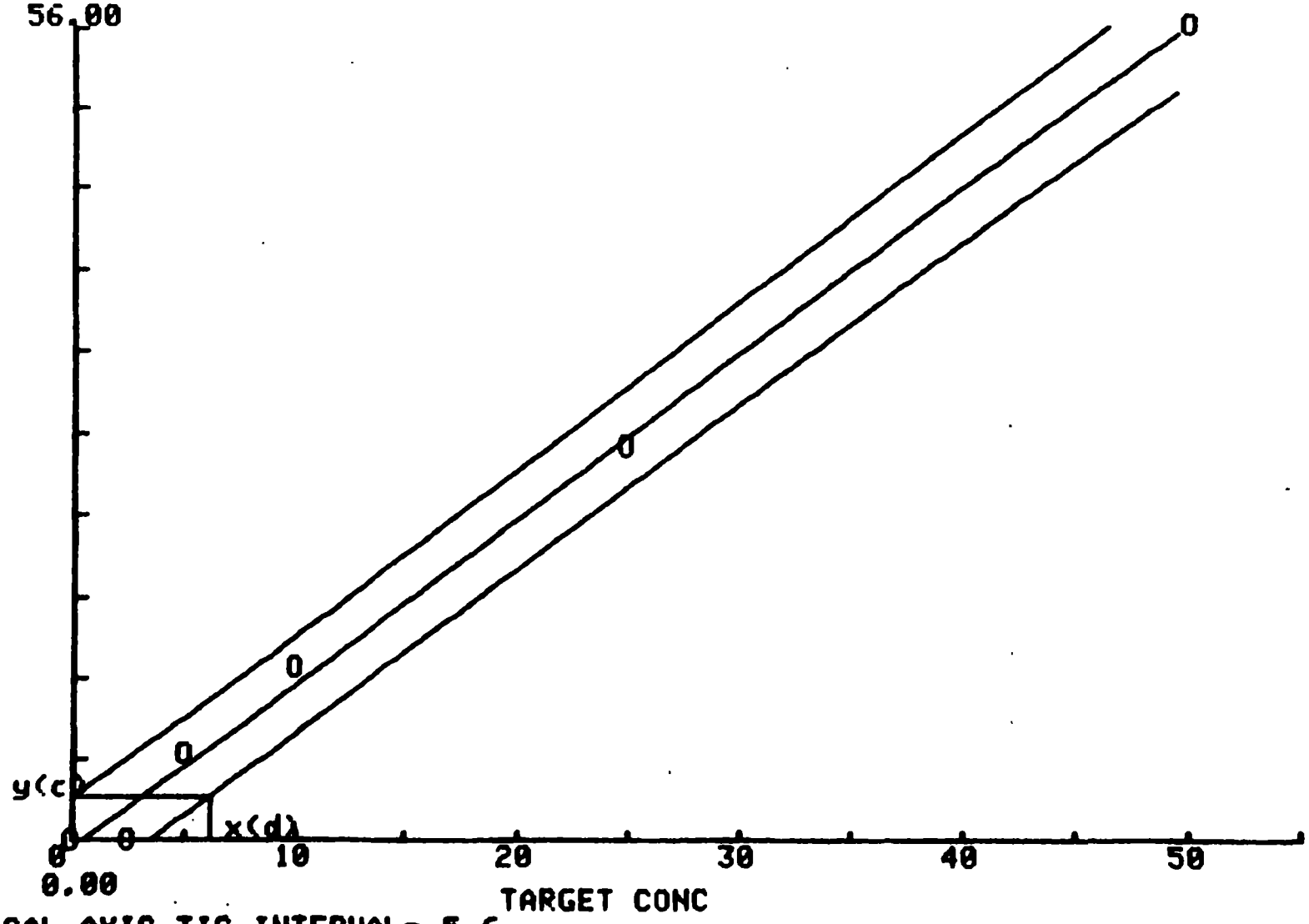
VERTICAL AXIS TIC INTERVAL= 5.5

```
NICKEL ON FILTERS
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 15.4166666667  SD= 19.1322154145

FOUND CONC
MEAN= 17.3333333333  SD= 21.0301371053

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.472396129767
SLOPE= 1.0936824132
R= 0.994980081191
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 5.53642572568
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 6.18402593202
x(d)= 10.207739712
```

TOTAL CHROMIUM ON FILTERS
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/M2	Day 1 Found Conc. UG/M2	Day 2 Found Conc. UG/M2	Day 3 Found Conc. UG/M2	Day 4 Found Conc. UG/M2
0.00	0.00			
2.50	0.00			
5.00	6.00			
10.00	12.00			
25.00	27.00			
50.00	56.00			

TOTAL CHROMIUM ON FILTERS
1
FOUND CONC



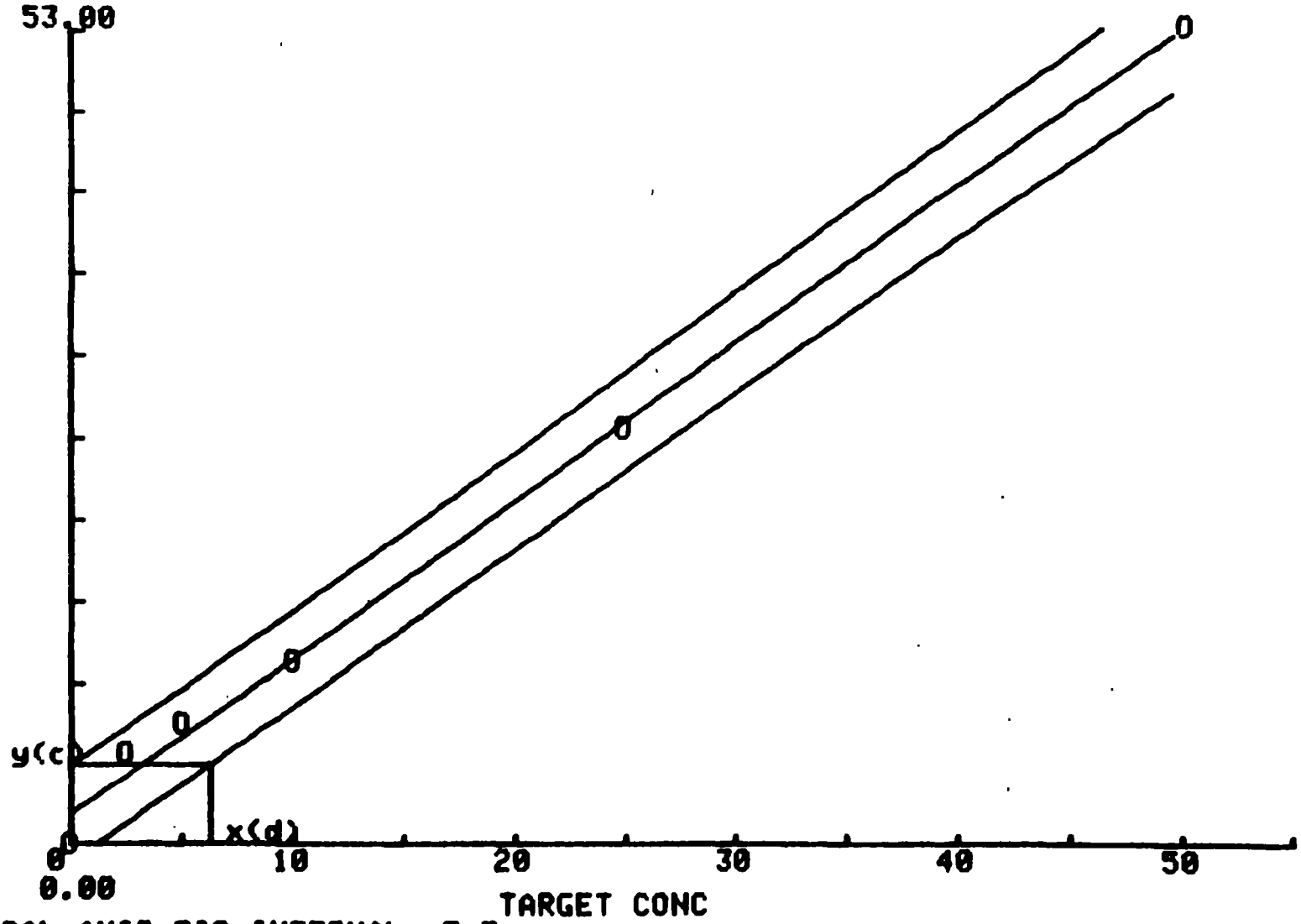
VERTICAL AXIS TIC INTERVAL= 5.6

```
TOTAL CHROMIUM ON FILTERS
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 15.4166666667  SD= 19.1322154145

FOUND CONC
MEAN= 16.8333333333  SD= 21.6556382189

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.585657370518
SLOPE= 1.12988047809
R= 0.998221178287
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 2.08366533866
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 2.9183038876
x(d)= 6.10213883257
```

LEAD ON FILTERS
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/M2	Day 1 Found Conc. UG/M2	Day 2 Found Conc. UG/M2	Day 3 Found Conc. UG/M2	Day 4 Found Conc. UG/M2
0.00	0.00			
2.50	6.00			
5.00	8.00			
10.00	12.00			
25.00	27.00			
50.00	53.00			

LEAD ON FILTERS
1
FOUND CONC

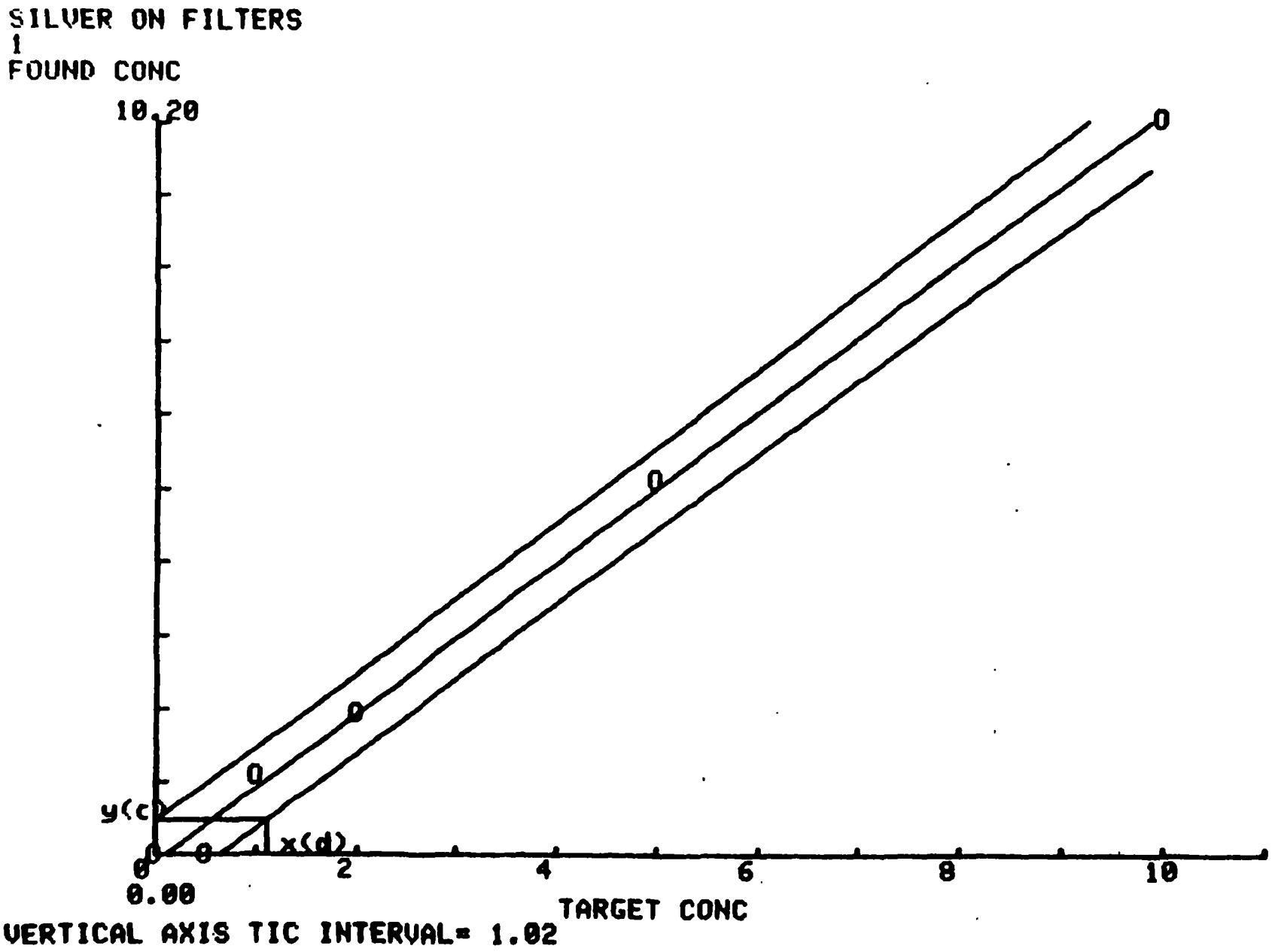


VERTICAL AXIS TIC INTERVAL= 5.3

```
LEAD ON FILTERS
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 15.4166666667  SD= 19.1322154145

FOUND CONC
MEAN= 17.6666666667  SD= 19.5414090246

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 1.94991462721
SLOPE= 1.01946499715
R= 0.998117582439
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 1.7953898691
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 5.20246998679
x(d)= 6.27557897609
```

SILVER ON FILTERS
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/M2	Day 1 Found Conc. UG/M2	Day 2 Found Conc. UG/M2	Day 3 Found Conc. UG/M2	Day 4 Found Conc. UG/M2
0.00	0.00			
0.50	0.00			
1.00	1.10			
2.00	2.00			
5.00	5.20			
10.00	10.20			

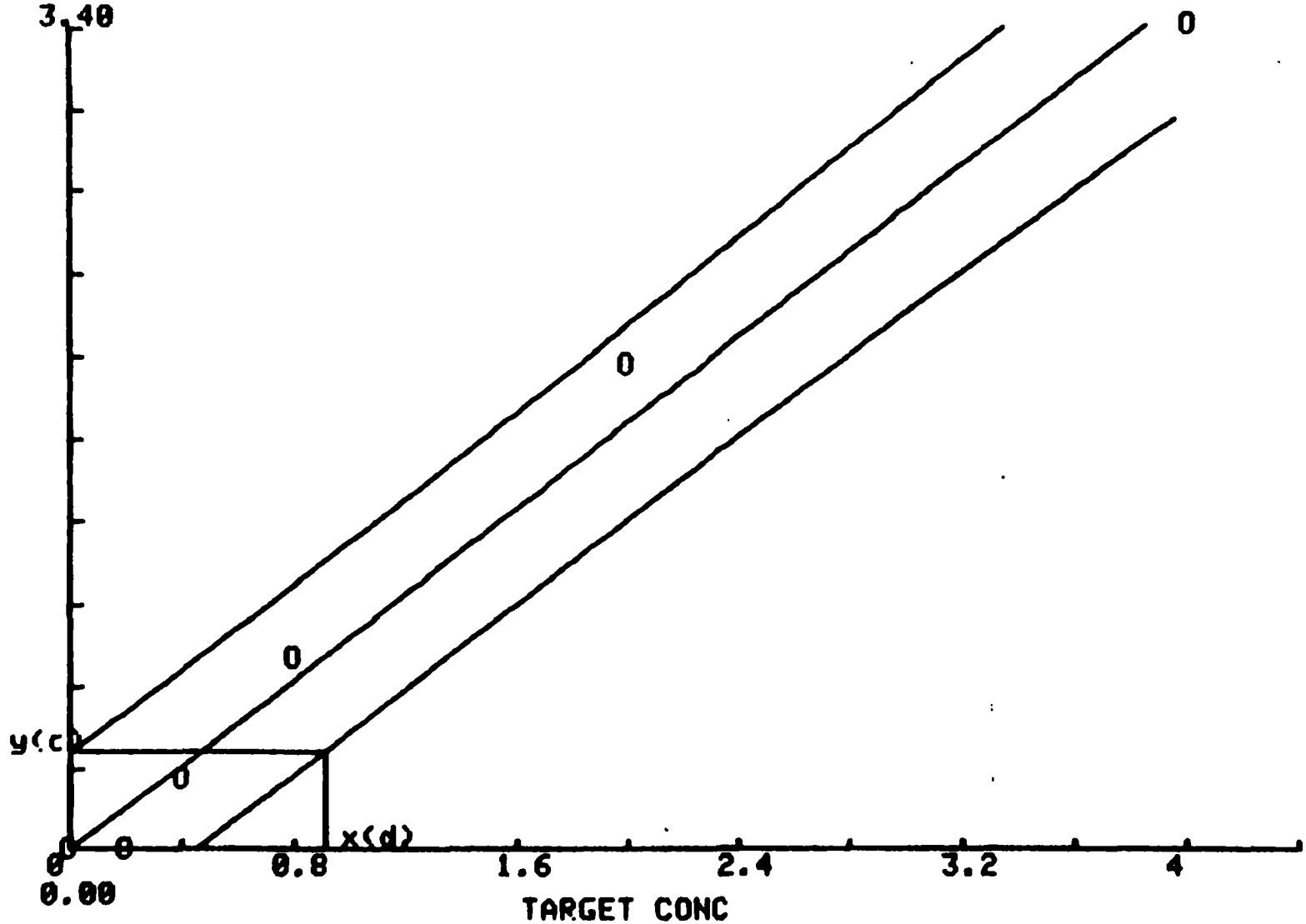

SILVER ON FILTERS
1
FOUND CONC
10.20
y(c)
x(d)
0
0.00
2
4
6
8
10
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 1.02

```
SILVER ON FILTERS
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 3.08333333333  SD= 3.8264430829

FOUND CONC
MEAN= 3.08333333333  SD= 3.9811639839

N0. RUNS 1 TOTAL X-Y ALL RUNS 6 N0. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.120034149118
SLOPE= 1.03892999431
R= 0.998553816527
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.0572623790555
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.460837266725
x(d)= 1.10153175206
```

MERCURY IN WATER
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	0.00			
0.20	0.00			
0.40	0.30			
0.80	0.80			
2.00	2.00			
4.00	3.40			

MERCURY IN WATER
1
FOUND CONC



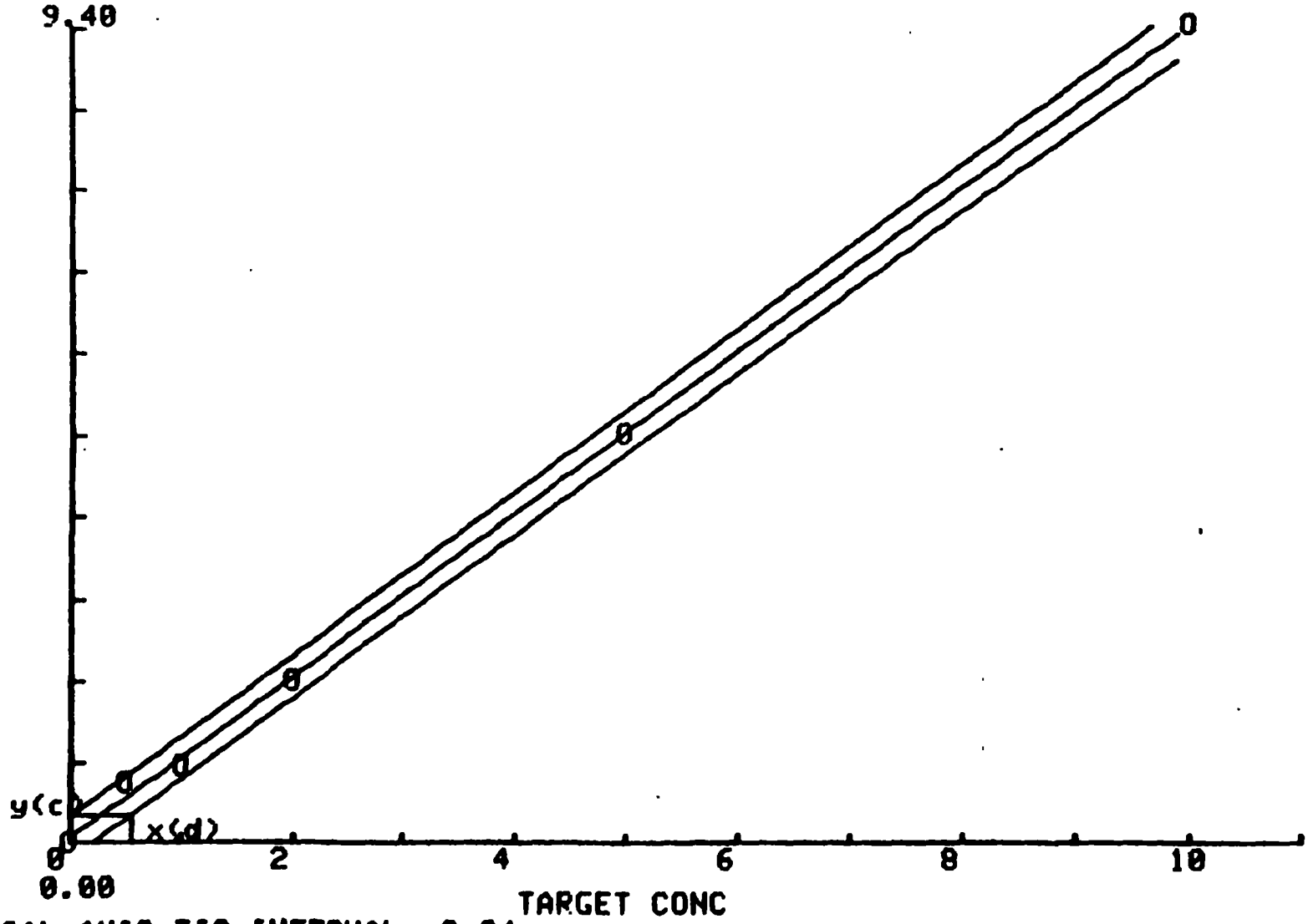
VERTICAL AXIS TIC INTERVAL= 0.34

```
MERCURY IN WATER
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 1.23333333333  SD= 1.53057723316

FOUND CONC
MEAN= 1.08333333333  SD= 1.36002450958

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.00574843483211
SLOPE= 0.883039271485
R= 0.993776064621
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.0286909504838
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.405418119054
x(d)= 0.909018140513
```

CADMIUM IN WATER
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	0.00			
0.50	0.70			
1.00	0.90			
2.00	1.90			
5.00	4.70			
10.00	9.40			

CADMIUM IN WATER
1
FOUND CONC



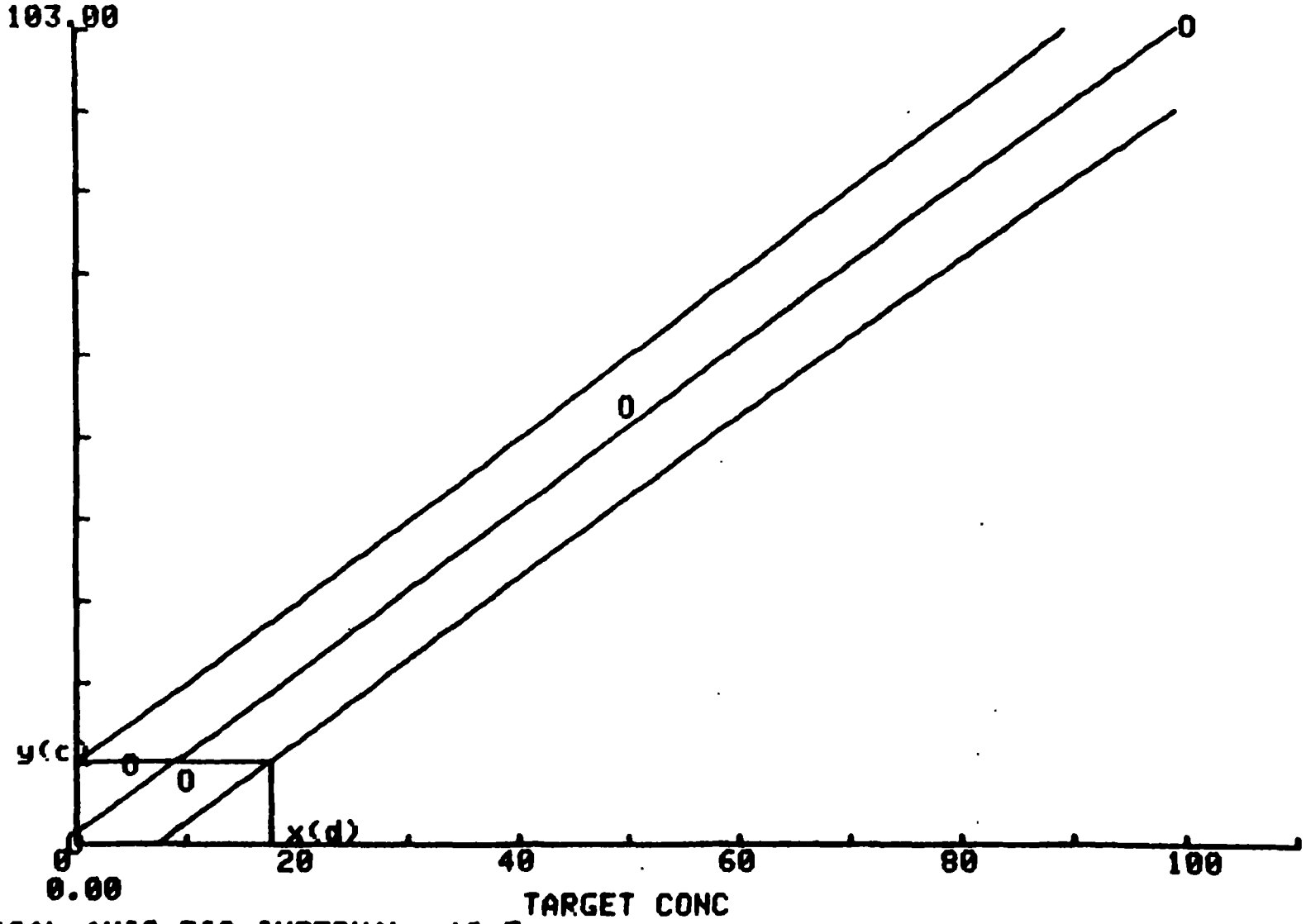
VERTICAL AXIS TIC INTERVAL= 0.94

```
CADMIUM IN WATER
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 3.08333333333  SD= 3.8264430829

FOUND CONC
MEAN= 2.93333333333  SD= 3.57024742373

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.0574274331246
SLOPE= 0.932726237906
R= 0.999657289169
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.0109191804212
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.311080625786
x(d)= 0.539512092829
```

NICKEL IN WATER
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	0.00			
5.00	10.00			
10.00	8.00			
50.00	55.00			
100.00	103.00			

NICKEL IN WATER
1
FOUND CONC



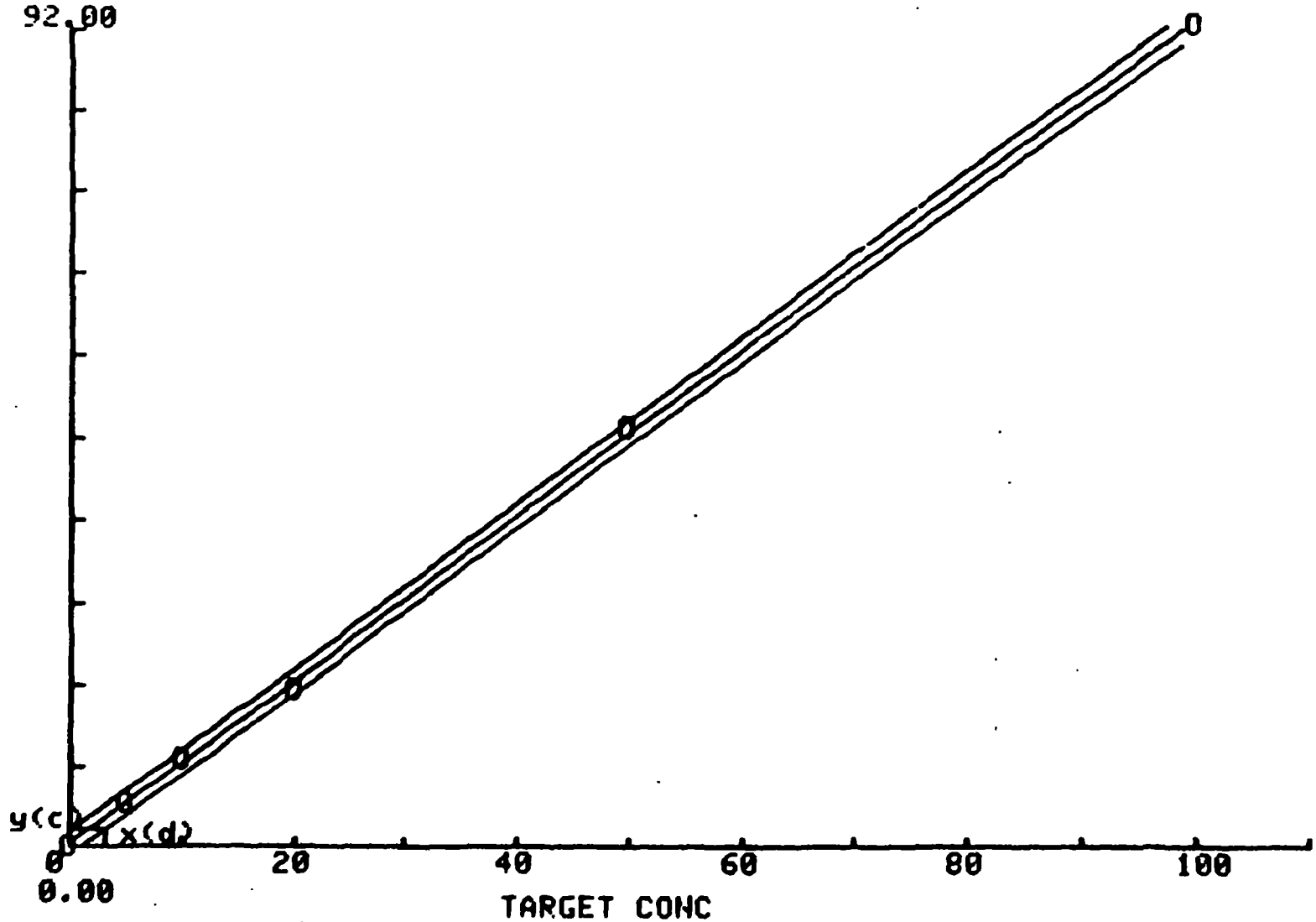
VERTICAL AXIS TIC INTERVAL= 10.3

```
NICKEL IN WATER
1
TARGET CONC
ANALYSIS OF 5 TARGET CONC-FOUND CONC POINTS

MEAN= 33  SD= 42.3674403286

FOUND CONC
MEAN= 35.2  SD= 43.5970182467

NO. RUNS 1 TOTAL X-Y ALL RUNS 5 NO. CONCENTR 5
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 1.31754874652
SLOPE= 1.02674094708
R= 0.997783508084
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 11.2219127206
COMPUTE T
D.F.= 3
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.3533525706
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 10.483045069
x(d)= 17.4550574531
```

TOTAL CHROMIUM IN WATER
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	0.00			
5.00	5.00			
10.00	10.00			
20.00	18.00			
50.00	47.00			
100.00	92.00			

TOTAL CHROMIUM IN WATER
1
FOUND CONC



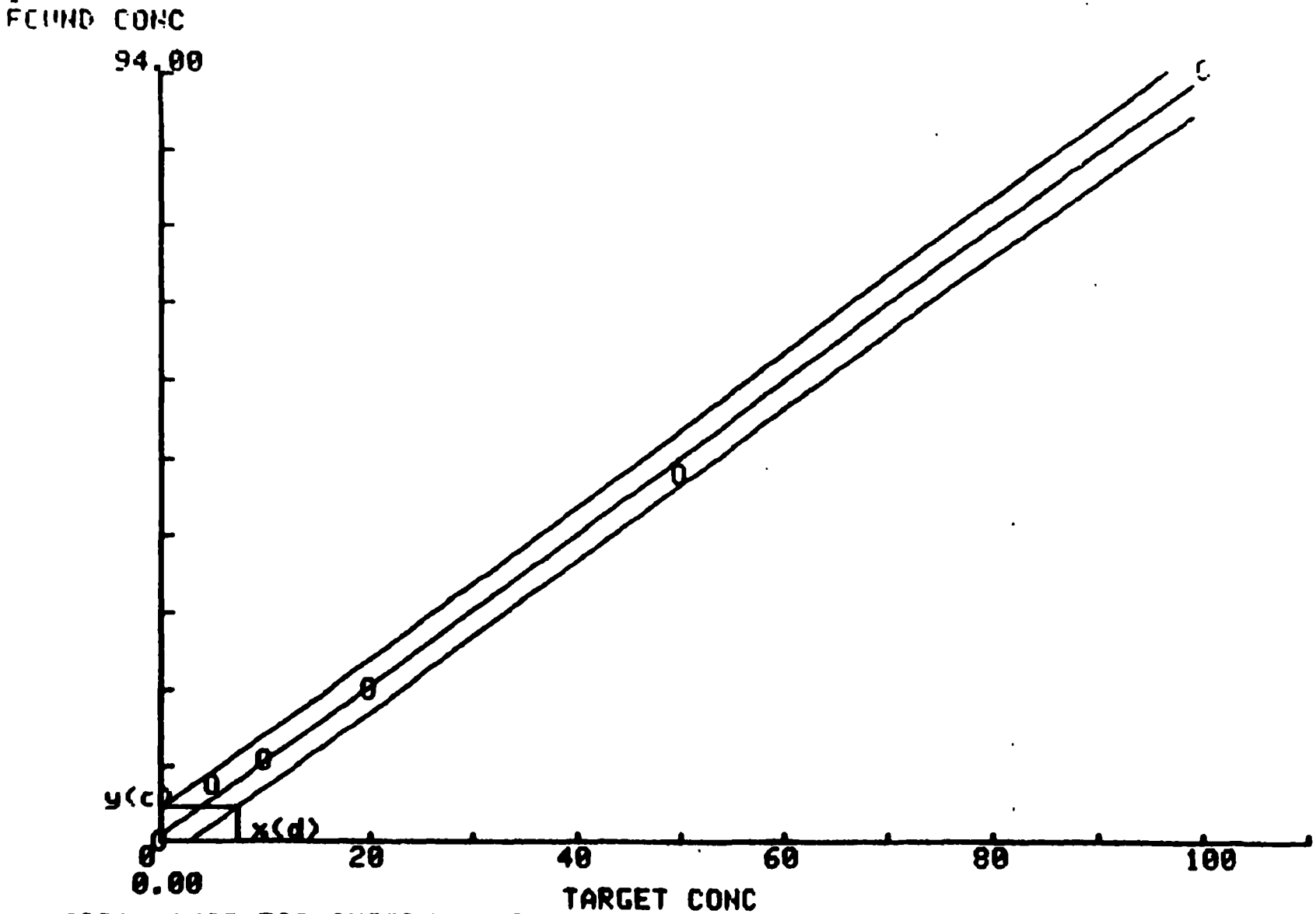
VERTICAL AXIS TIC INTERVAL= 9.2

```
TOTAL CHROMIUM IN WATER
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 30.8333333333  SD= 38.264430829

FOUND CONC
MEAN= 28.6666666667  SD= 35.189013437

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.314741035857
SLOPE= 0.919521912351
R= 0.999885452143
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.354581673319
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 1.76019230441
x(d)= 3.12867970673
```

LEAD IN WATER
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	0.00			
5.00	7.00			
10.00	10.00			
20.00	19.00			
50.00	45.00			
100.00	94.00			

LEAD IN WATER



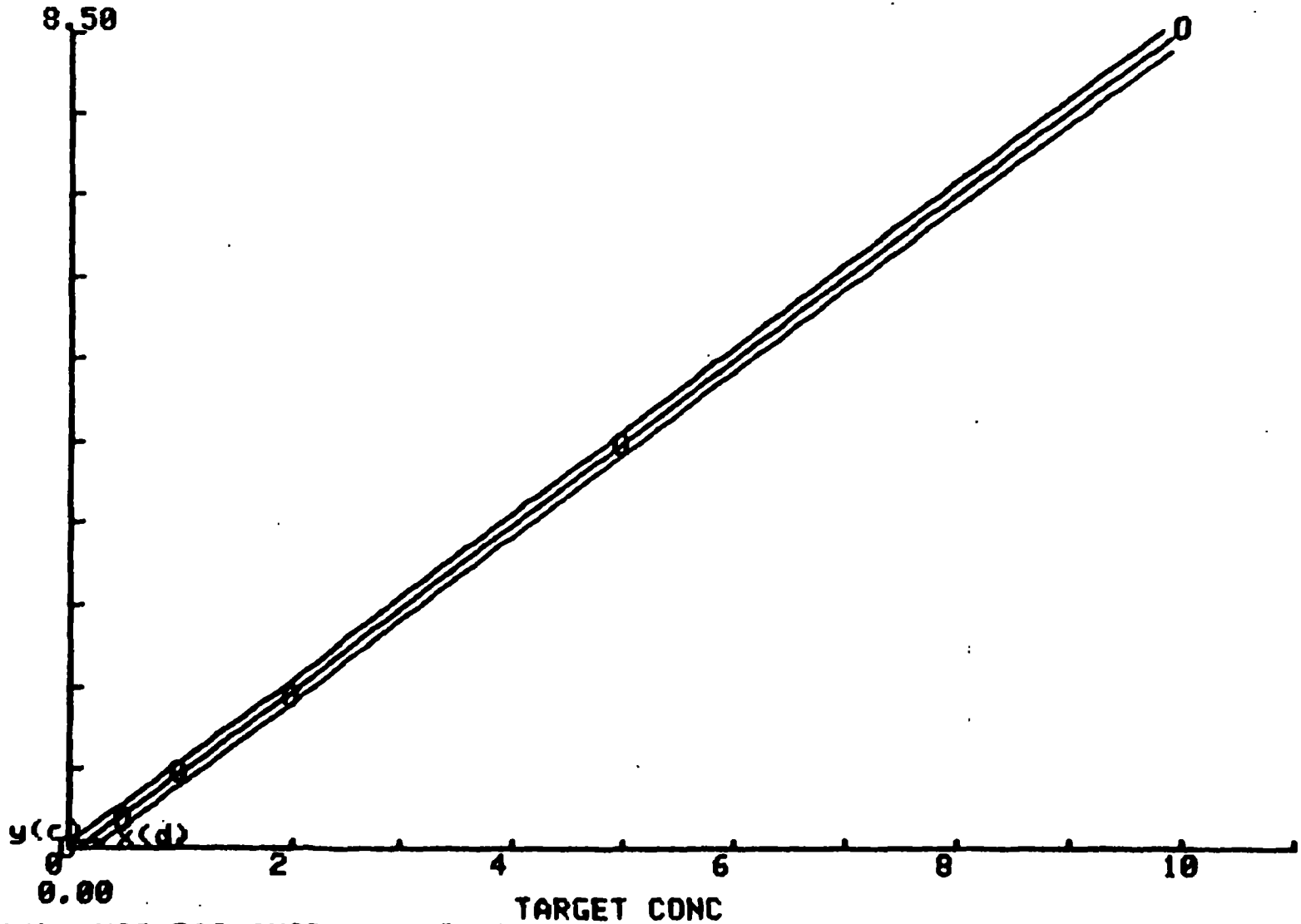
VERTICAL AXIS TIC INTERVAL= 9.4

```
LEAD IN WATER
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 30.8333333333  SD= 38.264430829

FOUND CONC
MEAN= 29.1666666667  SD= 35.4029189004

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.656801365965
SLOPE= 0.924644280023
R= 0.999380508537
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 1.94052361982
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 4.03826544762
x(d)= 7.23740098413
```

SILVER IN WATER
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	0.00			
0.50	0.30			
1.00	0.80			
2.00	1.60			
5.00	4.20			
10.00	8.50			

SILVER IN WATER
1
FOUND CONC



VERTICAL AXIS TIC INTERVAL= 0.85

```
SILVER IN WATER
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 3.08333333333  SD= 3.8264430829

FOUND CONC
MEAN= 2.56666666667  SD= 3.27576962967

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.0726807057484
SLOPE= 0.856004553216
R= 0.999903250801
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.00259533295406
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.0509828849724
x(d)= 0.287639419638
```

Method No. 3

Revised December 18, 1980

NITROGYLCERIN (NG) AND NITROCELLULOSE (NC) ON SURFACES

I. Application: This method is applicable for the qualitative determination of nitroglycerin and nitrocellulose on surfaces.

A. Tested Concentration Range - 0.04 to 40 micrograms per square centimeter.

B. Sensitivity - N/A.

C. Detection Limits - 0.4 micrograms per square centimeter determined by testing the above concentration range for visible color response.

D. Interferences - Other nitrate esters will give a positive response. The color of the surface can affect ability to distinguish the color.

E. Analysis Rate - Approximately 2 minutes are required to conduct this analysis. Limitations on the number of analyses that can be performed by this method are generally dictated by the proximity of the surfaces to be analyzed.

II. Chemistry

A. Alternate Nomenclautre and Chemical Abstracts Registry Number - Nitroglycerin: NB; Trinitroglycerin; Glyceryl trinitrate CAS RN-55-63-0 Nitrocellulose: NC; Cellulose nitrate Pyroxylin; colloidon cotton; soluble gun cotton. CAS RN-9004-70-0

B. Physical and Chemical Properties - NG: mp = 13°C, decomposes at 145°C NC: decomposes on heating. Hazards: Explosive hazard, avoid heat, shock, or open flame. Toxic inhalation and skin absorption hazards exist.

C. Chemical Reactions - Nitrite ion is cleaved in basic solution which diazotizes procaine, in acidic solution, which in turn couples with N,N-dimethyl-1-naphthylamine to produce an azo-dye. This presence or absence of color is decided by visual inspection.

III. Apparatus

A. Instrumentation - N/A

B. Parameters - N/A

C. Hardware/Glassware

1. cotton-tipped swabs
2. 1 dram screw cap vials
3. volumetric flasks - 100 ml, 10 ml
4. pipettes - 50 ml, 1 ml, 10 µl, and 5 ml graduated
5. 100-ml graduated cyclinder
6. 1-cm^2 confined area spottest paper
7. Sprayers and reservoir bottles

D. Chemicals

1. KOH, Analytical Reagent grade
2. ethanol, ACS grade
3. glacial acetic acid, ACS grade
4. procaine
5. N,N-dimethyl-1-naphthylamine

E. Reagents

1. Reagent A (5% ethanolic KOH) - Weigh 5 g of KOH into the sprayer reservoir. Add 100 ml of ethanol, measured using the graduated cylinder. Swirl to dissolve KOH.

2. 50% acetic acid - water (nitrate free). Dilute to volume with deionized water.

3. Reagent B - Weigh 0.35 grams each of procaine and N,N-dimethyl-1-naphthylamine into a second sprayer reservoir. Add the 100 ml of 50% acetic acid. Cap and shake until the reagents are dissolved.

IV. Standards

A. Calibration Standards

1. A 4 g/l solution of NC is prepared by weighing 40 mg of NC in a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 40 µg/cm^2.

2. A 0.4 g/l solution of NC is prepared by pipetting 1 ml of the 4 g/l solution into a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 4 µg/cm^2.

3. A 40 mg/l solution of NC is prepared by pipetting 1 ml of the 0.4 g/l solution into a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 4 µg/cm^2.

4. The NG standards having 4 g/l, 0.4 g/l, and 40 mg/l are prepared in a way analogous to Steps 1, 2, and 3. The 4 g/l solution of NG is prepared by pipetting 4 ml of a 1% NG in acetone SARM into a 10 ml volumetric flask and diluting to the mark with acetone.

5. A 100 mg/l solution of NC is prepared by pipetting 2.5 ml of the 0.4 g/l solution into a 10 ml volumetric flask, using the 5 ml graduated pipette, and diluting to the mark with acetone. This solution is used routinely for a procedure check.

B. Control Spikes - N/A.

V. Procedure

A. Testing the Spray Solution

1. Dip a cotton swab into a vial containing a 100 mg/l (0.01%) solution of NC

2. Withdraw the swab and allow it to air dry.

3. Spray the swab with Reagent A and allow it to dry.

4. Spray the swab with Reagent B.

5. A positive test is indicated by a violet or red violet color and indicates that the spray solution is adequate for testing.

B. Surface Testing - The surface to be tested is not prepared in any way. Holding the sprayer approximately 6 inches from the surface, apply Reagent A for approximately one second. Allow the alcohol to evaporate, then spray with Reagent B in the same manner and in the same location as Reagent A. A postive test is indicated by a violet or red violet color against a pale pink background.

VI. Calculations - N/A.

VII. References - NAVEODFAC Technical Report TR-185 Development of a Simple Portable Detection Kit for Selected Explosives, Robert E. Wyant, Battelle Columbus Laboratories, September 1977.

Method No. 4

Revised December 18, 1980

2,4,6-TRINITROTOLUENE (TNT), 2,4- AND 2,6-DINITROTOLUENE (DNT) AND 2,4,6-TRINITROPHENYLMETHYLNITRAMINE (TETRYL) ON SURFACES

I. Application: This method is applicable for the qualitative determination of TNT, DNTs, and tetryl on surfaces.

A. Tested Concentration Range - 0.4 to 40 micrograms per square centimeter.

B. Sensitivity - N/A.

C. Detection Limits - 0.4 micrograms per square centimeter determined by testing the above concentration range for visible color response.

D. Interferences - Background color can affect ability to distinguish the color reaction.

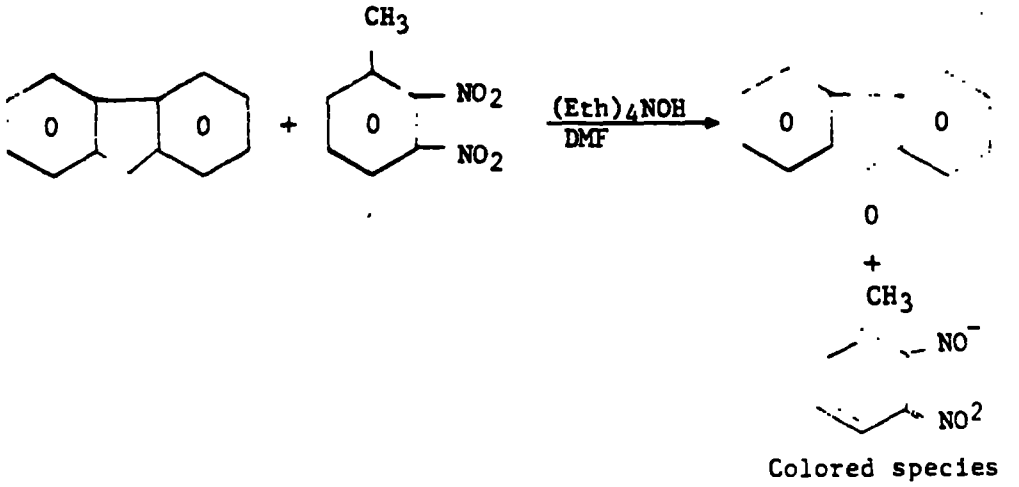
E. Analysis Rate - Approximately 2 minutes are required to conduct this analysis. Limitations on the number of analyses that can be performed by this method are generally dictated by the proximity of the surfaces to be analyzed.

II. Chemistry

A. Alternate Nomenclature and Chemical Abstracts Registry Numbers - 2,4,6-Trinitrotoluene: TNT; CAS RN 118-96-7; 2,4-Dinitrotoluene: 2,4-DNT; CAS RN 121-14-2; 2,6-Dinitrotoluene: 2,6-DNT; CAS RN 606-20-2; Tetryl: 2,4,6-Trinitrophenylmethylnitramine; 2,4,6-Tetranitro-N-methyl-N-aniline; CAS RN 479-45-8.

B. Physical and Chemical Properties - TNT: mp = 82°C; bp = 240°C (explodes). 2,4-DNT: mp =°71 C; bp = 300°C (decomposes). 2,6-DNT: mp = 66°C; bp = 300°C (decomposed) Tetryl: mp = 131°C; bp = 187°C (explodes). Hazards: Use caution in handling. Potential explosive, toxic inhalation, and skin absorption hazards exist.

C. Chemical Reactions - An example of the chemical reaction which occurs is given below for 2,4-DNT.



III. Apparatus

A. Instrumentation - N/A.

B. Parameters - N/A.

C. Hardware/Glassware

1. cotton tipped swabs
2. 1-dram screw cap vials
3. volumetric flasks - 10 ml
4. sprayers and reservoir bottles
5. pipettes - 50 ml, 1 ml, 10 µl, and 5 ml graduated
6. 1-cm^2 confined area spotting paper

D. Chemicals

1. DMF, ACS Grade
2. fluorene
3. 10% tetraethyl ammonium hydroxide in water.

E. Reagents

1. Reagent A - Weigh 0.2 g of fluorene into the sprayer reservoir. Add 10 ml of DMF, measured using the graduated cylinder. Swirl until the fluorene is dissolved.

2. Reagent B - Using a graduated cylinder, measure 100 ml of 10% tetraethylammonium hydroxide into a sprayer reservoir.

IV. Standards

A. Calibration Standards

1. A 4 gram per liter solution of TNT is prepared by weighing 40 mg of TNT into a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area spotting filter paper, this concentration corresponds to 40 µg/cm^2.

2. A 0.4 g/l solution of TNT is prepared by pipetting 1 ml of the 4 g /l solution into a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area filter paper. This concentration corresponds to 4 µg/cm^2.

3. A 100 mg/l solution of TNT is prepared by pipetting 2.5 ml of the 4 g/l solution into a 10 ml volumetric flask using the 5 ml graduated pipette, and diluting to the mark with acetone. This solution is used routinely for a procedure check.

4. A 40 mg/l solution of TNT is prepared by pipetting 1 ml of the 0.4 g/l solution into a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area spotting filter paper, this concentration corresponds to 0.4 $\mu g/cm^2$.

5. Steps 1, 2 and 4 are repeated for 2,4-DNT, 2,6-DNT and tetryl.

B. Control Spikes - N/A.

V. Procedure

A. Validation of the Spray Solution

1. Dip a cotton swab into a vial containing a 100 mg/l (0.01%) solution of TNT.

2. Withdraw the swab and allow it to air dry.

3. Spray the swab with Reagent A.

4. Spray the swab with Reagent B.

5. A positive test is indicated by a maroon color and indicates that the spray solution is adequate for testing.

B. Surface Testing - The surface to be tested is not prepared in any way. Holding the sprayer approximately 6 inches from the surface, apply Reagent A for approximately one second. Wait 5 seconds and apply Reagent B in the same manner and in the same location as Reagent A. A positive test is indicated by the following color reactions against a colorless background: TNT - maroon; DNTs - blue green; Tetryl - orange.

VI. Calculations - N/A.

VII. References - Colorimetric and Fluorimetric Analysis of Organic Compounds. M. Pesez and J. Barton, Marcel Dekker, Inc., New York, N.Y. 1974.

TETRAZENE ON SURFACES

I. Application - This method is applicable for the qualitative determination of tetrazene on surfaces.

A. Tested Concentration Range - 0.4 to 40 $\mu g/cm^2$.

B. Sensitivity - N/A.

C. Detection Limits - 0.4 $\mu g/cm^2$ determined by testing the above concentration range for visible color response.

D. Interferences - Background color will interfere with the ability to distinguish the color reaction.

E. Analysis Rate - Approximately 1 minute is required to conduct this analysis. Limitations on the number of analyses that can be performed by this method are generally dictated by the proximity of the surfaces to be analyzed.

II. Chemistry

A. Alternate Nomenclature and Chemical Abstracts Registry Number - Tetrazene: CAS RN

B. Physical and Chemical Properties - mp = decomposes; bp = N/A. Hazard: Tetrazene is explosive, especially in the dry state. The neat solid should be stored in isopropanol and only a small portion should be dried, by placing on a clean filter paper, to prepare analytical standards.

C. Chemical Reactions - The precise chemical complexation reaction which forms the colored species is not known.

III. Apparatus

A. Instrumentation - N/A.

B. Parameters - N/A.

C. Hardware/Glassware

1. cotton tipped swabs
2. 1-dram screw cap vials
3. volumetric flasks - 100 ml, 10 ml
4. pipettes - 1 ml, 10 µl, and 5 ml graduated
5. 10-ml and 25-ml graduated cylinders
6. 1-cm^2 confined area spottest paper
7. sprayer and reservoir bottle
8. 8 oz. screw cap bottles

D. Chemicals

1. NaOH, Analytical Reagent grade
2. acetone, ACS grade
3. sodium nitroprusside
4. potassium ferricyanide
5. methanol, ACS grade

E. Reagents

1. Reagent A - Weigh 100 g of NaOH into a screw cap bottle. Add 100 ml of distilled water, cap, and swirl until dissolved.

2. Reagent B - Weigh 10 g of sodium nitroprusside into a screw cap bottle. Add 10 ml of distilled water, cap, and swirl until dissolved.

3. Reagent C - Weigh 10 g of potassium ferricyanide into a screw cap bottle. Add 10 ml of distilled water, cap, and swirl until dissolved.

4. Fresh each day, mix 10 ml each of reagents A, B, and C in a sprayer reservoir bottle. Add 30 ml of distilled water, swirl, and allow to stand for 20 minutes. Add 60 ml of acetone and swirl.

IV. Standards

A. Calibration Standards

1. A 4 g/l solution of tetrazene is prepared by weighing 40 mg of tetrazene into a 10 ml volumetric flask and diluting to the mark with methanol. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 40 $\mu g/cm^2$.

2. A 0.4 g/l solution of tetrazene is prepared by pipetting 1 ml of the 4 g/l solution into a 10 ml volumetric flask and diluting to the mark with methanol. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 4 $\mu g/cm^2$.

3. A 100 mg/l solution of tetrazene is prepared by pipetting 2.5 ml of the 0.4 g/l solution into a 10 ml volumetric flask, using a 5 ml graduated pipette, and diluting to the mark with methanol. This solution is used routinely for a procedure check.

4. A 40 mg/l solution of tetrazene is prepared by pipetting 1 ml of the 0.4 g/l solution into a 10 ml volumetric flask and diluting to the mark with methanol. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 0.4 $\mu g/cm^2$.

B. Control Spikes - N/A.

V. Procedure

A. Testing the Spray Solution

1. Dip a cotton swab into a vial containing a 100 mg/l (0.01%) solution of tetrazene.

2. Withdraw the swab and allow it to air dry.

3. Spray the swab with the color reagent.

4. A positive test is indicated by a red-orange color and indicates that the spray is adequate for testing.

B. Surface Testing - The surface to be tested is not prepared in any way. Holding the sprayer approximately six inches from the surface, apply the spray reagent for about one second. A positive test is indicated by a red-orange color against a yellow background.

VI. Calculations - N/A.

VII. References - personal communication with R. E. Wyant, Battelle, Columbus Laboratories.

Method No. 6

Revised December 18, 1980

2,4,6-TRINITRORESORCINOL (STYPHNIC ACID) AND LEAD STYPHNATE ON SURFACES

I. Application: This method is applicable for the qualitative determination of styphnic acid and lead styphnate on surfaces.

A. Tested Concentration Range - 0.4 to 40 $\mu g/cm^2$.

B. Sensitivity - N/A.

C. Detection Limits - 0.4 $\mu g/cm^2$ determined by testing the above concentration range for visible color response.

D. Interferences - Background color will interfere with ability to see the color reaction.

E. Analysis Rate - Approximately 1 minute is required to conduct this analysis. Limitations on the number of analyses that can be performed by this method are generally dictated by the proximity of the surfaces to be analyzed.

II. Chemistry

A. Alternate Nomenclature and Chemical Abstracts Registry Number - 2,4,6-Trinitroresorcinol: TNR; Styphnic Acid; CAS RN-82-71-3

B. Physical and Chemical Properties - mp = 175°C;
Hazards: TNR is explosive and toxic. Only small quantities of the neat material should be handled with the analyst wearing gloves. Avoid heating the material.

C. Chemical Reactions - The precise chemical complexation reaction of the Styphnate ion which forms the colored species is not known.

III. Apparatus

A. Instrumentation - N/A.

B. Parameters - N/A.

C. Hardware/Glassware

1. cotton tipped swabs
2. 1 dram screw cap vials
3. volumetric flasks - 100 ml, 10 ml
4. pipettes - 1 ml, 10 µl, and 5 ml graduated
5. 100 ml graduated cylinder
6. 1 cm^2 confined area spottest paper
7. sprayers and reservoir bottles

8. filter paper - 11 cm Whatman 42
9. glass funnel
10. 125 ml Erlenmeyer flask

D. Chemicals

1. NaOH, Analytical Reagent Grade
2. Stannous chloride trihydrate
3. Acetone, ACS Grade

E. Reagents

The reagent for this test must be prepared fresh at least every 3 days.

Weigh 5 g of NaOH and 10 g of stannous chloride trihydrate into an Erlenmeyer flask. Add 100 ml of distilled water, measured using the graduated cylinder, and swirl until all NaOH is dissolved. Filter the reagent through a Whatman 42 paper into the sprayer reservoir.

IV. Standards

A. Calibration Standards

1. A 4 g/l solution of TNR is prepared by weighing 40 mg of TNR into a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 40 $\mu g/cm^2$.

2. A 0.4 g/l solution of TNR is prepared by pipetting 1 ml of the 4 g/l solution into a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 4 $\mu g/cm^2$.

3. A 100 mg/l solution of TNR is prepared by pipetting 2.5 ml of the 0.4 g/l solution into a 10 ml volumetric flask, using a 5 ml graduated pipette, and diluting to the mark with acetone. This solution is used routinely for a procedure check.

4. A 40 mg/l solution of TNR is prepared by pipetting 1 ml of the 0.4 g/l solution into a 10 ml volumetric flask, and diluting to the mark with acetone. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 0.4 $\mu g/cm^2$.

B. Control Spikes - N/A.

V. Procedure

A. Testing the Spray Solution

1. Dip a cotton swab into a vial containing a 100 mg/l (0.01%) solution of TNR.

2. Withdraw the swab and allow it to air dry.

3. Spray the swab with the color reagent.

4. A positive test indicated by a yellow-brown color and indicates that the spray solution is adequate for testing.

B. Surface Testing - The surface to be tested is not prepared in any way. Holding the sprayer approximately six inches from the surface, apply the spray reagent for about one second. A positive test is indicated by a yellow-brown color.

VI. Calculations - N/A.

VII. References - personal communication with R. E. Wyant, Battelle, Columbus Laboratories.

Method No. 7

Revised December 18, 1980

CYCLOTETRAMETHYLENETETRANITRAMINE (HMX) AND PENTAERYTHRITE TETRANITRATE (PETN) ON SURFACES

I. Application: This method is applicable for the qualitative determination of HMX and PETN on surfaces.

A. Test Concentration Range - 0.4 to 40 micrograms per square centimeter.

B. Sensitivity - N/A.

C. Detection Limits - 0.4 micrograms per square centimeter determined by testing the above concentration range for visible color response.

D. Interferences - Other nitrate esters will give a positive response. The color of the surface can affect ability to see the color.

E. Analysis Rate - Approximately 2 minutes are required to conduct this analysis. Limitations on the number of analyses that can be performed by this method are generally dictated by the proximity of the surfaces to be analyzed.

II. Chemistry

A. Alternate Nomenclature and Chemical Abstracts Registry Number - Cyclotetramethylenetetranitramine: HMX; homocyclonite; 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane; CAS RN-479-45-8

Pentaerythrite Tetranitrate: PETN; penta; pentrit; nitro pentaerythrite CAS RN-78-11-5

B. Physical and Chemical Properties - HMX: mp = 276-7°C; bp = 337°(explodes) PETN: mp = 141.3°C; bp = 210°C (explodes). Hazards: Potential explosive, toxic inhalation, and skin absorption hazards exist. Use caution in handling.

C. Chemical Reactions - Nitrate ion is cleaved by zinc which diazotizes procaine in acidic solution, which in turn couples with N,N-dimethyl-1-naphthylamine to produce an azo-dye. The presence or absence of color is decided by visual inspection.

III. Apparatus

A. Instrumentation - N/A.

B. Parameters - N/A.

C. Hardware/Glassware

1. cotton-tipped swabs
2. volumetric flasks - 100 ml, 10 ml
3. sprayers and reservoir bottles
4. 100-ml graduated cylinder
5. pipettes - 50 ml, 1 ml, 10 µl, and 5 ml graduated
6. 1 cm^2 confined area spottest paper
7. 1 dram screw cap vials

D. Chemicals

1. toluene, ACS grade
2. glacial acetic acid, ACS grade
3. zinc dust
4. procaine
5. N,N-dimethyl-1-naphthylamine.

E. Reagents

1. Reagent A - Weigh 10 grams of zinc dust into the sprayer reservoir. Add 100 ml of toluene, measured in the graduated cylinder. The zinc will be a dispersion upon shaking, but will not be dissolved.

2. 50% acetic acid - 50 ml of glacial acetic acid into a 100 ml volumetric flask which is partially filled with deionized water (nitrite free). Dilute to volume with deionized water.

3. Reagent B - Weigh 0.35 grams each of procaine and N,N-dimethyl-1-naphthylamine into a second sprayer reservoir. Add the 100 ml of 50% acetic acid. Cap and shake until the reagents are dissolved.

IV. Standards

A. Calibration Standards

1. A 4 gram per liter solution of PETN is prepared by weighing 40 mg of PETN in a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 40 $\mu g/cm^2$.

2. A 0.4 gram per liter solution of PETN is prepared by pipetting 1 ml of the 4 g/l solution into a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined are spottest paper, this concentration corresponds to 4 $\mu g/cm^2$.

3. A 100 mg/l solution of PETN is prepared by pipetting 2.5 ml of the 0.4 g/l solution into a 10 ml volumetric flask, using the 5 ml graduated pipette and diluting to the mark with acetone. This solution is used routinely for a procedure check.

4. A 40 mg/l solution of PETN is prepared by pipetting 1 ml of the 0.4 g/l solution into a 10 ml volumetric flask and diluting to the mark with acetone. When 10 µl are spotted on confined area spottest paper, this concentration corresponds to 0.4 $\mu g/cm^2$.

5. Steps 1, 2, and 4 are repeated for HMX.

B. Control Spikes - N/A.

V. Procedure

A. Testing the Spray Solution

1. Dip a cotton swab into a vial containing a 100 mg/l (0.01%) solution of PETN.

2. Withdraw the swab and allow it to air dry.

3. Spray the swab with Reagent A, shaking will before using.

4. Spray the swab with Reagent B.

5. A positive test is indicated by a violet or red violet color and indicates that the spray solution is adequate for testing.

B. Surface Testing - The surface to be tested is not prepared in any way. Holding the sprayer approximately 6 inches from the surface, apply Reagent A, after shaking, for approximately one second. Wait 15 seconds and apply Reagent B in the same manner and in the same location as Reagent A. A positive test is indicated by a violet or red violet color against a pale pink background.

VI. Calculations - N/A.

VII. References - NAVEODFAC Technical Report TR-185 "Development of a Simple Portable Detection Kit for Selected Explosives", Robert E. Wyant, Battelle Columbus Laboratories, September 1977.

Method No. 8
Revised December 18, 1980

DETERMINATION OF 2,4,6-TRINITRORESORCINOL (STYPHNIC ACID) IN WATER

I. APPLICATION

This method is used to quantitatively determine the concentration of styphnic acid (TNR) in aqueous samples.

A. Tested Concentration Range. The concentration range is from 20 to 500 μg/ℓ.

B. Sensitivity Limits. The signal to noise ratio was 10:1 for 2.5 ng of TNR.
At detection limit 1 ng = 8.5×10^{-5} AU

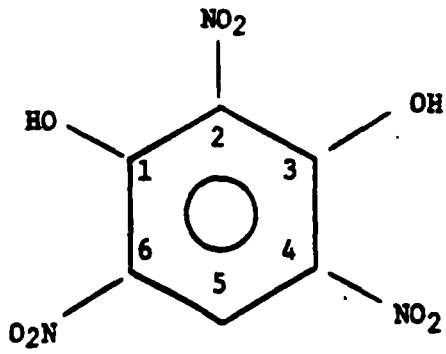
C. Detection Limits. The detection limit has been determined to be 32 μg/liter.

D. Interferences. Compounds which adsorb UV light at 254nm and coelute with TNR will interfere.

E. Analysis Rate. Approximately fifteen samples can be analyzed by one worker in an eight hour day.

II. SEPARATION SYSTEM AND CHEMISTRY

TNR, whose chemical structure is shown below, has a high UV absorbance at 254nm, so it can be detected using a UV detector (with a fixed wavelength of 254nm) with high sensitivity. The separation is performed using a reversed-phase high performance liquid chromatographic system with a C_{18}-bonded-phase column. In order to avoid ionization of the TNR, some acetic acid is added to the mobile phase, thereby protonating the TNR.



TNR

CAS RN # -- 82-71-3

Melting Point -- 175°C

Boiling Point -- N/A

Handling Hazards -- TNR is explosive and toxic. Only small quantities of the neat material should be handled with the analyst wearing gloves. Avoid heating the material.

III. APPARATUS

A. Instrumentation. Waters Model 45 HPLC pump, a Rheodyne Model 7120 injection valve, an LDC UV III Monitor (1203) detector and a Linear Model 235 strip-chart recorder.

B. HPLC Parameters

1. Column: 25 x 0.46 cm ID SS
2. Column Packing: Spherisorb ODS
3. Particle Diameter: 5 µm
4. Mobile Phase: 15% Acetonitrile/85% Water + 0.5% Acetic Acid
5. Flow Rate: 1.5 ml/min.
6. Inlet Pressure: ~2000 psi
7. Temperature: ambient
8. Injection Volume: 50 µl
9. Detector Wavelength: 254 nm
10. Detector Sensitivity: 0.04 AUFS
11. Recorder Span: 10 mV FS
12. Chart Speed: 0.5 cm/min
13. Retention Time for TNR: 3.50 min

C. Hardware/Glassware

1. Millipore all glass filter apparatus
2. Nuclepore polyester filters, 0.2 µm pore size, 47 mm diameter
3. 1000-ml graduated cylinder
4. 250-ml graduated cylinder
5. 10-ml pipet
6. 1-ml pipet
7. 50-ml volumetric flask
8. 10-ml volumetric flask
9. 10-µl Hamilton syringe
10. 25-µl Hamilton syringe
11. 100-µl syringe - for injector
12. Syringe filtration apparatus
13. Millipore filters, 0.45 µm, type GS, 13 mm diameter
14. 2-oz bottle with Teflon lined screw cap
15. Labels
16. 2-dram screw cap vials with Teflon cap liners
17. Refrigerator

D. Chemicals.

1. Acetonitrile, DIG grade, Burdick and Jackson
2. HPLC water, Millipore Model RO4, organic free, deionized
3. Glacial acetic acid, Baker reagent grade
4. Methanol, DIG, Burdick and Jackson

E. Reagents. None

VI. STANDARDS

A. Calibration standards.

1. Stock. (1000 mg/l) weigh 50 mg of styphnic acid into a 50 ml volumetric flask and dilute to the mark with methanol.
2. Diluted Stock. (100 mg/l) Pipet 1 ml of stock into a 10 ml volumetric flask and dilute to the mark with 0.5% of acetic acid in water.

3. Working. Prepare calibration standards containing 0, 0.05, 0.1, 0.2, 0.5, and 1 mg/l in 0.5% acetic acid as described below:

Concentration (mg/l)	Dilution Procedure
0	0 ml of diluted stock in 100 ml
0.05	0.05 ml of diluted stock in 100 ml
0.1	0.1 ml of diluted stock in 100 ml
0.2	0.2 ml of diluted stock in 100 ml
0.5	0.5 ml of diluted stock in 100 ml
1	1 ml of diluted stock in 100 ml

B. Control Spikes: Control spiked are equivilent to working standards since the method involves direct injection.

V. PROCEDURE

A. Sample Handling/Preparation. Filter the sample through a 0.45 µm Millipore filter prior to analysis and store refrigerated in a Teflon lined screw capped vial until analyzed.

B. Calibration. Inject 50 µl of each TNR calibration standard 4 times into the HPLC system. Record the retention time, concentration and peak height. Also inject a mobile phase blank (50 µl).

C. Analysis. Inject 50 µl of sample into the HPLC system. Record the retention time and peak height for peak eluting at the retention time for TNR.

VI. CALCULATIONS

Use the calibration data for TNR to establish a linear regression curve (concentration vs. peak height). Interpolate sample concentration from these curves.

The relationship between found component concentration and sample volume of water is as follows:

$\mu g/\ell$ water = ng/50ul x 20

VII. REFERENCES

None

VIII. RESPONSE DATA

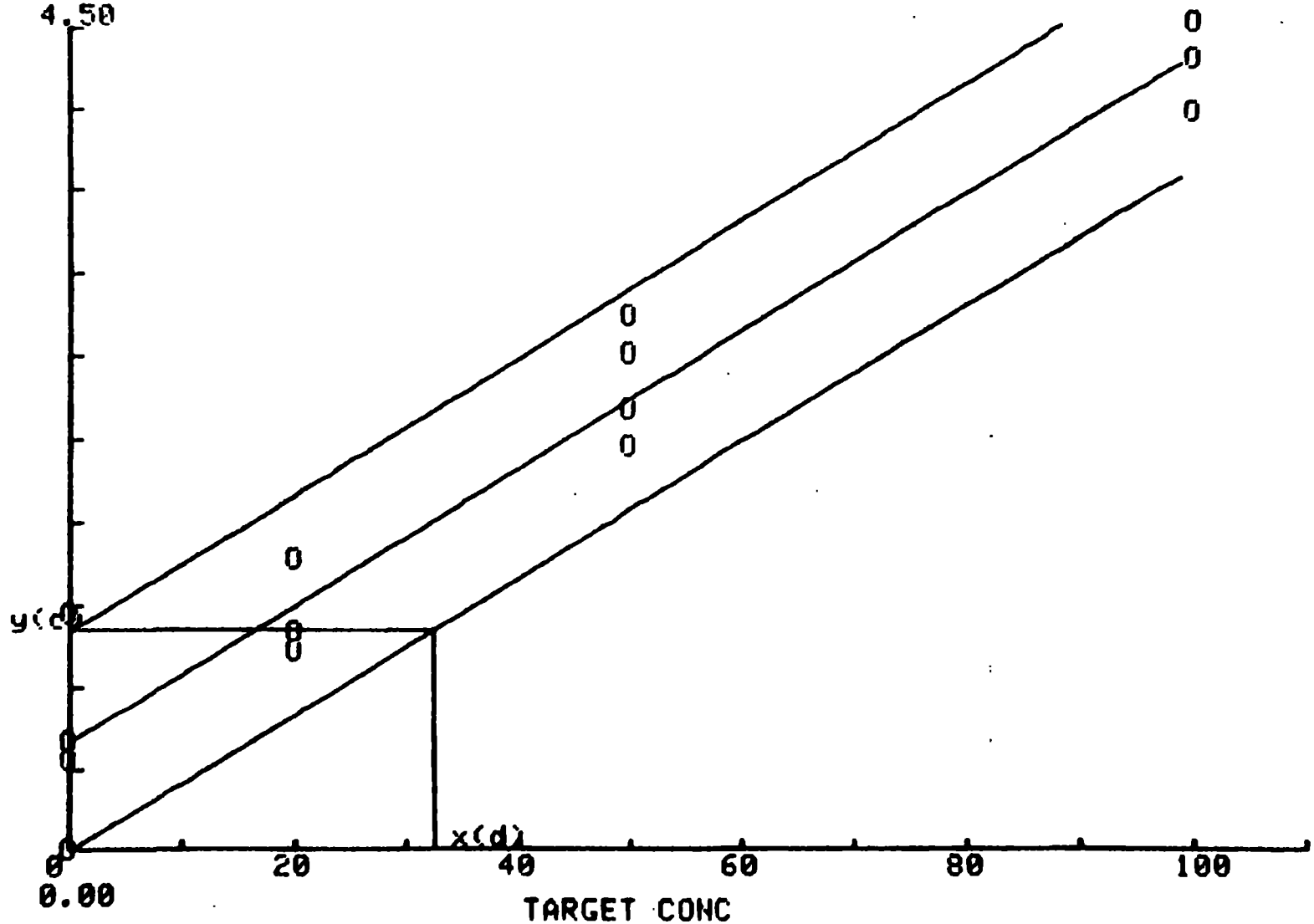
µg/l TNR	Peak Height (mm)			
	Day 1	Day 2	Day 3	Day 4
0	1.3	0.6	0	0.5
20	16	11	12	12
50	29	22	27	24
100	43	45	40	43
200	71	83	83	85
500	192	196	210	200

THR IN WATER
RUNS 1 2 3 4
COMPILATION OF TARGET CONC. VS PEAK AREA

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	3.39	2.74	-4.79	0.66
20.00	12.97	17.20	22.23	18.96
50.00	54.47	49.01	56.01	50.35
100.00	99.17	101.06	96.55	100.03

```
TNR IN WATER
RUNS 1 2 3 4
TARGET CONC
ANALYSIS OF 16 TARGET CONC-PEAK AREA POINTS

MEAN= 42.5  SD= 38.9015852291

PEAK AREA
MEAN= 2.175  SD= 1.47851276626

NO. RUNS 4 TOTAL X-Y ALL RUNS 16 NO. CONCENTR 16
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.596696035242
SLOPE= 0.0371365638767
R= 0.977111079273
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.105991189428
COMPUTE T
D.F.= 14
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.7613101065
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 1.20949378794
x(d)= 32.4504911485
```

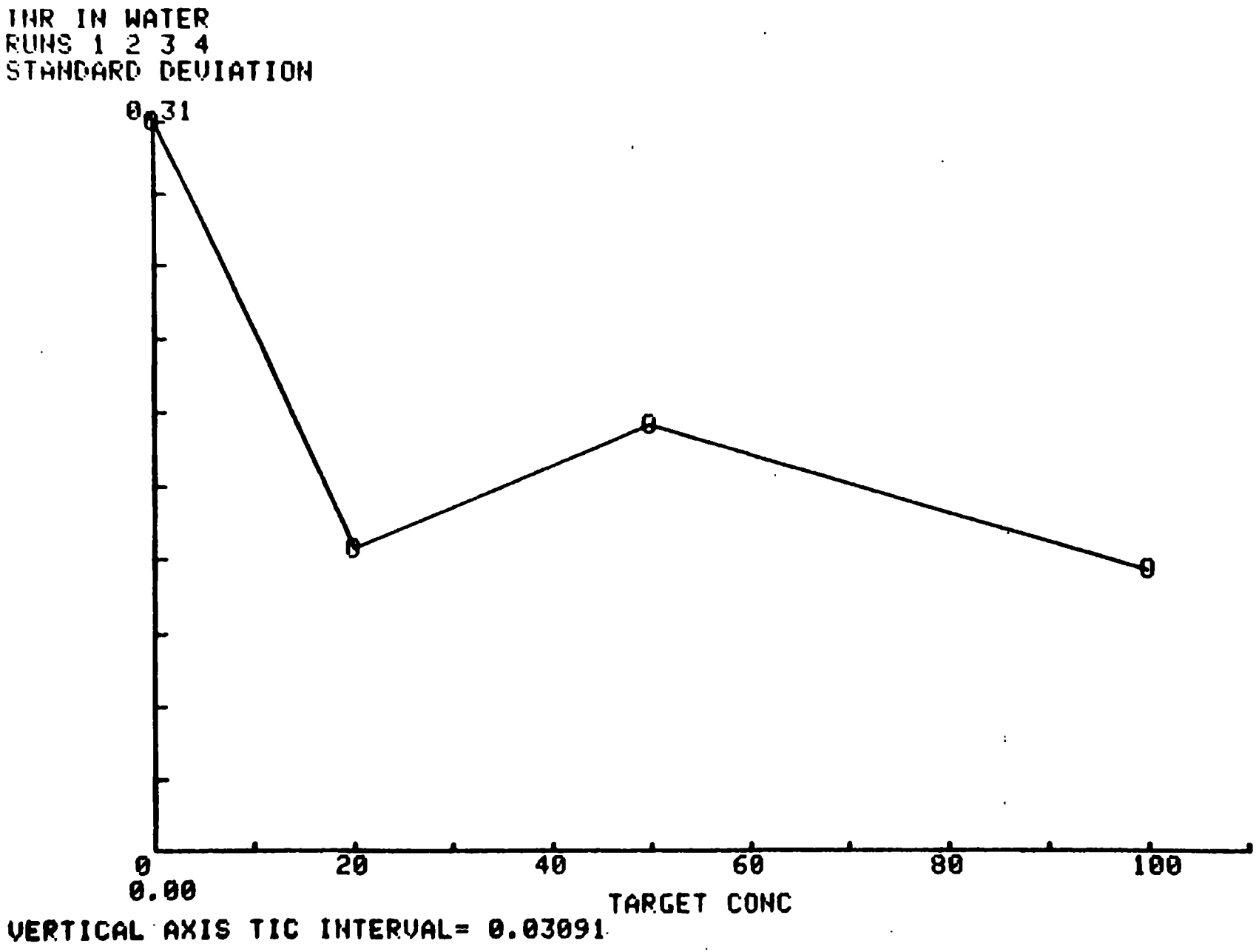
INK IN WATER
RUNS 1 2 3 4
PEAK AREA



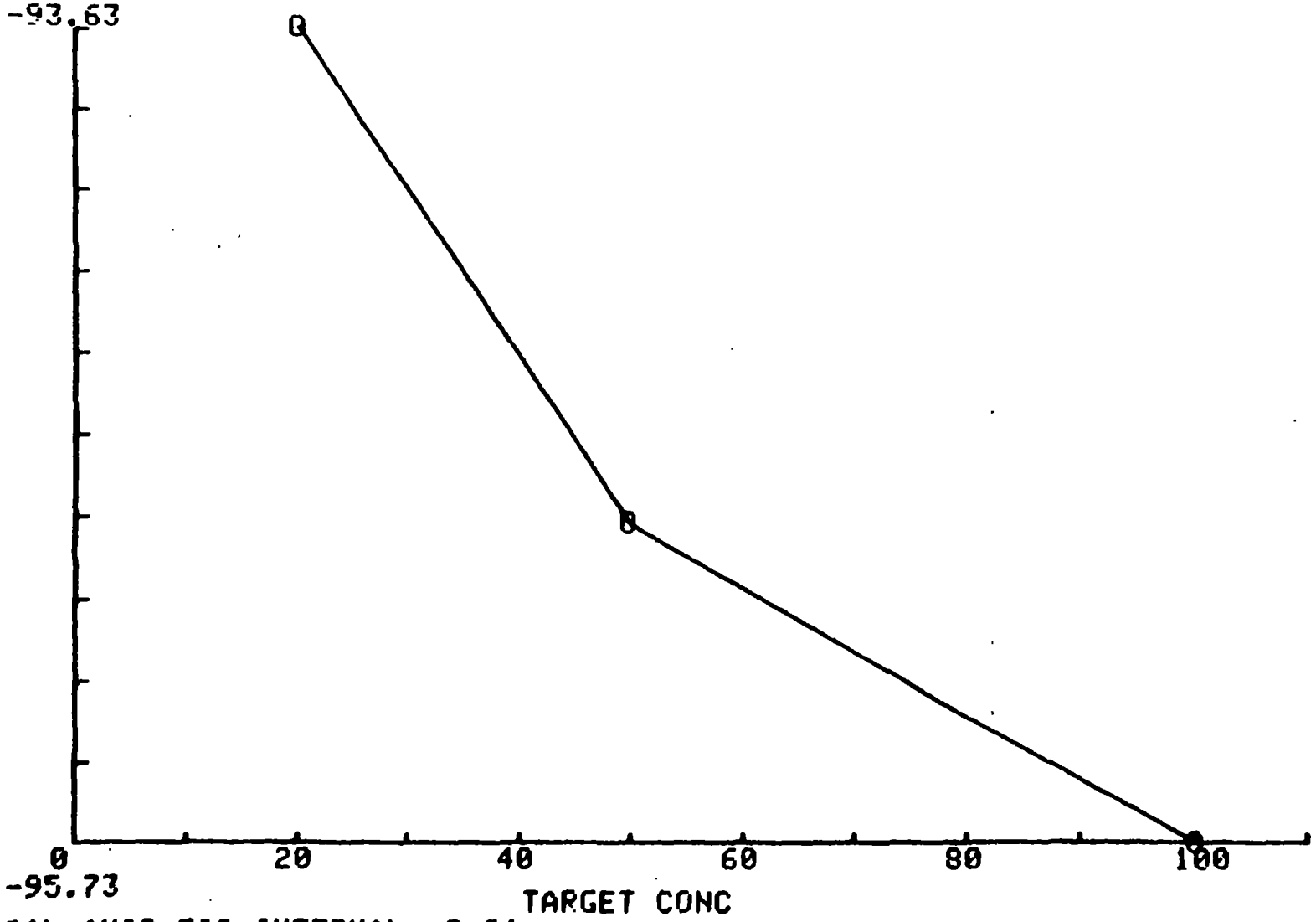
VERTICAL AXIS TIC INTERVAL= 0.45

TNR IN WATER
RUNS 1 2 3 4
STATISTICAL DATA USED TO DETERMINE PERCENT
INACCURACY AND COEFFICIENT OF VARIATION

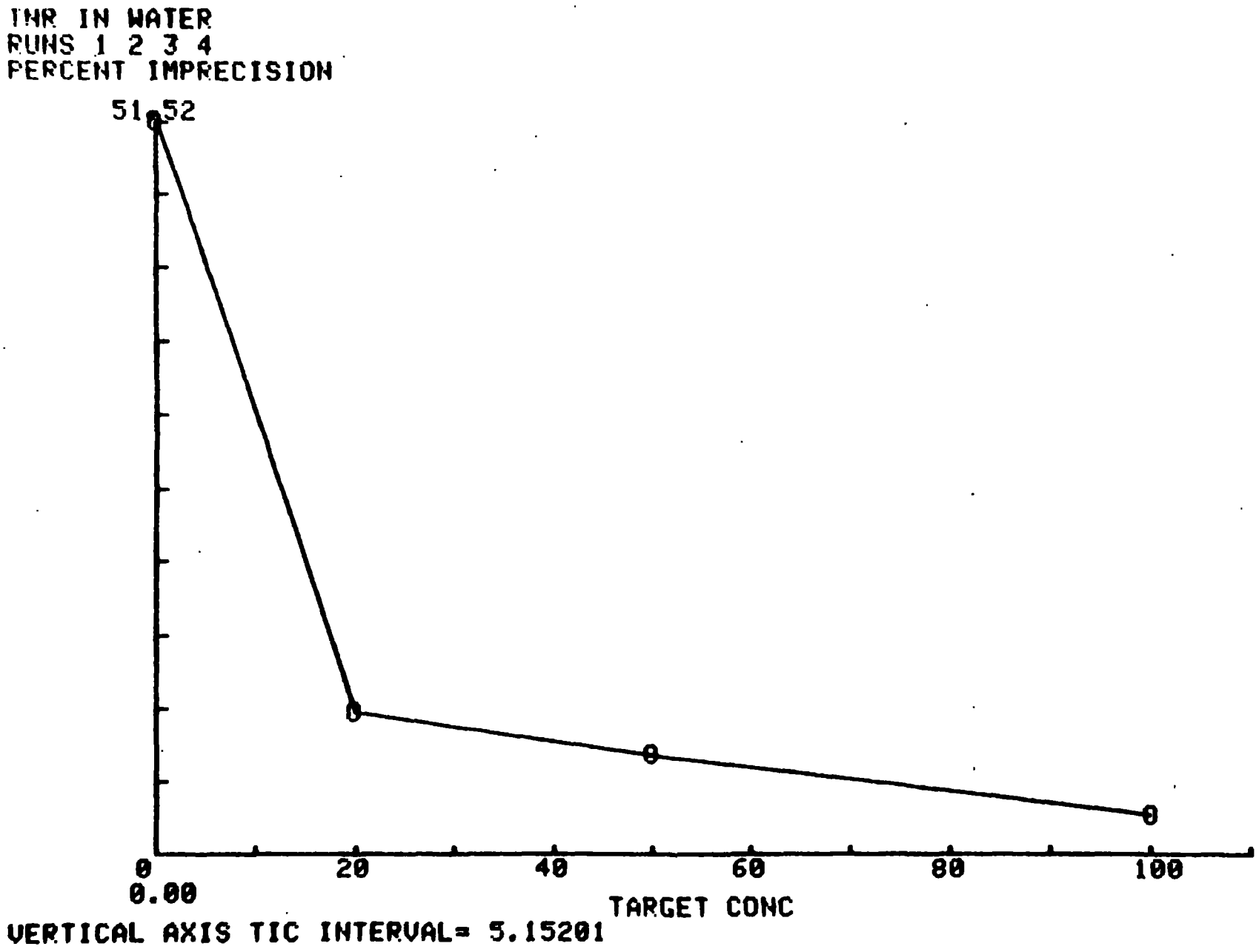
Target Conc. UG/L	Mean Found Conc. UG/L	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.00	0.50	2.14		430.30
20.00	17.84	2.23	-10.80	12.49
50.00	52.46	1.92	4.92	3.65
100.00	99.20	1.11	-0.80	1.12


INR IN WATER
RUNS 1 2 3 4
STANDARD DEVIATION
0.31
0
0.00
20
40
60
80
100
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 0.03091

THR IN WATER
RUNS 1 2 3 4
MEAN PERCENT INACCURACY



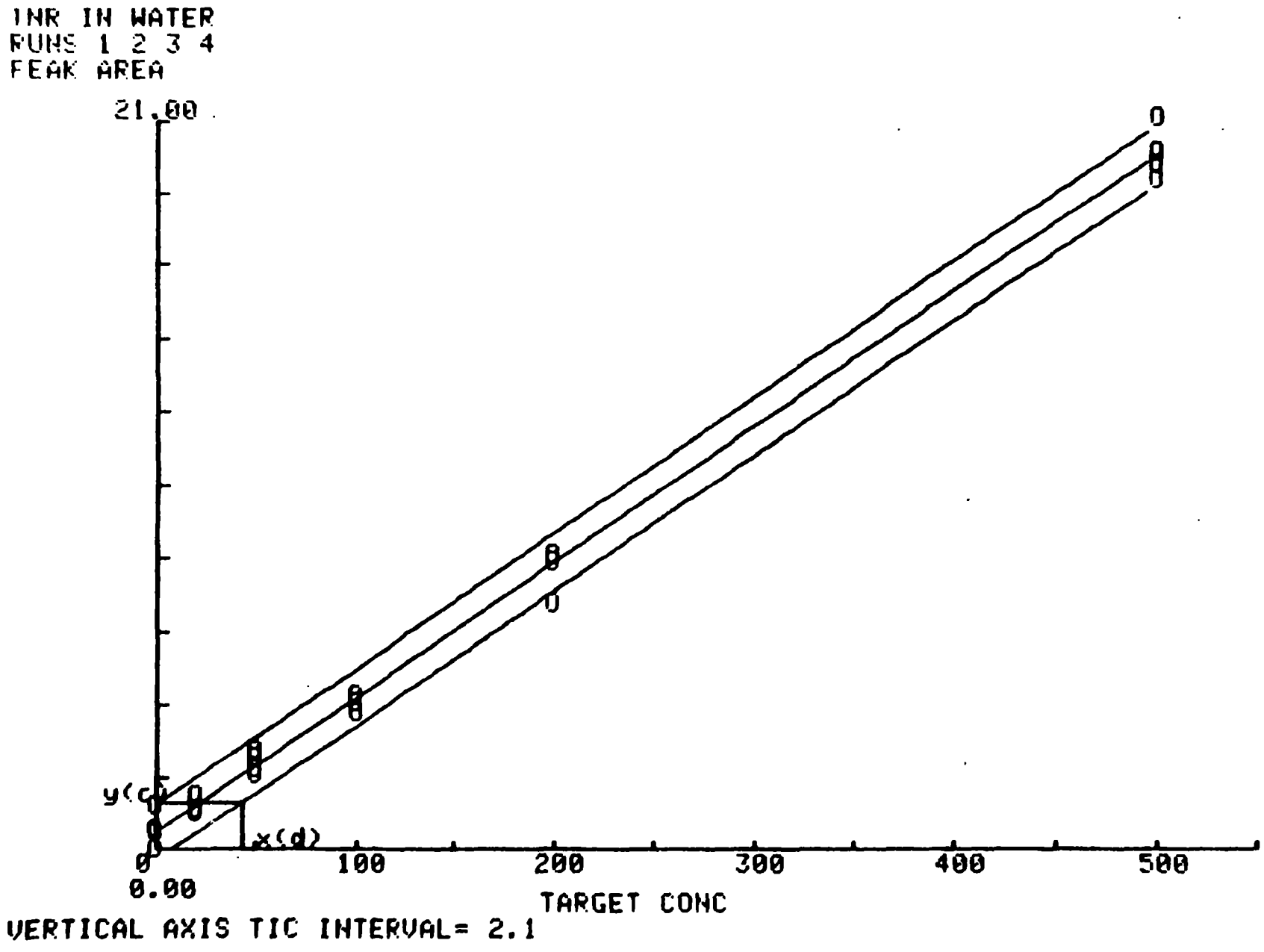
VERTICAL AXIS TIC INTERVAL= 0.21


THR IN WATER
RUNS 1 2 3 4
PERCENT IMPRECISION
51.52
0
0.00
20
40
60
80
100
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 5.15201

THR IN WATER
RUNS 1 2 3 4
COMPILATION OF TARGET CONC. VS PEAK AREA

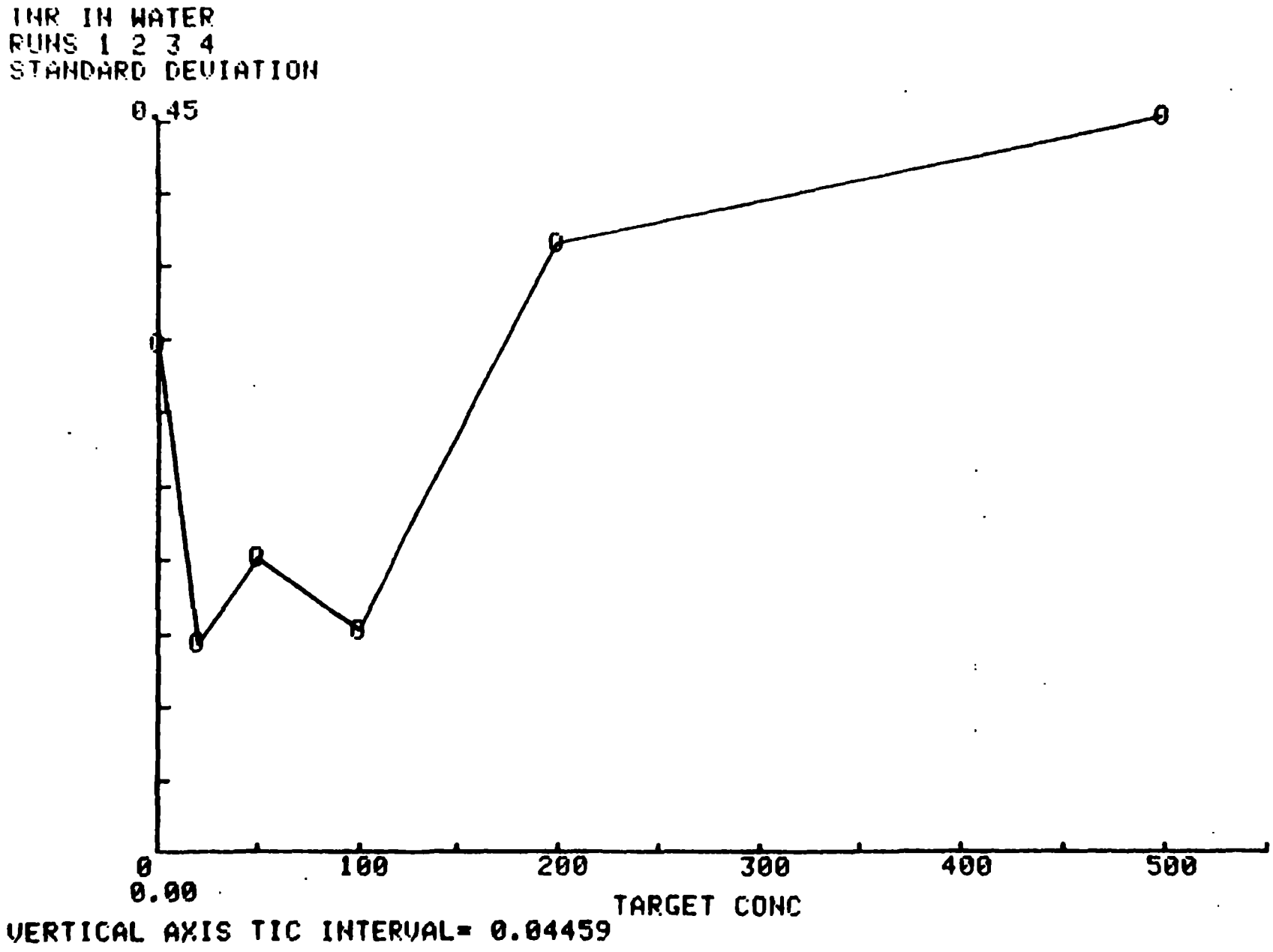
Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	12.30	5.53	-7.08	-0.28
20.00	20.65	18.52	21.96	17.61
50.00	56.84	47.11	58.27	48.29
100.00	95.82	93.89	101.84	101.97
200.00	173.77	205.64	193.81	204.22
500.00	510.62	499.31	501.20	498.18

```
THR IN WATER
RUNS 1 2 3 4
TARGET CONC
ANALYSIS OF 24 TARGET CONC-PEAK AREA POINTS

MEAN= 145  SD= 175.325783714

PEAK AREA
MEAN= 6.125  SD= 6.80186994749

NO. RUNS 4 TOTAL X-Y ALL RUNS 24 NO. CONCENTR 24
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.51224893918
SLOPE= 0.0387086280057
R= 0.997758056822
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.216635334965
COMPUTE T
D.F.= 22
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.71713909197
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 1.33951833223
x(d)= 42.5942304591
```

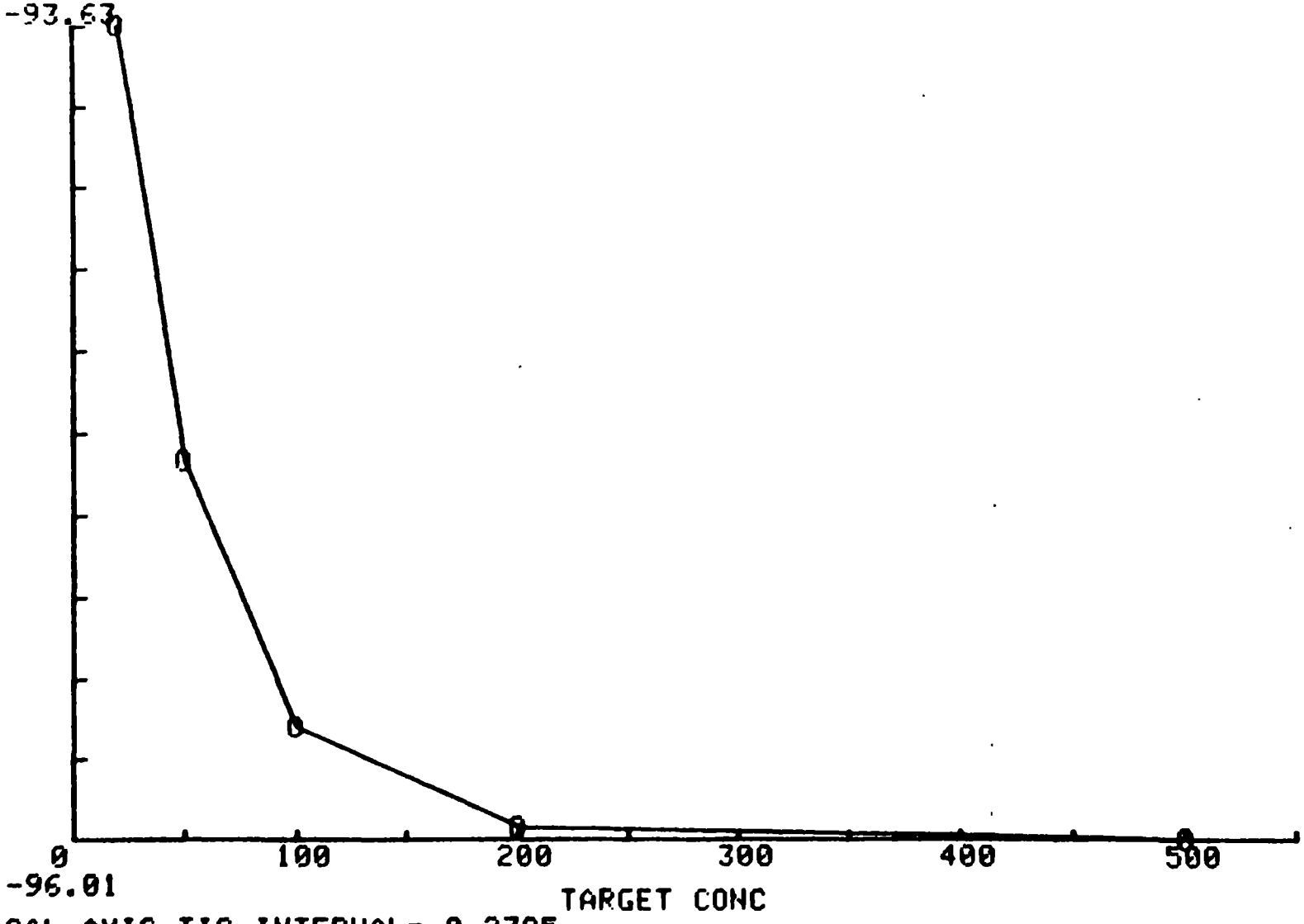

INR IN WATER
RUNS 1 2 3 4
PEAK AREA
21.00
y(c)
x(d)
0
0.00
100
200
300
400
500
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 2.1

THR IN WATER
RUNS 1 2 3 4
STATISTICAL DATA USED TO DETERMINE PERCENT INACCURACY AND COEFFICIENT OF VARIATION

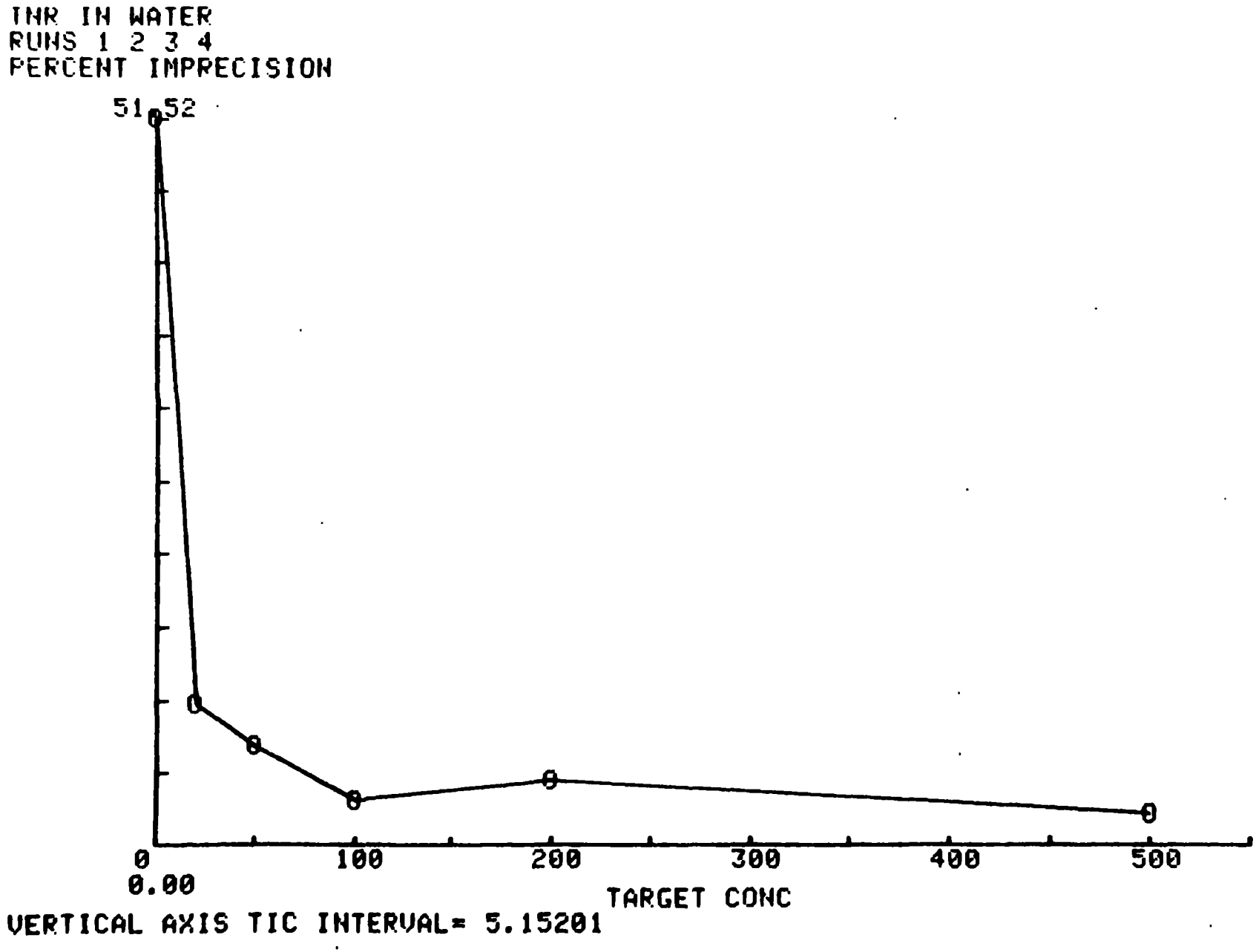
Target Conc. UG/L	Mean Found Conc. UG/L	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.00	2.62	4.77		182.26
20.00	19.69	1.14	-1.56	5.81
50.00	52.63	3.31	5.26	6.30
100.00	98.38	2.39	-1.62	2.43
200.00	194.36	8.49	-2.82	4.37
500.00	502.33	3.27	0.47	0.65


THR IN WATER
RUNS 1 2 3 4
STANDARD DEVIATION
0.45
0
0.00
0
100
200
300
400
500
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 0.04459

INF IN WATER
RUNS 1 2 3 4
MEAN PERCENT INACCURACY

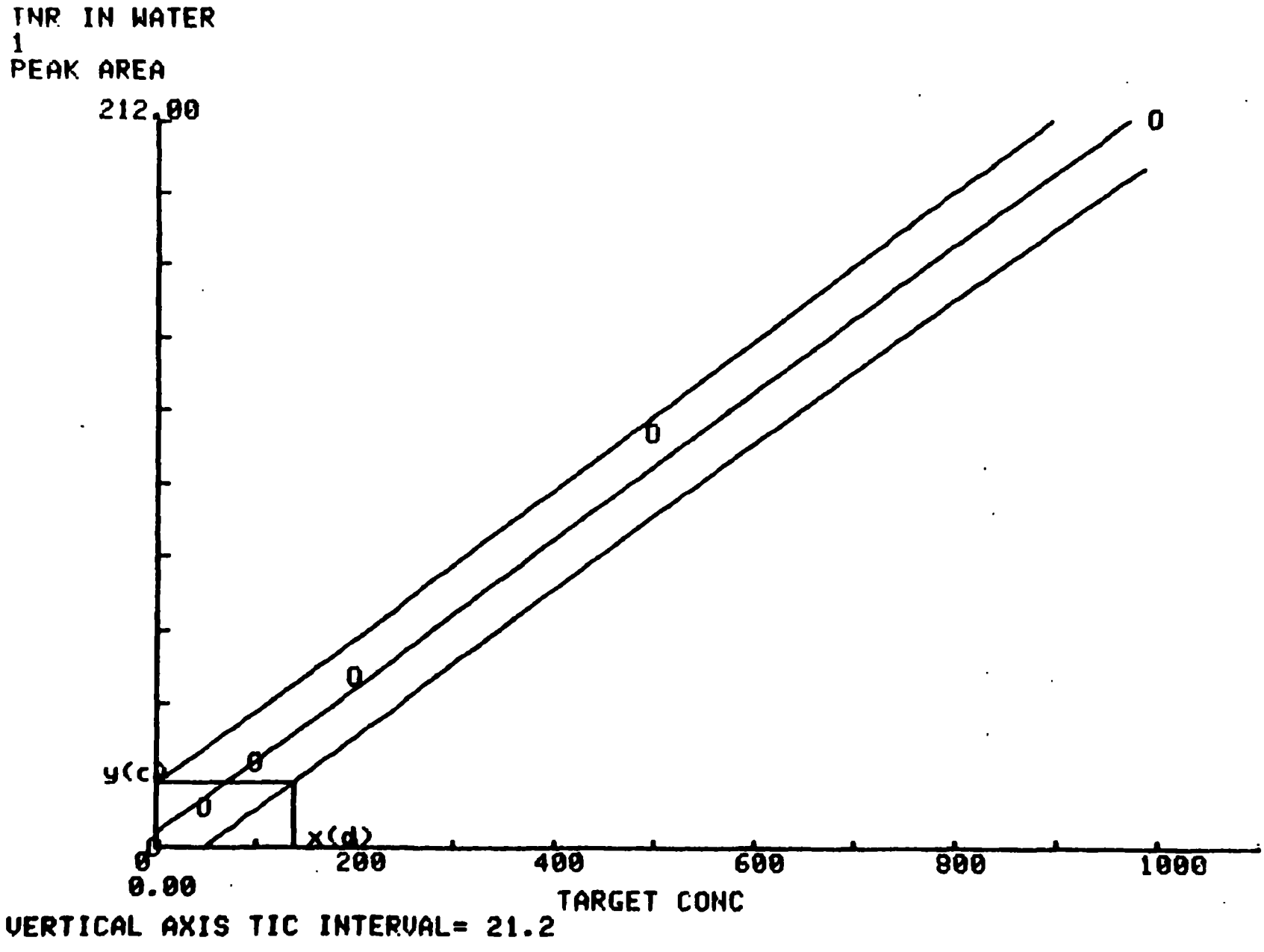


VERTICAL AXIS TIC INTERVAL= 0.2385


TNR IN WATER
RUNS 1 2 3 4
PERCENT IMPRECISION
51.52
0
0.00
100
200
300
400
500
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 5.15201

THR IN WATER
1
COMPILATION OF TARGET CONC. VS PEAK AREA

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	-19.58			
50.00	36.77			
100.00	97.81			
200.00	215.20			
500.00	543.90			
1000.00	975.89			


TNR IN WATER
1
PEAK AREA
212.00
0
0
0
0
0
y(c)
x(d)
0
200
400
600
800
1000
0.00
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 21.2

```
TNR IN WATER
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-PEAK AREA POINTS

MEAN= 308.333333333  SD= 382.64430829

PEAK AREA
MEAN= 69.8333333333  SD= 81.673537126

N0. RUNS 1 TOTAL X-Y ALL RUNS 6 N0. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 4.16903813318
SLOPE= 0.21296528173
R= 0.997752219201
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 37.4428002277
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 19.022561111
x(d)= 137.03470759
```

Method No. 9
Revised December 18, 1980

DETERMINATION OF HMX IN WATER

I. APPLICATION

This method is used to quantitatively determine the concentration of HMX (1,3,5,7-tetranitro-1,3,5,7-tetracyclo octane) in aqueous samples.

A. Tested Concentration Range. The concentration range analyzed is 8.0 µg/l to 200 µg/l in water.

B. Sensitivity Limits. The signal to noise ratio was 11:1 for 2 ng injected of HMX.

All the detection limit, 1 ng of HMX = 1.4×10^{-4} AU

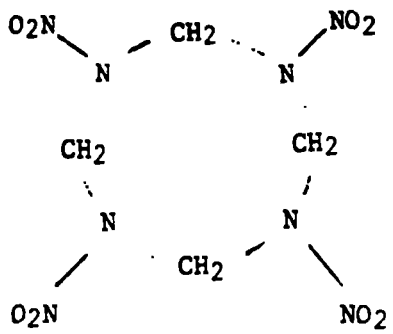
C. Detection Limits. Employing the method of Hubeaux and Vos, the detection limit for HMX in water was determined to be 8.0 µg/ℓ (lowest level standard).

D. Interferences. Components which elute with the same retention time as HMX and absorb UV light (254 nm) will interfere.

E. Analysis Rate. Approximately twenty samples can be analyzed by a worker in an 8 hour day after instrument calibration.

II. CHEMISTRY

Potential explosive, toxic inhalation and skin absorption hazards exist. Chemical structure for HMX:



Alternate nomenclature - cyclotetramethylene tetranitramine; 1, 3, 5, 7- tetranitro-1, 3, 5, 7-tetracyclooctane; homocyclonite

CAS RN # - 479-45-8

Melting point - 276-7°C

Boiling point - 337°C (explodes)

III. APPARATUS

A. Instrumentation. An Altex Model 100A pump equipped with an Altex Model 420 microprocessor. An LDC UV III Monitor (1203) detector, a Rheodyne Model 7120 injection valve with a 100 µl loop, and a Varian Model 9176 recorder. A Spectra Physics SP 4000 data system.

B. HPLC Parameters.

1. Column: Spherisorb 5 micron ODS, 250x4.6 mm.
2. Mobile Phase: Acetonitrile/water, 40/60, v/v.
3. Flow: 1 ml/min.
4. Temperature: 25°C
5. Detector wavelength and sensitivity: 254 nm, 0.004 AUFS
6. Recorder Span: 10 mv/full scale.
7. Injection volume: 100 µl.
8. Retention time for HMX: 9.8 ± 0.2 minutes.

C. Hardware/Glassware.

1. Microspatula.
2. 50, 100, 250 ml volumetric flasks.
3. 4 ounce bottles with Teflon lined screw caps
4. 2 dram vials with Teflon lined screw caps
5. Pasteur pipets (5 3/4") and bulbs.
6. 5 ml pipet and bulb.
7. Millipore solvent filtering apparatus.
8. Millipore filters, 0.45µ, type HA, 47 mm.
9. 100 µl Hamilton syringe.
10. Refrigerator and freezer.

D. Chemicals.

1. Acetone, DIG grade, Burdick and Jackson.
2. Millipore, Milli-Q purified water.

E. Reagents. None

IV. STANDARDS

A. Calibration Standards.

1. Stock. Ten milligrams of HMX are transferred to a 50 ml volumetric flask. The flask is diluted to the mark with acetone, and its contents are mixed well.

2. Diluted Stock. Ten milliters of the stock solution are pipetted into a 100 ml volumetric flask. The flask is diluted to the mark with acetone, and its contents are mixed well.
3. Working. Five calibration standards are prepared from the stock solutions in distilled water by placing 0, 25, 100, 250, 500, and 1000 microliters of diluted stock in a 100 ml volumetric flask and diluting to the mark, to give solutions containing 0, 8, 20, 50, 100, and 200 µg/ℓ.

B. Control Spikes. Control spikes are equivalent to the working standards, since the method involves direct aqueous injection.

V. PROCEDURE

A. Sample Handling/Preparation. Filter the samples through a 0.45 micron Millipore filter (Type GC). The samples, in Teflon lined, screw capped, two dram vials are stored in a refrigerator until analyzed.

B. Calibration. Inject 100 µls of each standard two times onto the chromatographic system. A solvent blank, represented by distilled water is also analyzed. Record the concentration, retention time and peak height for HMX. Average the peaks heights for the duplicate injections of each standard.

C. Analysis. Inject 100 µl of each sample onto the chromatographic system. Record the retention time and peak height for peaks eluting at the same time as HMX (within 0.1 minute of the HMX standard).

VI. CALCULATIONS

A linear regression curve (concentration vs. peak height) is generated from the HMX calibration data. The sample concentrations are interpolated using the curve.

The relationship between found component concentration and sample volume of water is as follows:

$$\text{ng found} \div 100\ \mu l = \frac{\text{Conc}(\mu g/l)}{1000}$$

VII. REFERENCES

None.

Spike Recovery Data for Water

HMX in water

N	Target Value ng/ml	Found Value ng/ml			
4	8.0	7.5	7.5	7.5	7.5
4	20	19	19	20	20
4	40	41	39	47	37
4	80	79	76	80	76
4	200	193	193	191	191

HMX IN WATER
RUNS 1 2 3 4
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
8.00	7.50	7.50	7.50	7.50
20.00	19.00	19.00	20.00	20.00
40.00	41.00	39.00	40.00	37.00
80.00	79.00	76.00	80.00	76.00
200.00	193.00	193.00	191.00	191.00

HMX IN WATER
RUNS 1 2 3 4
TARGET CONC
ANALYSIS OF 20 TARGET CONC-FOUND CONC POINTS

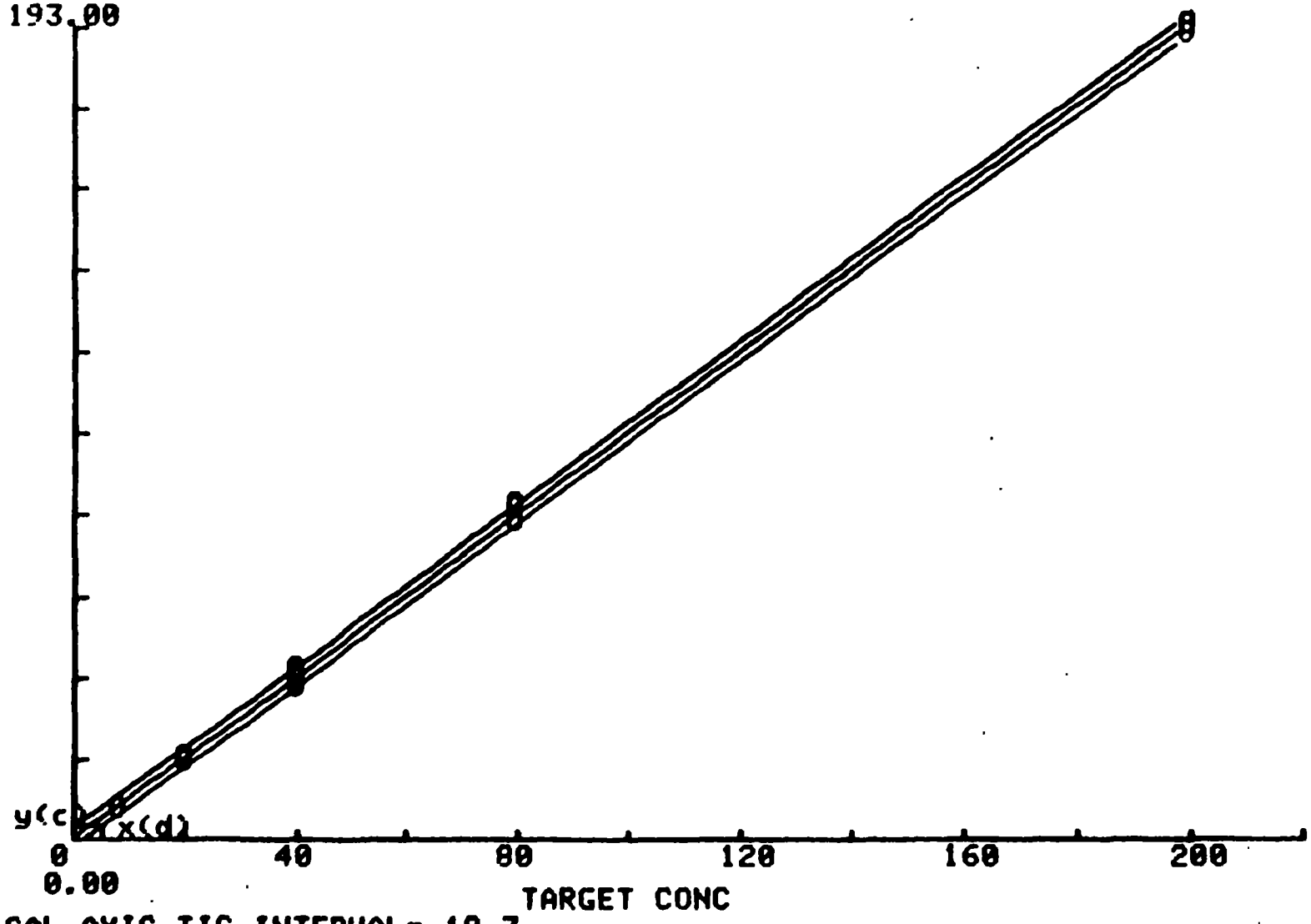
MEAN= 69.6 SD= 71.4411056672

FOUND CONC
MEAN= 67.2 SD= 68.5389631792

NO. RUNS 4 TOTAL X-Y ALL RUNS 20 NO. CONCENTR 20
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.438753959873
SLOPE= 0.959213305174
R= 0.999829234549
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 1.69335914584
COMPUTE T
D.F.= 18
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.73406096408
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 2.80536084237
x(d)= 4.92681190763

HMX IN WATER
RUNS 1 2 3 4
FOUND CONC

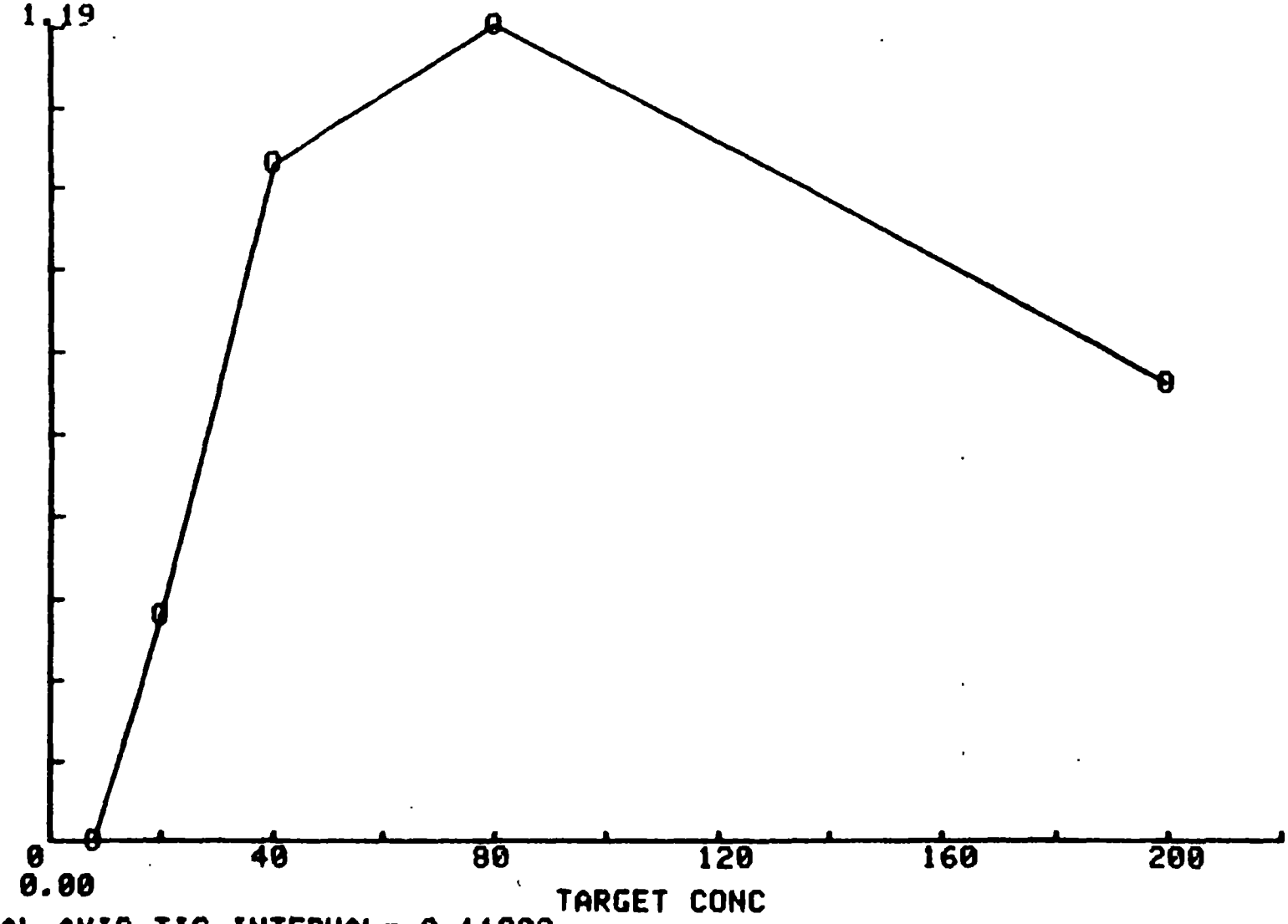


VERTICAL AXIS TIC INTERVAL= 19.3

HMX IN WATER
RUNS 1 2 3 4
STATISTICAL DATA USED TO DETERMINE PERCENT INACCURACY AND COEFFICIENT OF VARIATION

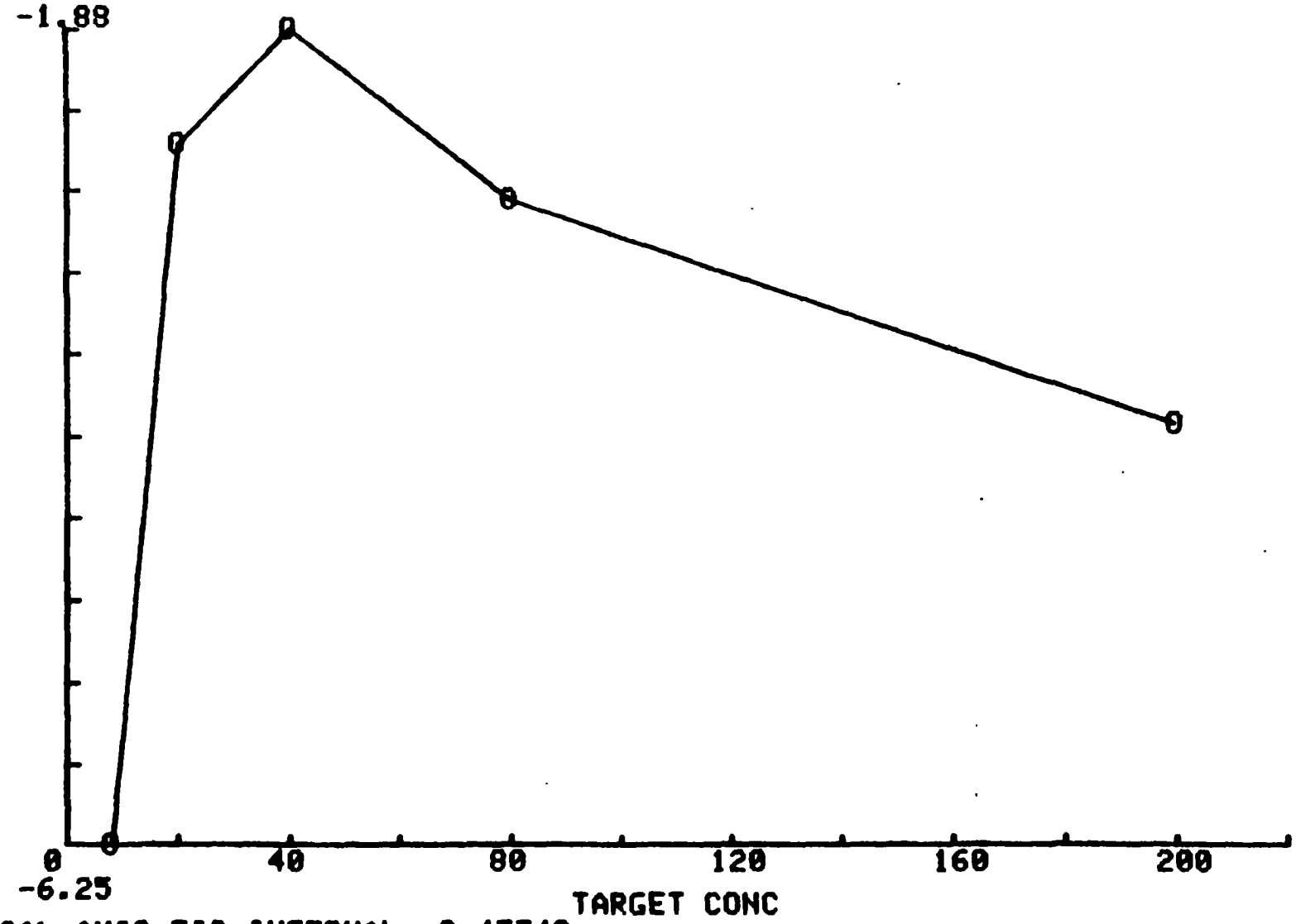
Target Conc. UG/L	Mean Found Conc. UG/L	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
8.00	7.50	0.00	-6.25	0.00
20.00	19.50	0.33	-2.50	1.71
40.00	39.25	0.99	-1.88	2.51
80.00	77.75	1.19	-2.81	1.53
200.00	192.00	0.67	-4.00	0.35

HMX IN WATER
RUNS 1 2 3 4
STANDARD DEVIATION



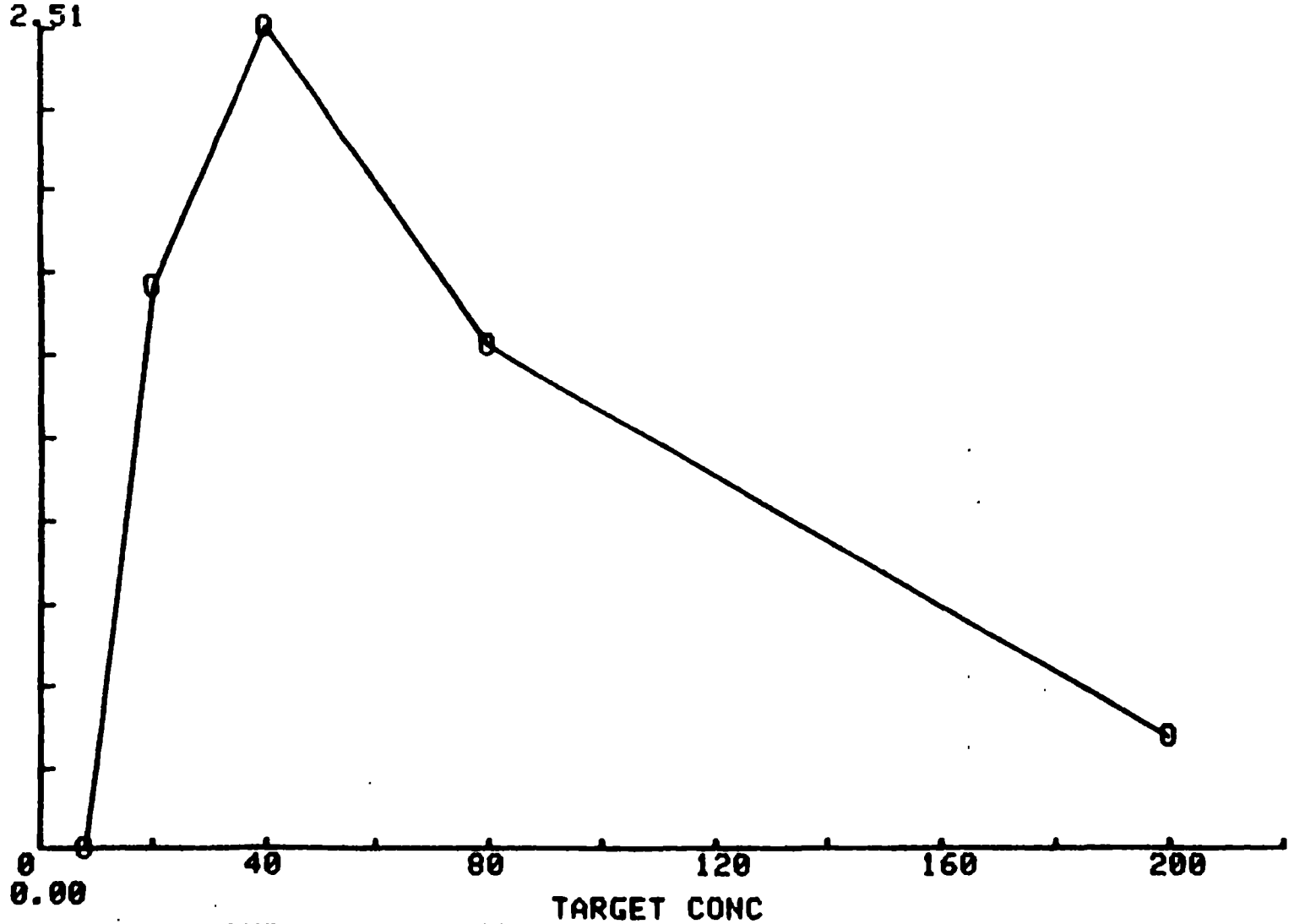
VERTICAL AXIS TIC INTERVAL= 0.11902

HMX IN WATER
RUNS 1 2 3 4
MEAN PERCENT INACCURACY



VERTICAL AXIS TIC INTERVAL= 0.43749

HMX IN WATER
RUNS 1 2 3 4
PERCENT IMPRECISION



VERTICAL AXIS TIC INTERVAL= 0.25121

Method No. 10

Revised December 18, 1980

THIN LAYER CHROMATOGRAPHIC SCREENING PROCEDURE FOR ORGANIC EXPLOSIVES ON BUILDING SURFACES AND IN SOLID PHYSICAL SAMPLES

I. APPLICATION

This method is a qualitative and semiquantitative screening procedure for explosives on building surfaces and physical samples.

The method involves 1) extraction of the explosives from the surface or physical sample with acetone, 2) separation of the explosives in the extract by TLC, and 3) identification of the individual components using a sequence of visualization techniques.

A. Tested Concentration Range. Given below are tested concentration ranges for some representative compounds.

Compound	µg on Plate	Surface Swabs µg/cm^2	Solid Physical samples µg/gram
TNT	3-15	0.4 -2.2	150-170
2,4 DNT	3-15	0.45-2.2	150-170
2,6 DNT	3-15	0.45-2.2	150-750
Tetryl	3-15	0.45-2.2	150-750
Styphnic acid	3-15	0.45-2.2	150-750
NG	4-15	0.6 -2.2	200-750
PETN	4-15	0.6 -2.2	200-750
NC	4-15	0.6 -2.2	200-750

B. Sensitivity. N/A

C. Detection Limits. Approximate detection limits for the various compounds are given below.

Compound	µg on Plate	Surface Swabs µg/cm^2	Solid Physical samples µg/gram
TNT	3	0.45	150
2,4 DNT	3	0.45	150
2,6 DNT	8	1.2	400
Tetryl	3	0.45	150
Styphnic acid	3	0.45	150
NG	4	0.6	200
PETN	4	0.6	200
NC	4	0.6	200

D. Interferences. Unknown compounds can interfere if they have the same RF value as the compound of interest. Use of a variety of visualization methods helps to reduce the number of interferences.

E. Analysis Rate. Approximately twenty samples can be analyzed by a worker in an eight hour day.

II. CHEMISTRY

Since this method is designed to be a general screening procedure for explosives individual compounds will not be discussed. In addition to the TLC separation system a series of visualization techniques are used to identify individual compounds. The utility of these visualization techniques is described below.

Visualization Techniques	Comments
Visible light	Colored compounds such as styphnic acid are detected.
UV light	UV active compounds will appear as dark spots on a green background by quenching the fluorescence of the dye on the TLC plate.
10% KOH	TNT for a bright red complex when base is applied. Tetryl also yields a red color.
Geiss reagent	Nitrate esters will give a red color with this spray.

III. APPARATUS

A. Instrumentation - N/A

B. Parameters - N/A

C. Hardware/Glassware.

1. 2 dram vials with polyseal caps.
2. TLC tank to hold 20 centimeter plates.
3. 100-µl syringe.
4. Cotton swabs (Q-tips).
5. 15-µl screw capped centrifuge tubes.
6. TLC sprayer.

7. Silica gel TLC plates, Whatman LK20F.
8. Oven.
9. Filter paper to line TLC tank.
10. 254 nm UV lamp.

D. Chemicals.

1. Butyl acetate, ACS grade.
2. Petroleum ether (30-60°C), Burdick and Jackson.
3. Acetone, Burdick and Jackson.
4. Potassium hydroxide, ACS grade.
5. Procaine, reagent grade.
6. N,N-dimethyl-1-naphthylamine, reagent grade.
7. Acetic acid, glacial, ACS grade.
8. Distilled water.

E. Reagents

A. 10% KOH in water. Dissolve 10 grams of KOH in distilled water and dilute to a final volume of 100 milliliters.

B. Modified Griess reagent. Dissolve 0.35 grams each of procaine and N,N-dimethyl-1-naphthylamine in 50% aqueous acetic acid solution.

IV. STANDARDS

Prepare individual solutions containing each compound of interest by placing 10 milligrams of the compound in a 100 milliliter volumetric flask and diluting to the mark with acetone. Mix the contents thoroughly, place in an eight ounce Teflon lined screw capped bottle, and store refrigerated.

V. PROCEDURE

A. Sample Collection and Preparation. (1) Building surfaces. Place 1.5 milliliters of acetone in a 2 dram vial. Mark a one meter square area on the surface to be sampled. Use cotton swabs (Q-tips) wetted with acetone to swab five 20

square centimeter areas within the marked area. Place the swabs in the vial, cap tightly, and return to the laboratory for analysis.

(2) Physical samples. Place 100 milligrams of the residue in a screw capped centrifuge tube containing 0.5 milliliters of acetone. Shake gently for 1 minute and let stand overnight. Remove a portion of the acetone extract for analysis.

B. TLC Separation. Spot 100 microliters of the acetone extract on the TLC plate. Spot standard explosives on separate channels at various levels (1-10 micrograms for most compounds). Allow the spots to dry on the plate.

Place the plate in a covered TLC tank lined with filter paper and containing 100 ml of 15% butyl acetate/85% petroleum ether (equilibrated 1 hour before placing the plate in the tank).

When the solvent front has advanced ~15 centimeters remove the plate from the tank, mark the solvent front and allow the plate to air dry in a hood.

C. Visualization and Component Identification. Apply the following sequence of visualization techniques:

- Visible light
- UV light
- Spray with 10% KOH
- Heat in oven at 105°C for 30 minutes
- Spray with modified Griess reagent.

Note all spots and measure their RF values. If the RF value of a particular component matches one of the standards estimate the level by visual comparision of the spot intensities of the sample and standard.

If a component responds equivilently to one of the standards in all visualization methods and has an RF value within .05 units of the expected value it should be reported as the compound of interest.

VI. CALCULATIONS

$$RF = \frac{\text{Distance travelled by component (cm)}}{\text{Distance travelled by solvent front (cm)}}$$

For building surfaces:

concentration ($\mu g/cm^2$) = μg/plate x 0.15

For physical samples

concentration (μg/gram) = μg/plate x 50

VII. REFERENCES None

VIII. SUPPORTING DATA

The following table provides typical RF and response data for several explosives of interest.

Compound	RF	Visible	UV	10% KOH	Griess
TNT	0.83		+	red color	
2,4 DNT	0.63		+		
2,6 DNT	0.73		+		
Tetryl	0.44			brown-red color	
Styphnic acid	0	yellow color	+		
NG	0.64				red color
PETN	0.82				red color
NC	0				red color

The accuracy of this method has been determined at various levels for several explosives by running a series of blind acetone spikes. These data arepresented in the following table:

	Concentration (ug on plate)									
Compound	Spiked	Found	Spiked	Found	Spiked	Found	Spiked	Found	Spiked	Found
TNT	0	0	3	5	6	10	8	15	15	13
2,4 DNT	0	0	3	4	6	5	8	10	15	12
2,6 DNT	0	0	3	ND	6	ND	8	4	15	6
Tetryl	0	0	3	3	6	4	8	11	15	16
Styphnic acid	0	0	3	7	6	23	8	12	15	33
NG	0	0	4	12	8	25	10	37	15	30
PETN	0	0	4	8	8	12	10	22	15	17
NC	0	0	4	2	8	5	10	7	15	7

The precision of the method is estimated to be ±25%, on the basis of intensities observed for replicate standards. The precision is highly dependant on the person conducting the analysis as well as the sample background level.

Method No. 11

Revised December 18, 1980

DETERMINATION OF 2,4-DNT, 2,6-DNT, TNT AND TETRYL IN WATER AND SOIL

I. Application: This method is used to qualitatively determine the concentration of 2,4-DNT, 2,6-DNT, TNT, and tetryl in water and soil samples.

A. Tested Concentration Range - The concentration ranges are as follows:

	Water	Soil
2,6-DNT	0.1-10	--
2,4-DNT	0.2-8.1	0.51-5.1
TNT	0.16-6.7	0.42-4.2
Tetryl	0.2-8.1	0.51-5.1

B. Sensitivity Limits -

At the detection limit, 1 ng of 2,6-DNT = 1,150,000 area counts
1 ng of 2,4-DNT = 1,150,000 area counts
1 ng of TNT = 1,060,000 area counts
1 ng of Tetryl = 378,000 area counts

C. Detection Limits - (Calculated using the method of Hubaux and Vox).

In water:

2,6-DNT	0.64 µg/l
2,4-DNT	0.39 µg/l
TNT	1.5 µg/l
Tetryl	1.3 µg/l

In soil:

2,4-DNT	0.51 µg/g (lowest std)
TNT	1.9 µg/g
Tetryl	1.1 µg/g

D. Interferences - None observed for water samples. Several soil samples had a large, broad eluting peak which interfered with the determination of 2,4-DNT, 2,6-DNT, and TNT. In these cases, the detection limit was reduced by a factor of 10, due to the sample dilution required.

E. Analysis Rate - Approximately 10 water samples or 15 soil samples can be analyzed by one worker in an eight hour day.

II. Chemistry

$C_7H_6N_2O_4$ Toluene, 2,4-Dinitro-
CAS RN 121-14-2
Melting PT-71C Boiling Pt-300 C (decomposes)

$C_7H_6N_2O_4$ Toluene, 2,6-Dinitro-
CAS RN 606-20-2
Melting Pt-66 C

$C_7H_5N_3O_6$ Toluene, 2,4,6-Trinitro-
CAS RN 118-96-7
Melting Pt-82 C Boiling Pt-240 C (explodes)

$C_7H_5N_5O_8$ Aniline, N-Methyl-N,2,4,6-Tetranitro-
CAS RN 479-45-8
Melting Pt-131 C Boiling Pt-187 C (explodes)

Hazards: Use caution in handling. Potential explosive, toxic inhalation, and skin absorption hazards exist.

A. Chemical Reactions - N/A

B. Retention Times

2,6-DNT	2.80 minutes
2,4-DNT	3.60 minutes
TNT	8.65 minutes
Tetryl	18.40 minutes

C. Hardware/Glassware

1. 1000 ml separatory funnels
2. 2 dram vials with polyseal caps
3. 5 ml volumetric flasks
4. 250 ml bottles with polyseal caps
5. 100 ml pipet
6. refrigerator
7. shaker
8. 30 mesh sieve
9. riffler
10. Kuderna-Danish tubes and columns
11. heated water bath
12. 100 ml volumetric flask
13. Millipore All Glass Filter Apparatus
14. Millipore Filters, 0.45 micron, type HA, 47 mm diameter

D. Chemicals

1. benzene, DIG grade, Burdick and Jackson
2. acetone, DIG grade, Burdick and Jackson

E. Reagents None.

III. Standards

A. Stock - Weigh 10 mg each of 2,4-DNT, 2,6-DNT, TNT, and Tetryl into a 100 ml volumetrick flask, dilute to the mark with benzene and mix thoroughly.

B. Working - Six calibration standards are prepared from the stock solutions to give solutions containing each component at levels of 0.02, 0.05, 0.1, 0.2, 0.5, and 1.0 µg/ml by placing 20, 50, 100, 200, 500, and 1000 µl of stock in a 100 ml flask and diluting to the mark with benzene.

IV. Procedure

A. Water Samples/Control Spikes

1. Sample Handling/Preparation - Refrigerate the samples until they are to be extracted. Filter through a 0.45 micron Millipore filter prior to analysis.

2. Extraction - Measure 500 ml of the sample into the separatory funnel. Add 25 ml of benzene and shake vigorously. Allow the layers to separate and remove the benzene layer. Transfer to a Kuderna-Danish tube with a short distillation column and concentrate the benzene to less than 5 ml using a heated water bath in a well ventilated hood. Transfer the benzene to a 5 ml volumetric flask and dilute to the mark with benzene.

3. Calibration - Inject 2 µl of each calibration standard in duplicate onto the GC column. Record the retention time, concentration, and peak area for each component.

4. Analysis - Inject 2 µl of sample extract onto the GC column. Record the retention time and peak area for the peaks of interest.

B. Soils

1. Sample Handling/Preparation - Samples are air dried and then sieved through a 30 mesh screen. Particles passing through are retained for analysis. Samples are then riffled to obtain even particle size distribution.

2. Extraction - Weigh 10 g of sample into a 250 ml bottle. Add 100 ml of DIG acetone and shake for 1 hour using a mechanical shaker. Allow particles to settle for 1 hour and then transfer an aliquot to a 2 dram vial. Refrigerate until ready to analyze.

3. Calibration - Inject 2 µl of each standard onto the GC column. Record the retention time, concentration, and peak area for each component.

4. Analysis - Inject 2 µl of each sample onto the GC column. Record the retention time and peak areas for those peaks of interest.

V. Calculations

Use the calibration data from each component to establish a linear regression curve for each component. Interpolate sample concentration from these curves.

The relationship between found component concentration and sample volume of water is as follows:

ng/2 µℓ = µg/5mℓ benzene ÷ 2.5 = µg/500 mℓ water ÷ 2.5

ng/2 µℓ x 5 = µg/liter = ppb

The relationship between found component concentration and sample weight for soil is as follows:

$$\text{ng/2 µℓ} = \frac{\text{µg in sample}}{50}$$

µg in sample = ng/2 µℓ x 50

$$\frac{\text{µg found}}{\text{sample wt. (gram)}} = \text{ppm}$$

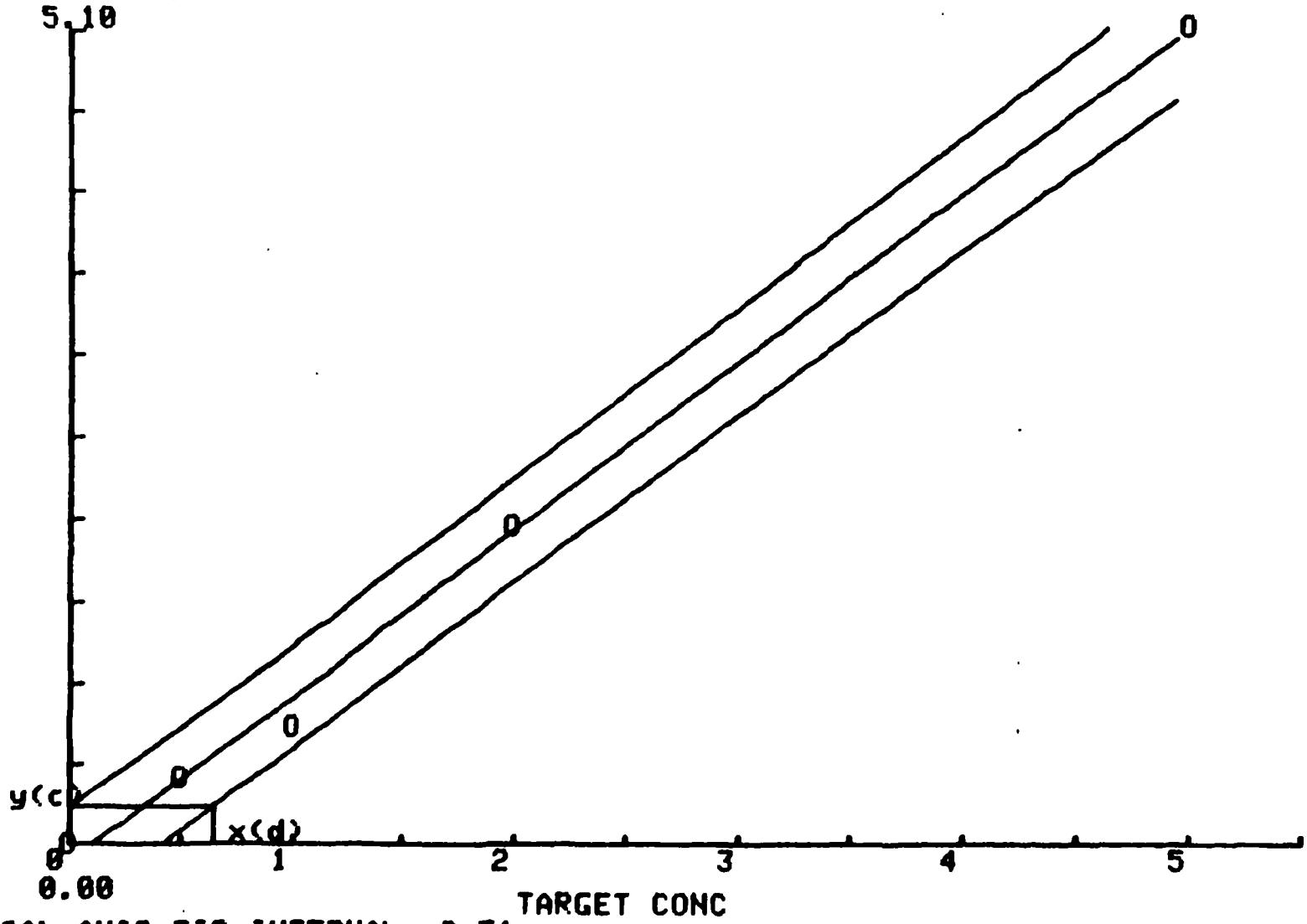
VI. References - None.

2,6-DNT IN WATER
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	0.00			
0.50	0.42			
1.00	0.75			
2.00	2.00			
5.00	5.10			

```
2,6-DNT IN WATER
1
TARGET CONC
ANALYSIS OF 5 TARGET CONC-FOUND CONC POINTS

MEAN= 1.7  SD= 1.98746069144

FOUND CONC
MEAN= 1.654  SD= 2.06581218895

NO. RUNS 1 TOTAL X-Y ALL RUNS 5 NO. CONCENTR 5
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.110664556962
SLOPE= 1.03803797468
R= 0.998667585533
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.0151530590719
COMPUTE T
D.F.= 3
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.3533525706
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.230005789158
x(d)= 0.642785953083
```

2,6-DNT IN WATER
1
FOUND CONC



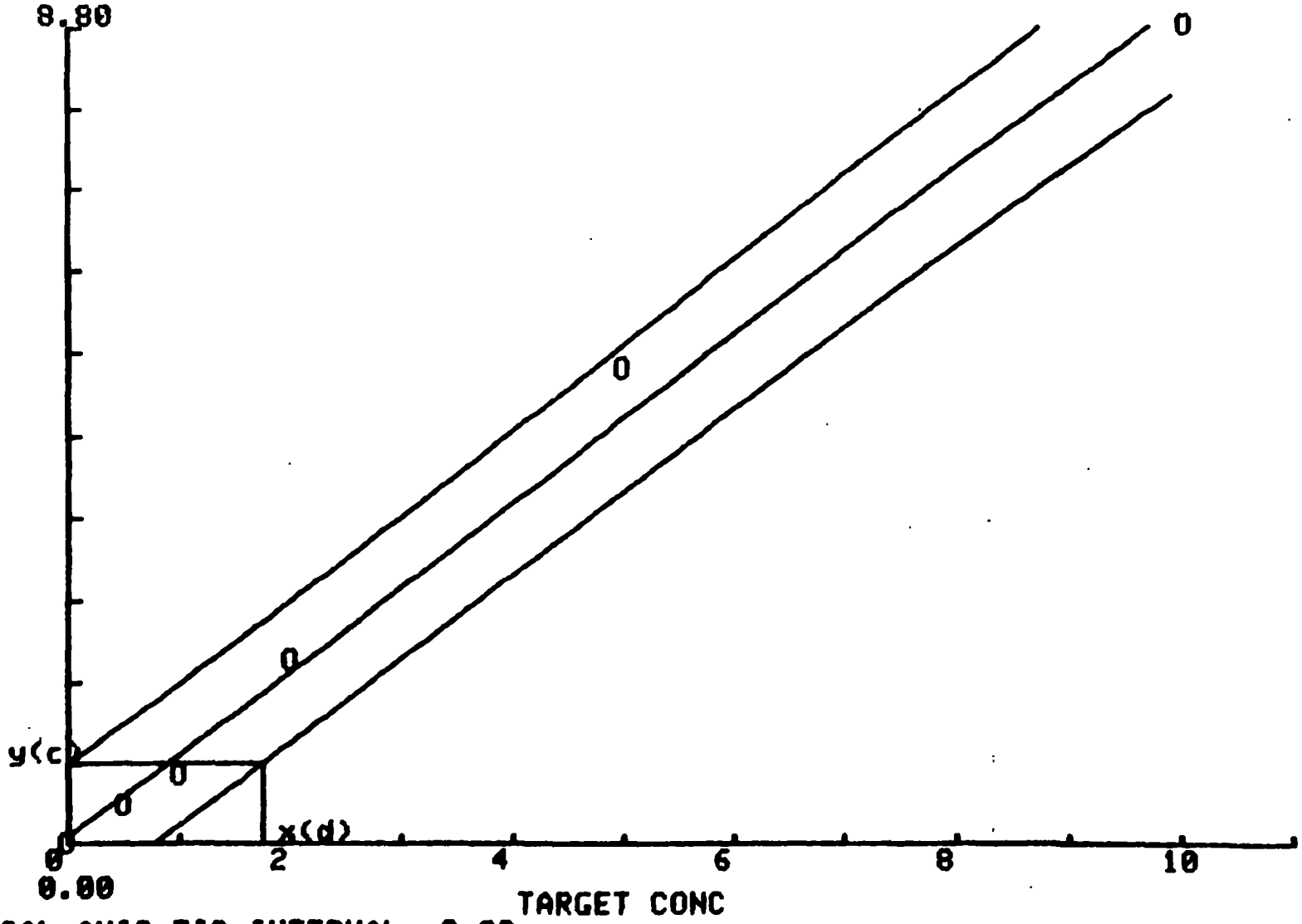
VERTICAL AXIS TIC INTERVAL= 0.51

2,6-DNT IN WATER
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	0.00			
0.50	0.42			
1.00	0.75			
2.00	2.00			
5.00	5.10			
10.00	8.80			

```
2,6-DNT IN WATER
1
TARGET CONC
ANALYSIS OF 6 TARGET CONC-FOUND CONC POINTS

MEAN= 3.08333333333  SD= 3.8264430829

FOUND CONC
MEAN= 2.845  SD= 3.45325209042

NO. RUNS 1 TOTAL X-Y ALL RUNS 6 NO. CONCENTR 6
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.0725270347183
SLOPE= 0.899180421172
R= 0.996354338688
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.108487706318
COMPUTE T
D.F.= 4
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 2.13183865604
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.872058528967
x(d)= 1.7415015287
```

2,6-DNT IN WATER
1
FOUND CONC



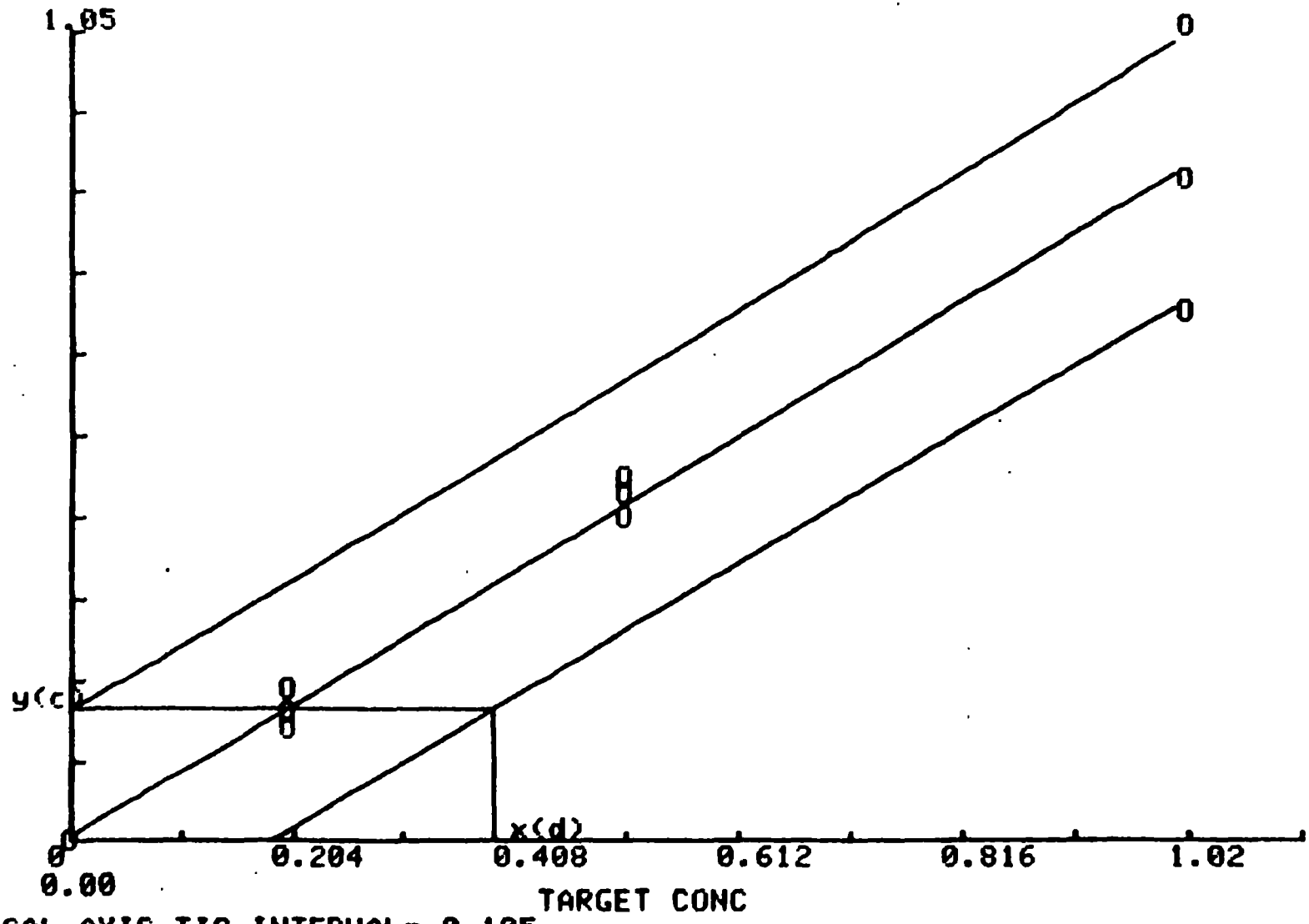
VERTICAL AXIS TIC INTERVAL= 0.88

2,4-DNT IN WATER
RUNS 1 2 3
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.00	0.00	0.00	0.00	
0.20	0.15	0.20	0.17	
0.51	0.45	0.47	0.42	
1.02	0.85	0.68	1.05	

```
3,4-DNT IN WATER
RUNS 1 2 3
TARGET CONC
ANALYSIS OF 12 TARGET CONC-FOUND CONC POINTS

MEAN= 0.4325  SD= 0.401907384175

FOUND CONC
MEAN= 0.37  SD= 0.348477206767

NO. RUNS 3 TOTAL X-Y ALL RUNS 12 NO. CONCENTR 12
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.00519888002476
SLOPE= 0.843470797631
R= 0.972795739063
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.00716903155911
COMPUTE T
D.F.= 10
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.81245868646
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.172507320123
x(d)= 0.387824637321
```

2,4-DNT IN WATER
RUNS 1 2 3
FOUND CONC

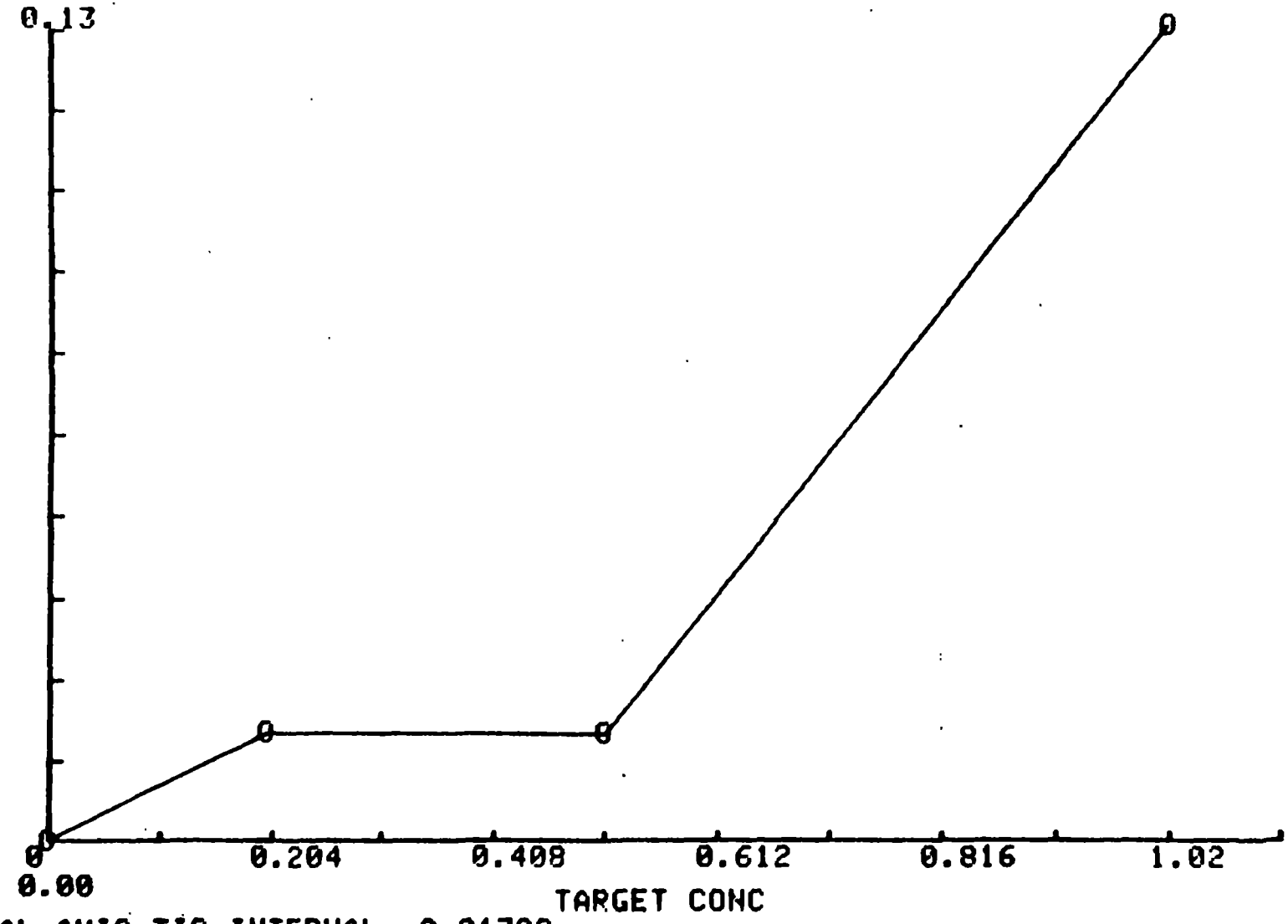


VERTICAL AXIS TIC INTERVAL= 0.105

2,4-DNT IN WATER
RUNS 1 2 3
STATISTICAL DATA USED TO DETERMINE PERCENT INACCURACY AND COEFFICIENT OF VARIATION

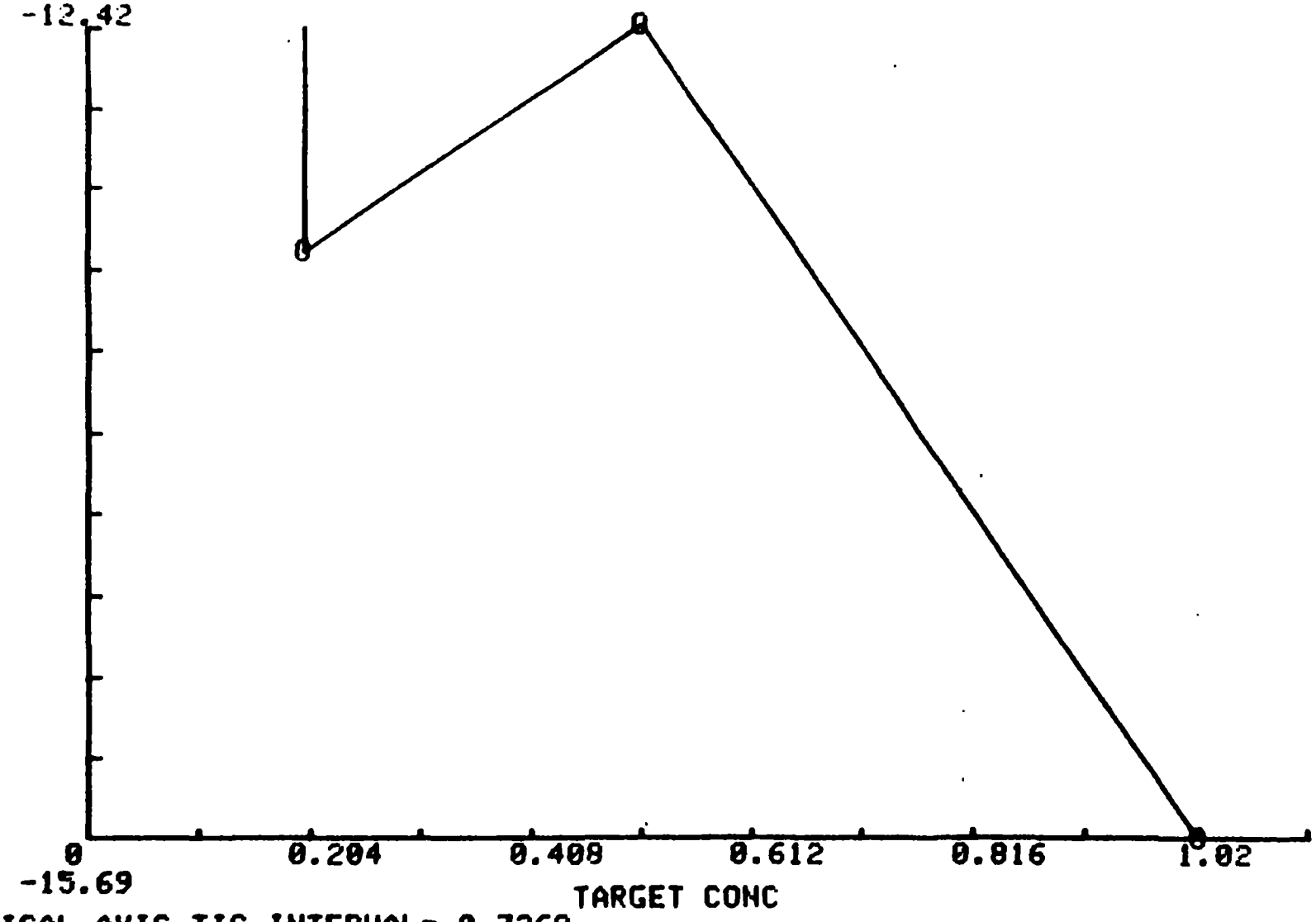
Target Conc. UG/L	Mean Found Conc. UG/L	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.00	0.00	0.00		
0.20	0.17	0.02	-13.33	10.27
0.51	0.45	0.02	-12.42	3.98
1.02	0.86	0.13	-15.69	15.23

2,4-DNT IN WATER
RUNS 1 2 3
STANDARD DEVIATION



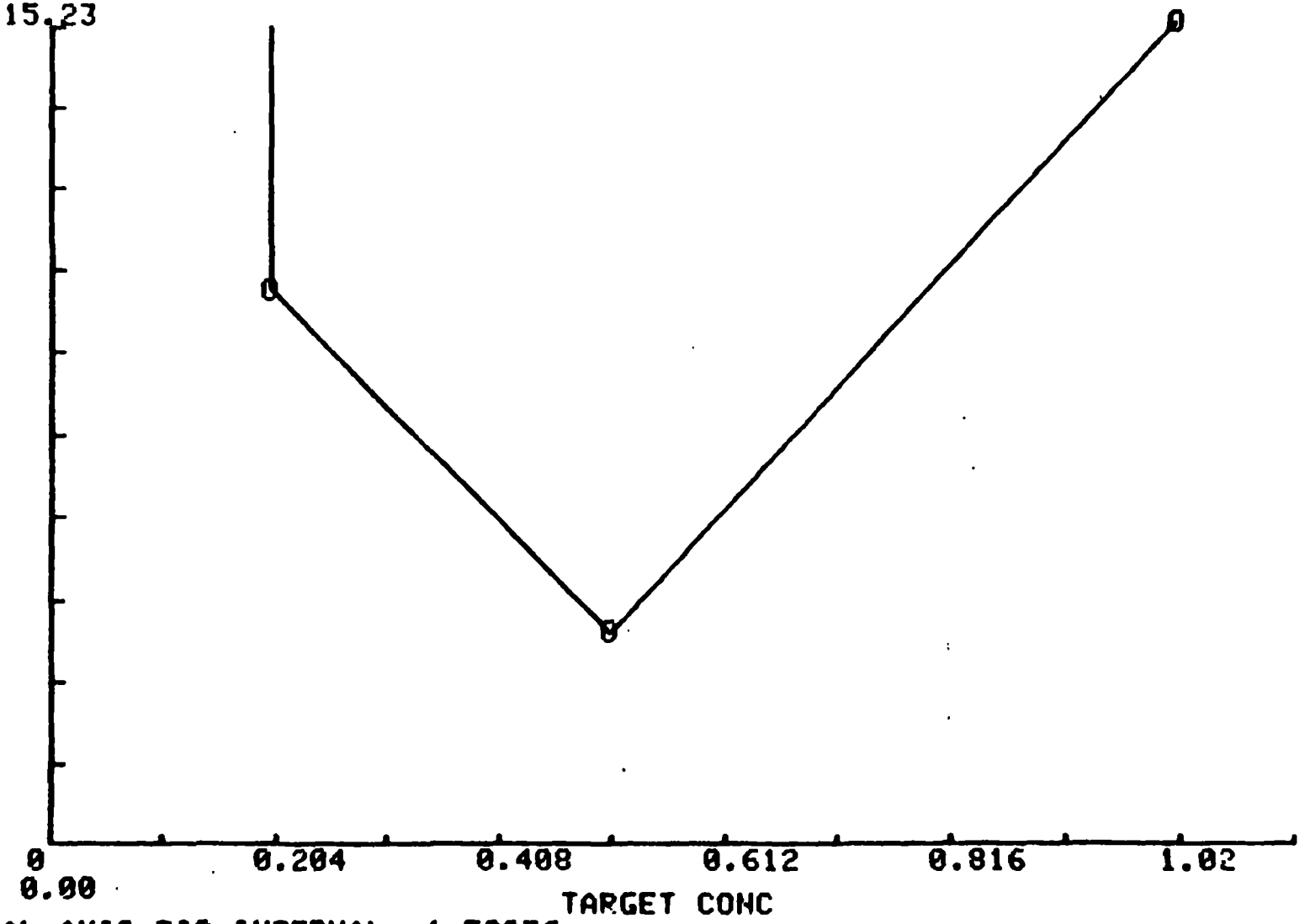
VERTICAL AXIS TIC INTERVAL= 0.01309

2,4-DNT IN WATER
RUNS 1 2 3
MEAN PERCENT INACCURACY



VERTICAL AXIS TIC INTERVAL= 0.3268

2,4-DNT IN WATER
RUNS 1 2 3
PERCENT IMPRECISION



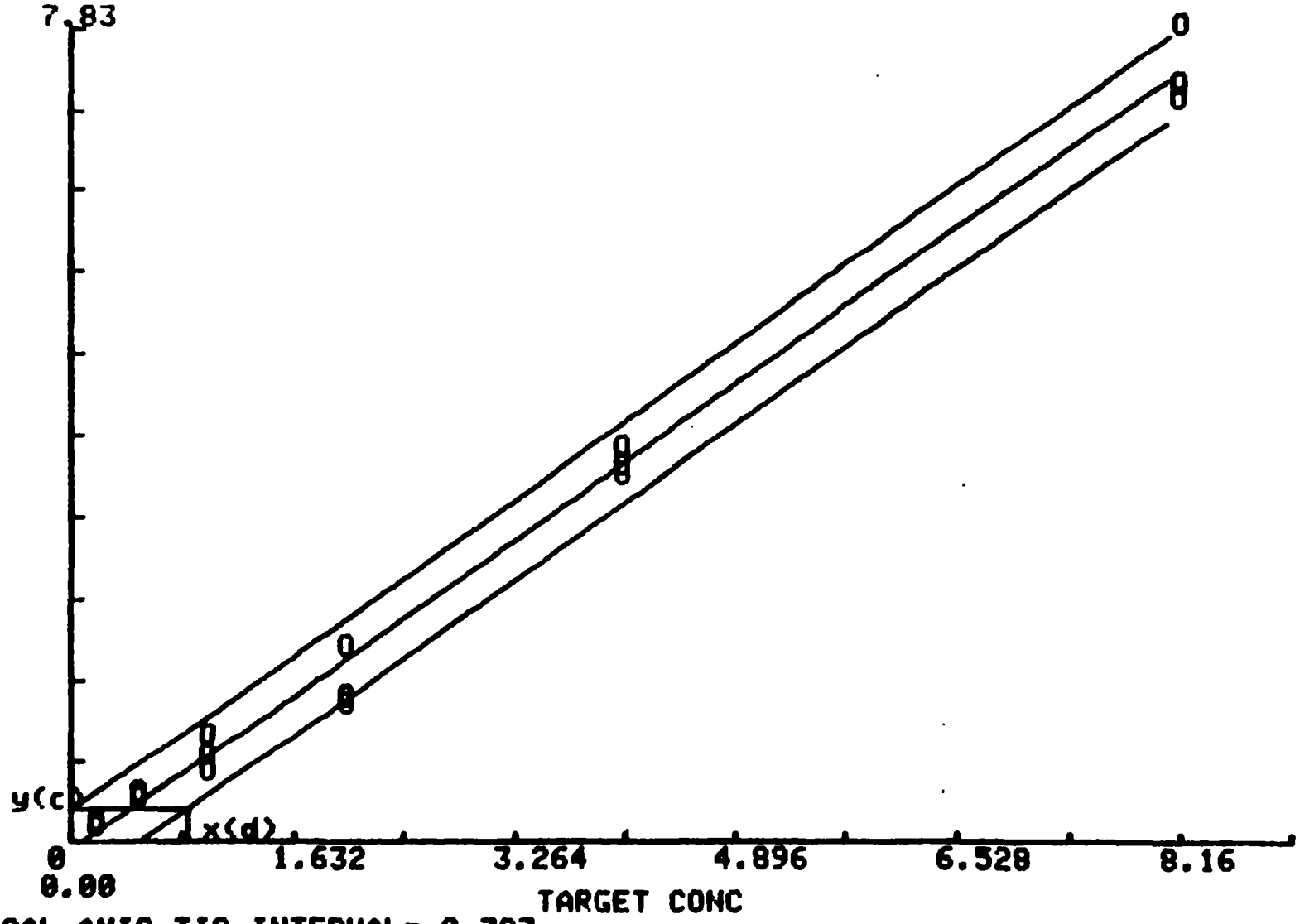
VERTICAL AXIS TIC INTERVAL= 1.52276

2,4-DNT IN WATER
RUNS 1 2 3
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.20	0.15	0.20	0.17	
0.51	0.45	0.47	0.42	
1.02	0.85	0.68	1.05	
2.04	1.37	1.43	1.90	
4.08	3.63	3.55	3.79	
8.16	7.26	7.13	7.83	

```
2,4-DNT IN WATER
RUNS 1 2 3
TARGET CONC
ANALYSIS OF 18 TARGET CONC-FOUND CONC POINTS

MEAN= 2.669  SD= 2.84897349935

FOUND CONC
MEAN= 2.35166666667  SD= 2.61175228534

NO. RUNS 3 TOTAL X-Y ALL RUNS 18 NO. CONCENTR 18
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.087540182218
SLOPE= 0.913902903291
R= 0.996911218214
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.0447032285582
COMPUTE T
D.F.= 16
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.74588066418
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.30087257849
x(d)= 0.844696342542
```

2,4-DNT IN WATER
RUNS 1 2 3
FOUND CONC

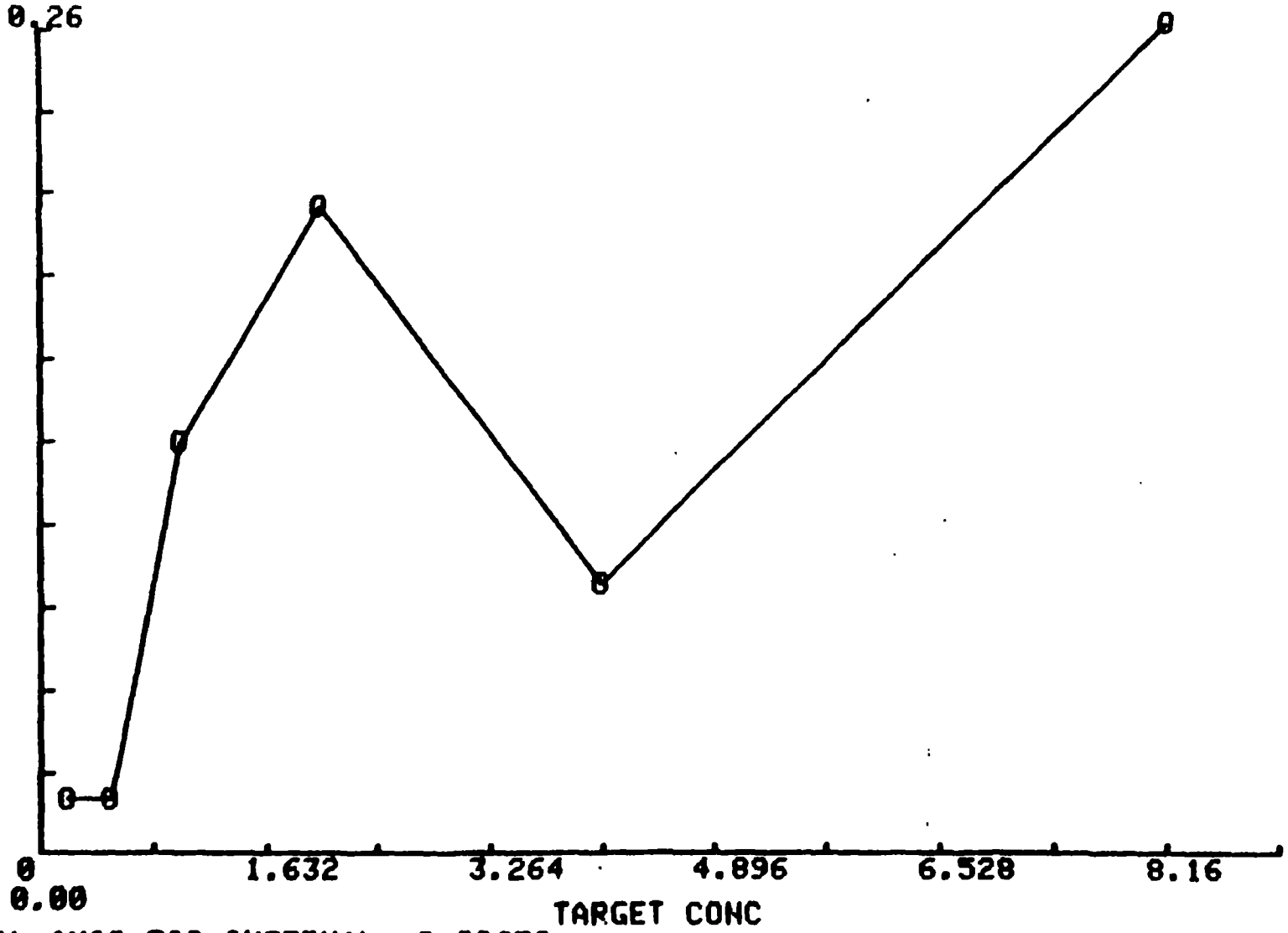


VERTICAL AXIS TIC INTERVAL= 0.783

2,4-DNT IN WATER
RUNS 1 2 3
STATISTICAL DATA USED TO DETERMINE PERCENT INACCURACY AND COEFFICIENT OF VARIATION

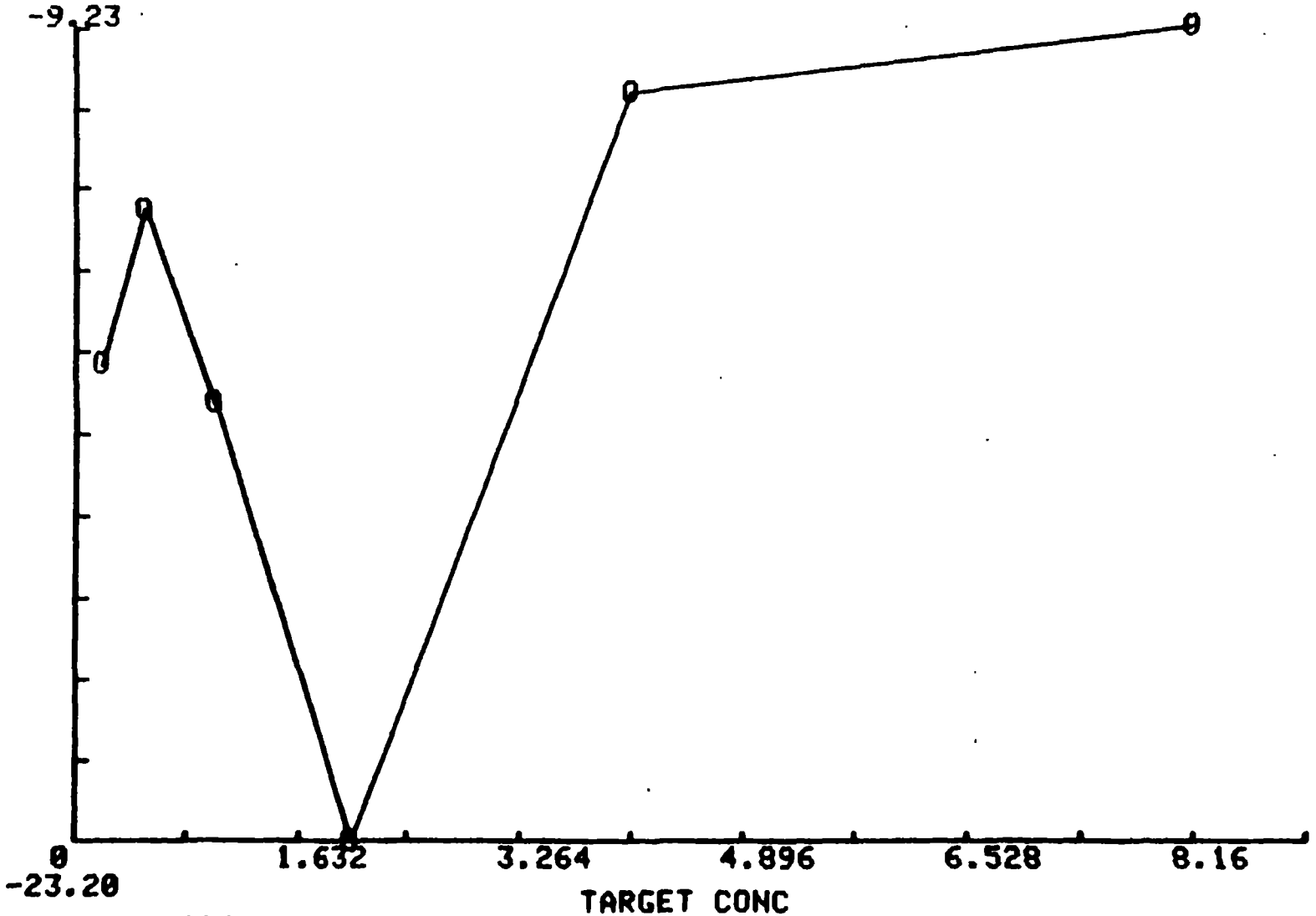
Target Conc. UG/L	Mean Found Conc. UG/L	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.20	0.17	0.02	-15.03	10.27
0.51	0.45	0.02	-12.42	3.98
1.02	0.86	0.13	-15.69	15.23
2.04	1.57	0.21	-23.20	13.10
4.08	3.66	0.09	-10.38	2.36
8.16	7.41	0.26	-9.23	3.55

2,4-DNT IN WATER
RUNS 1 2 3
STANDARD DEVIATION



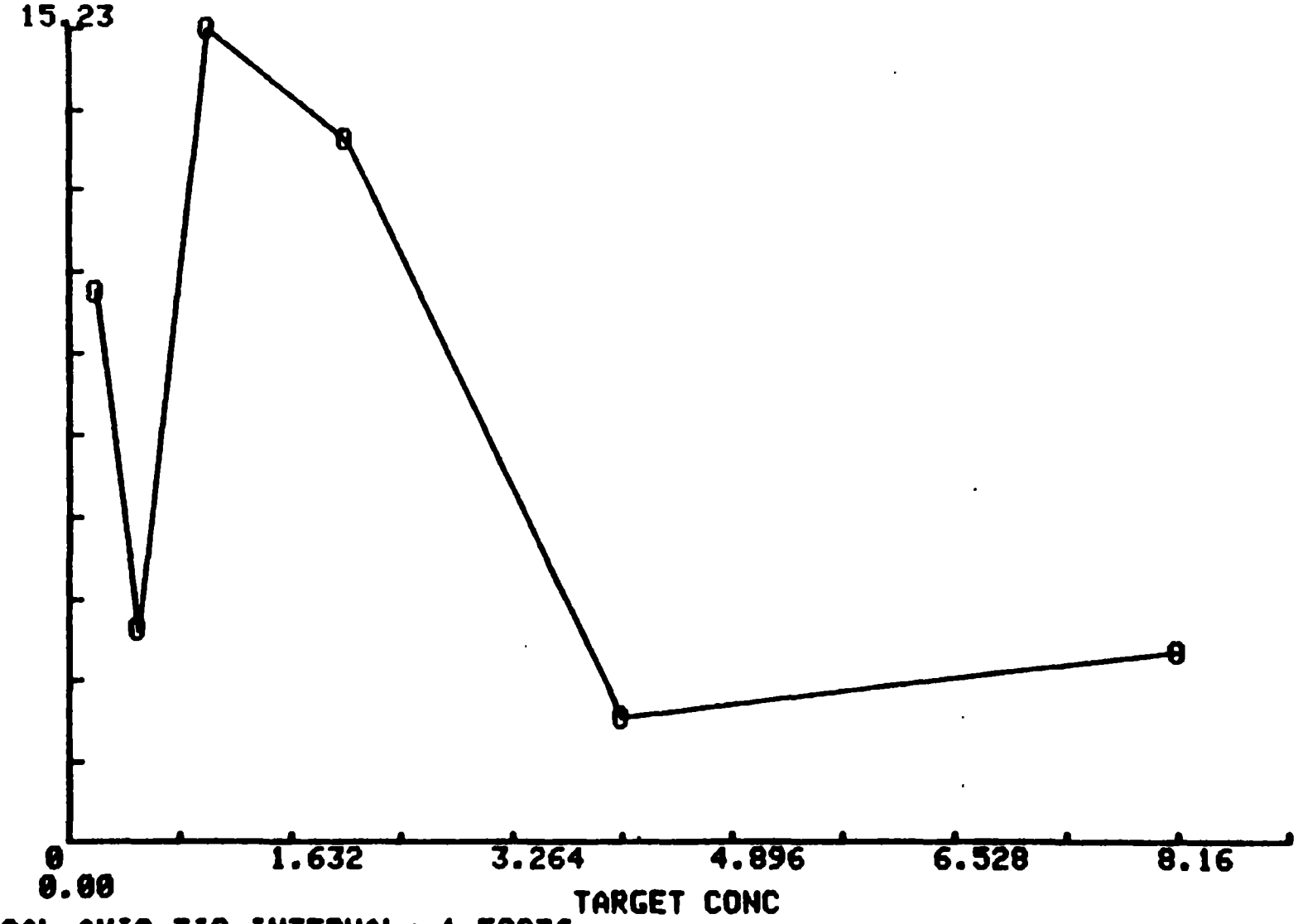
VERTICAL AXIS TIC INTERVAL= 0.02632

2,4-DNT IN WATER
RUNS 1 2 3
MEAN PERCENT INACCURACY



VERTICAL AXIS TIC INTERVAL= 1.39706

2,4-DNT IN WATER
RUNS 1 2 3
PERCENT IMPRECISION

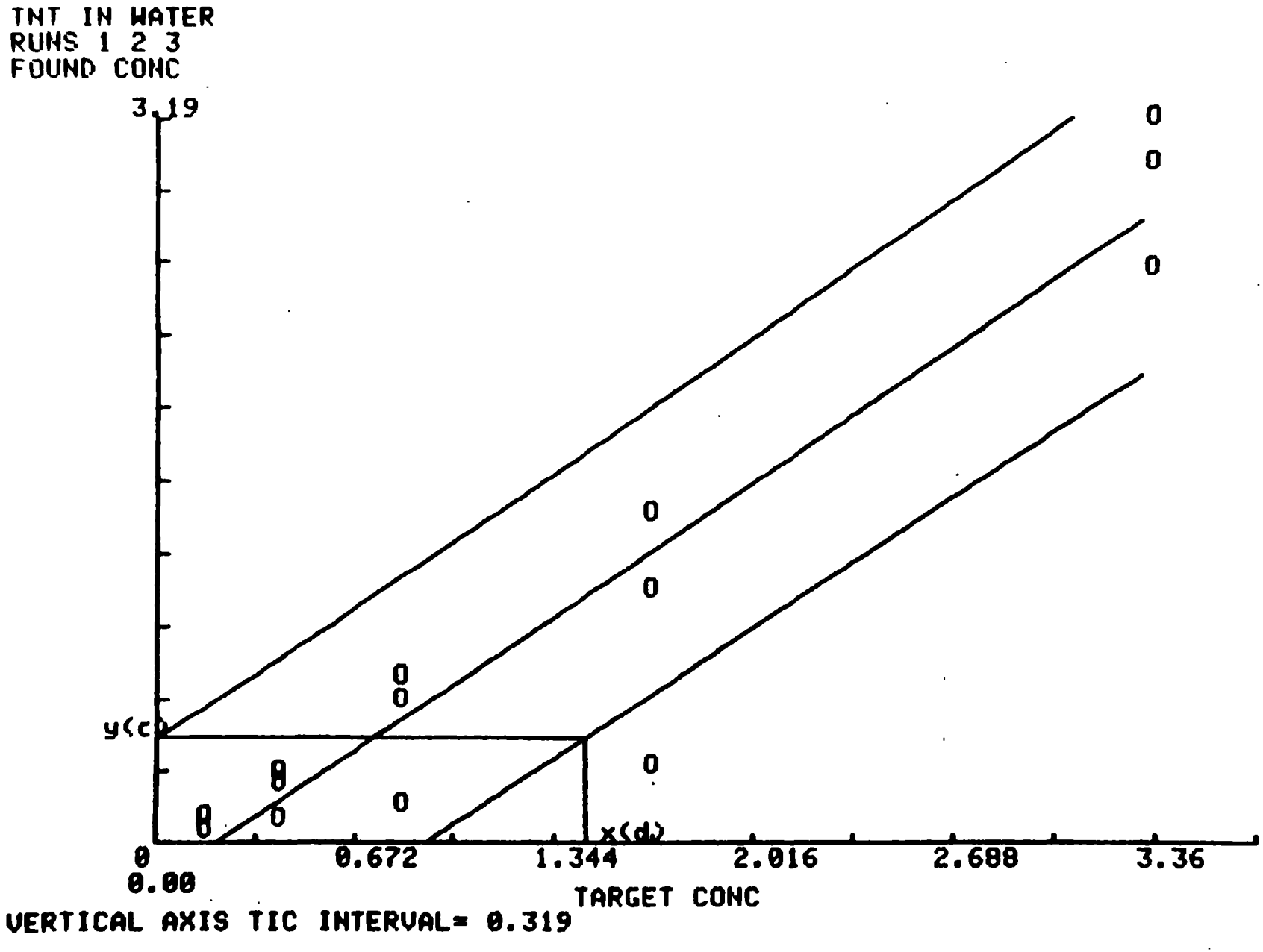


VERTICAL AXIS TIC INTERVAL= 1.52276

TNT IN WATER
RUNS 1 2 3
COMPILATION OF TARGET CONC. VS FOUND CONC

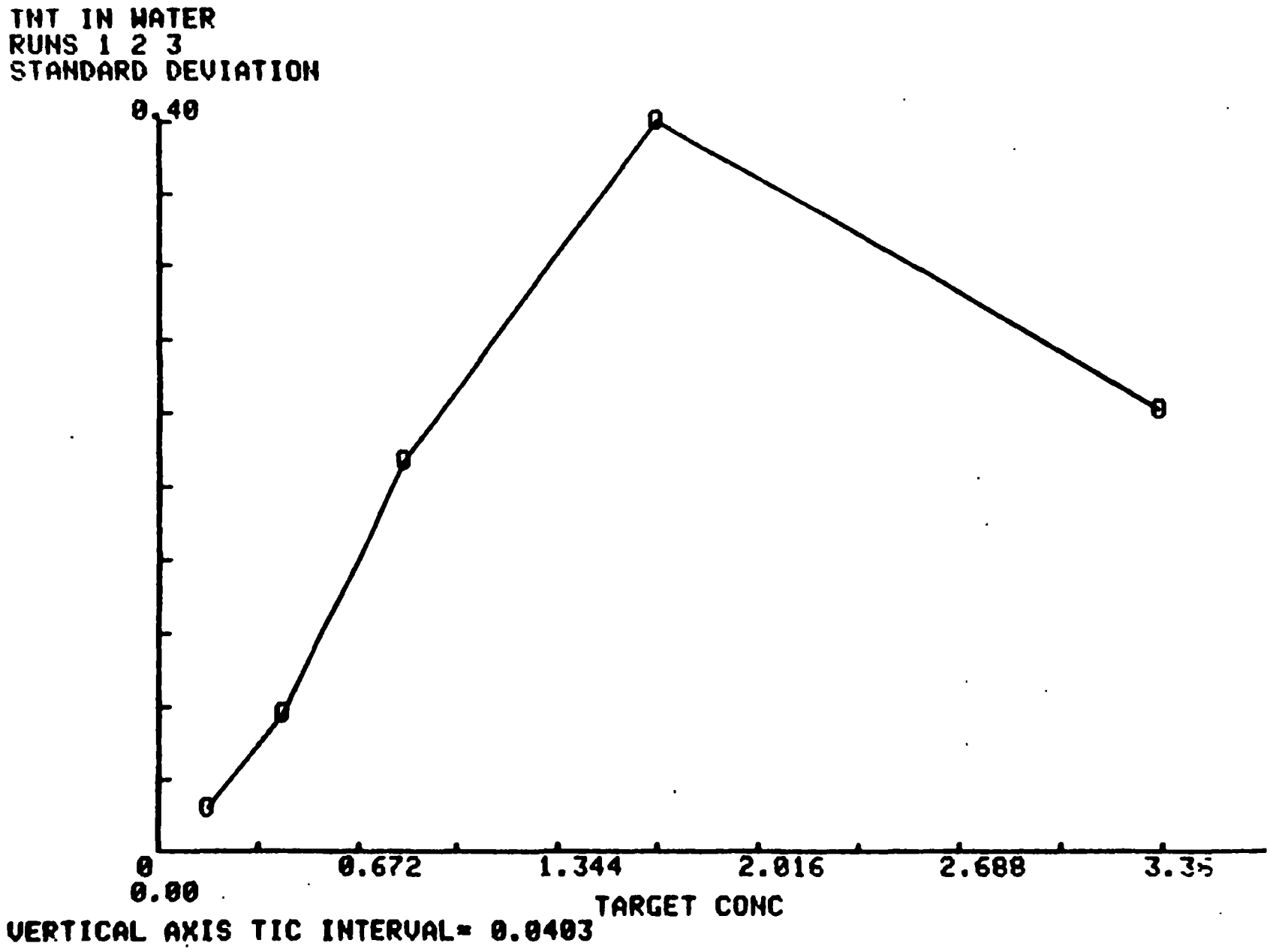
Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.17	0.12	0.06	0.12	
0.42	0.32	0.11	0.27	
0.84	0.65	0.18	0.75	
1.68	1.13	0.35	1.46	
3.36	2.99	2.52	3.19	

```
TNT IN WATER
RUNS 1 2 3
TARGET CONC
ANALYSIS OF 15 TARGET CONC-FOUND CONC POINTS

MEAN= 1.2932  SD= 1.19436505546

FOUND CONC
MEAN= 0.948  SD= 1.0939522058

NO. RUNS 3 TOTAL X-Y ALL RUNS 15 NO. CONCENTR 15
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.181970946192
SLOPE= 0.873778956227
R= 0.953982309269
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.115884894163
COMPUTE T
D.F.= 13
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.77093170942
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.464636625642
x(d)= 1.45332273315
```

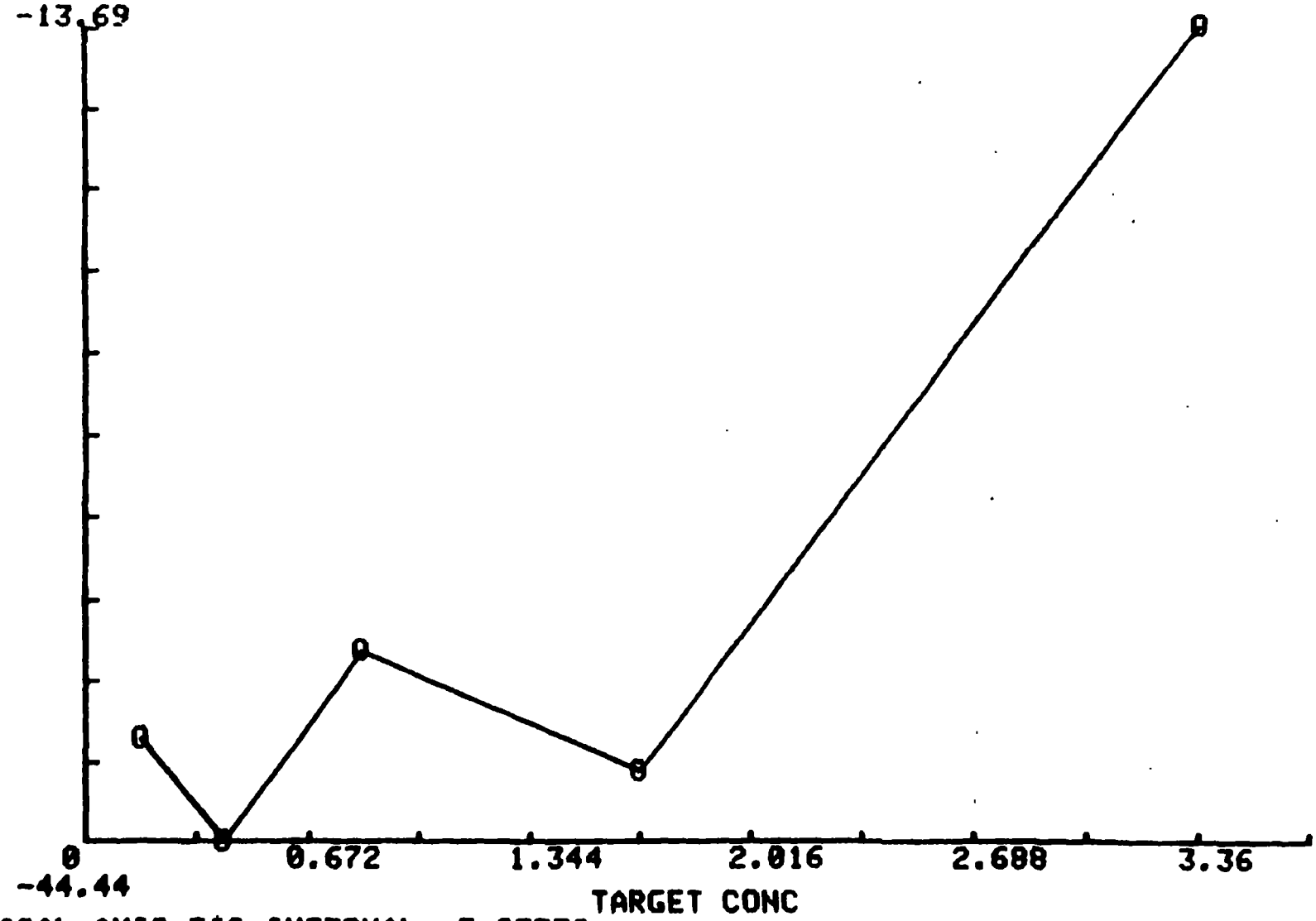

TNT IN WATER
RUNS 1 2 3
FOUND CONC
3.19
y(c)
x(d)
0
0.00
0.672
1.344
2.016
2.688
3.36
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 0.319

TNT IN WATER
RUNS 1 2 3
STATISTICAL DATA USED TO DETERMINE PERCENT INACCURACY AND COEFFICIENT OF VARIATION

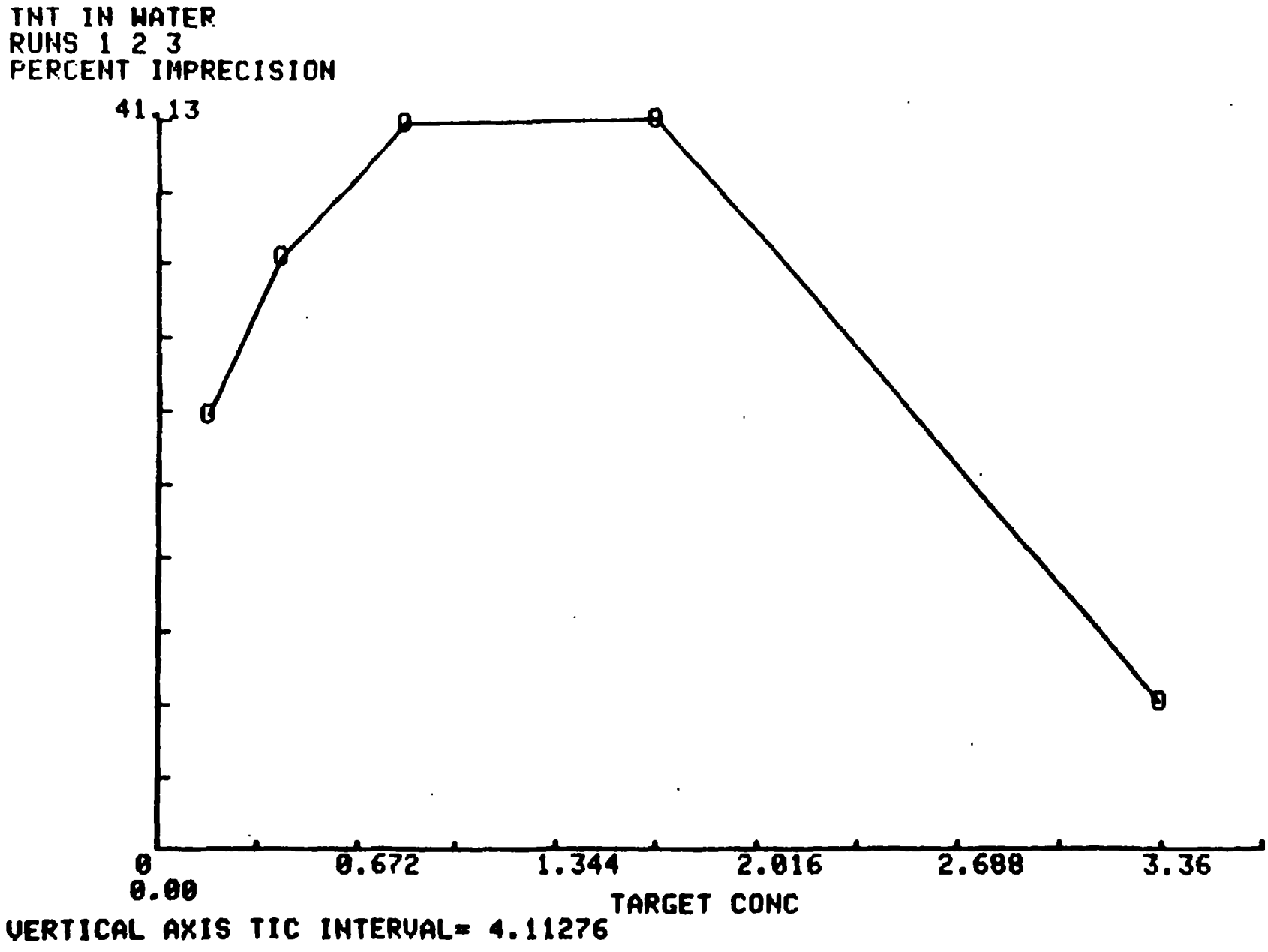
Target Conc. UG/L	Mean Found Conc. UG/L	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.17	0.10	0.02	-40.48	24.49
0.42	0.23	0.08	-44.44	33.24
0.84	0.53	0.22	-37.15	40.86
1.68	0.98	0.40	-41.67	41.13
3.36	2.90	0.24	-13.69	8.39


TNT IN WATER
RUNS 1 2 3
STANDARD DEVIATION
0.40
0
0.00
0.672
1.344
2.016
2.688
3.35
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 0.0403

TNT IN WATER
RUNS 1 2 3
MEAN PERCENT INACCURACY



VERTICAL AXIS TIC INTERVAL= 3.07539

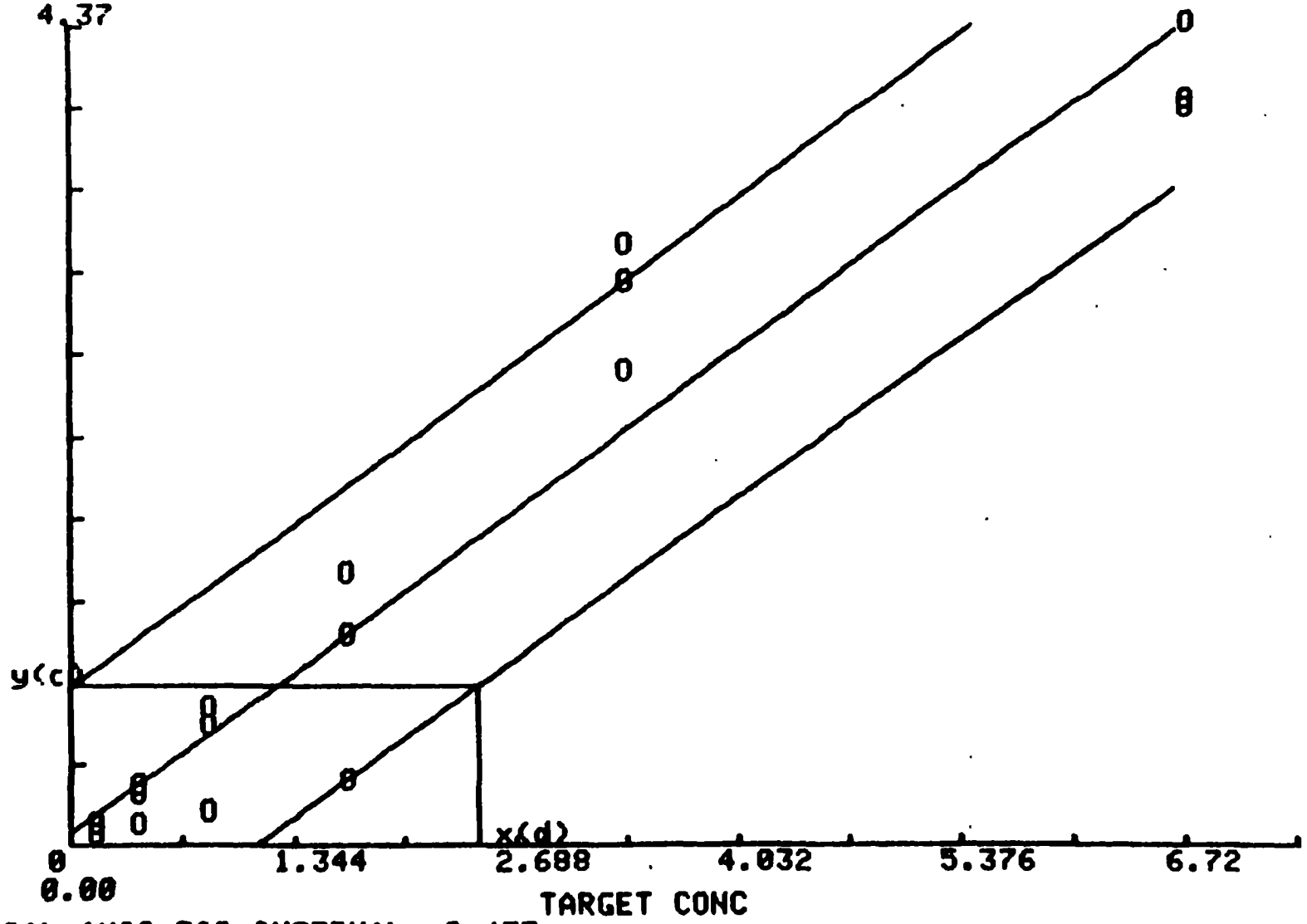

TNT IN WATER
RUNS 1 2 3
PERCENT IMPRECISION
41.13
0
0.00
0.672
1.344
2.016
2.688
3.36
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 4.11276

DNT IN WATER
RUNS 1 2 3
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.17	0.12	0.06	0.12	
0.42	0.32	0.11	0.27	
0.84	0.65	0.18	0.75	
1.68	1.13	0.35	1.46	
3.36	2.99	2.52	3.19	
6.72	3.91	4.37	3.96	

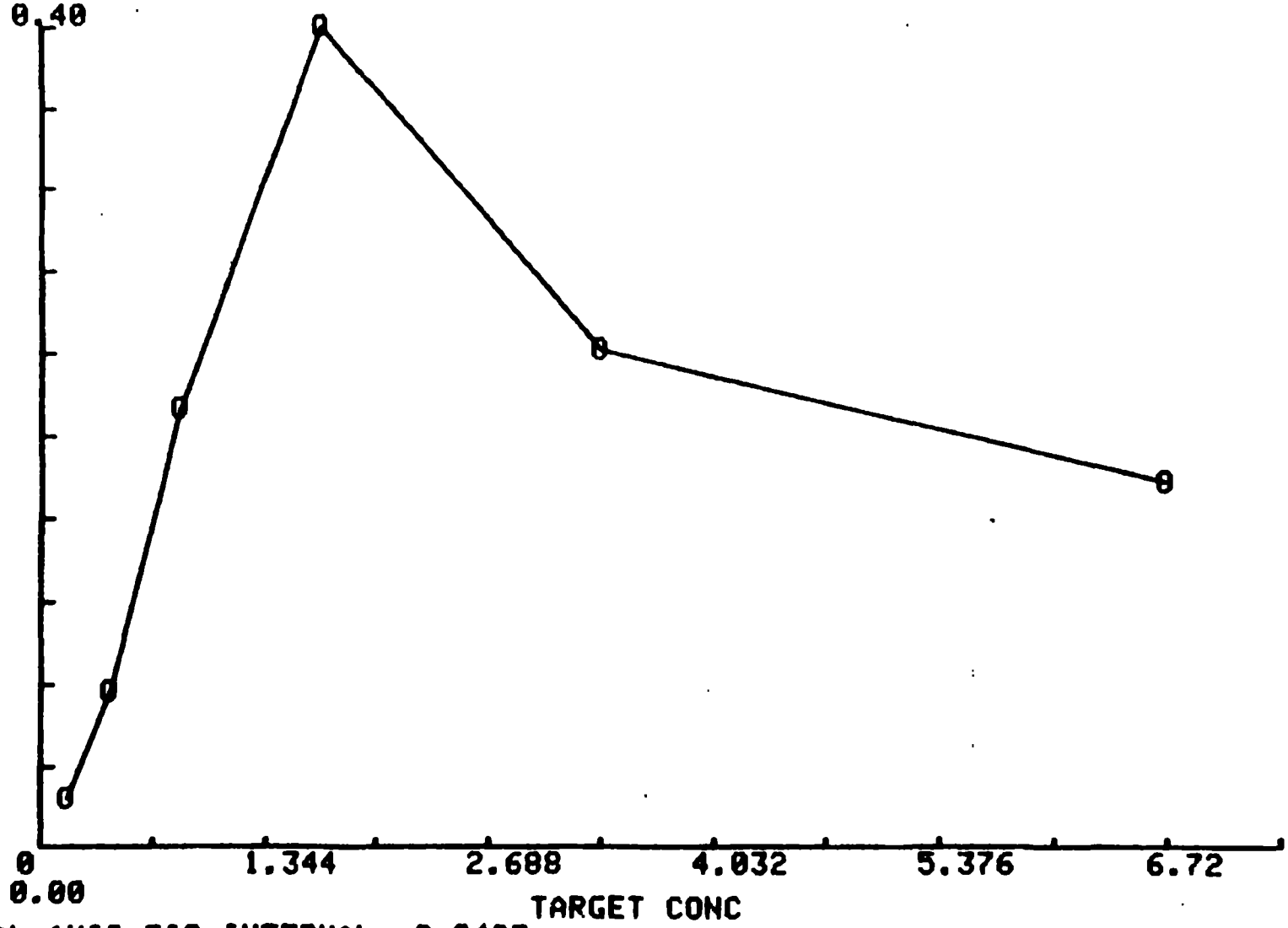
```
TNT IN WATER
RUNS 1 2 3
TARGET CONC
ANALYSIS OF 18 TARGET CONC-FOUND CONC POINTS

MEAN= 2.19766666667  SD= 2.34641787061

FOUND CONC
MEAN= 1.47  SD= 1.56064089399

NO. RUNS 3 TOTAL X-Y ALL RUNS 18 NO. CONCENTR 18
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.0625443529555
SLOPE= 0.6404318127
R= 0.962886885775
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.188520062837
COMPUTE T
D.F.= 16
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.74588066418
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.860167958188
x(d)= 2.46215133926
```

TNT IN WATER
RUNS 1 2 3
FOUND CONC

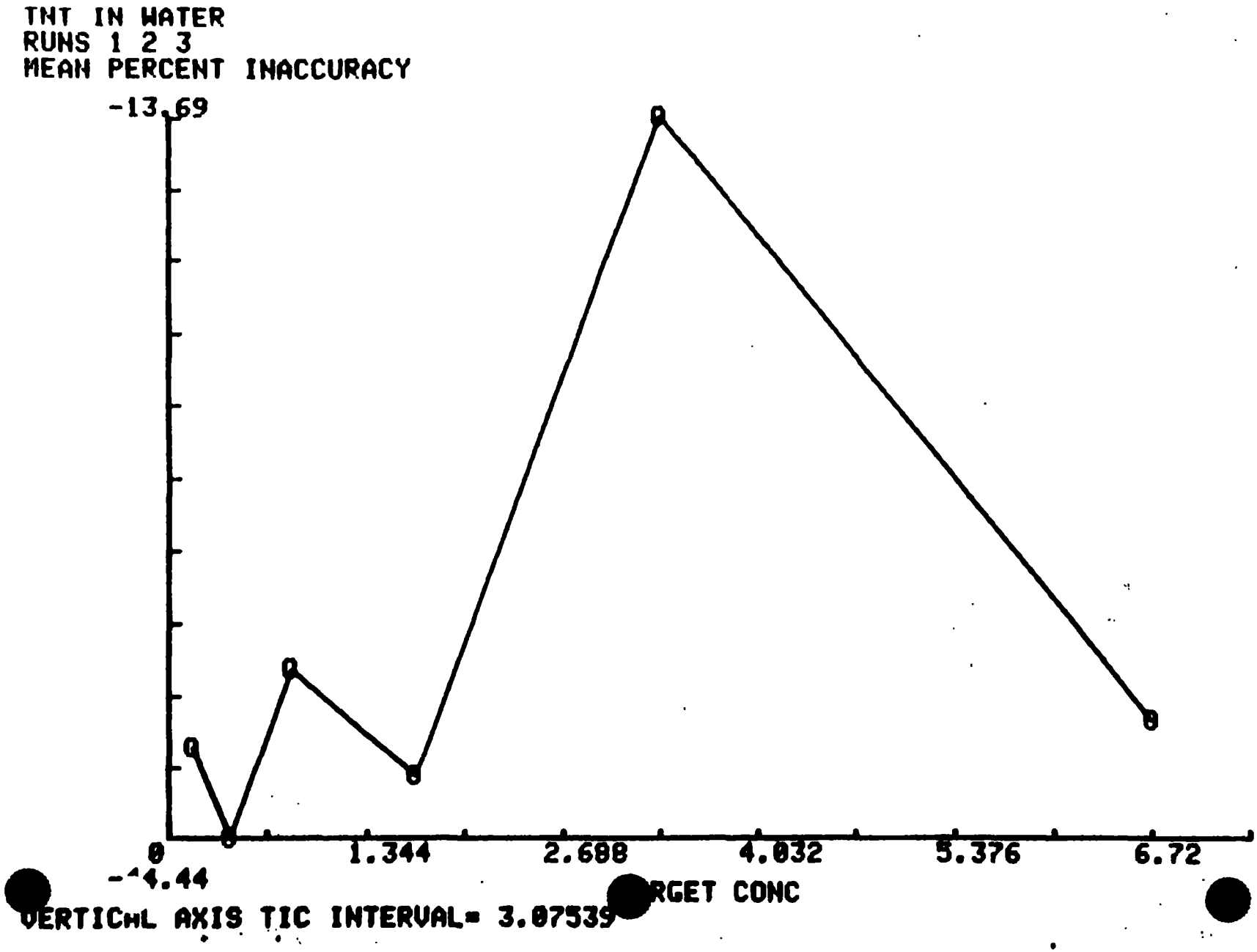


VERTICAL AXIS TIC INTERVAL= 0.437

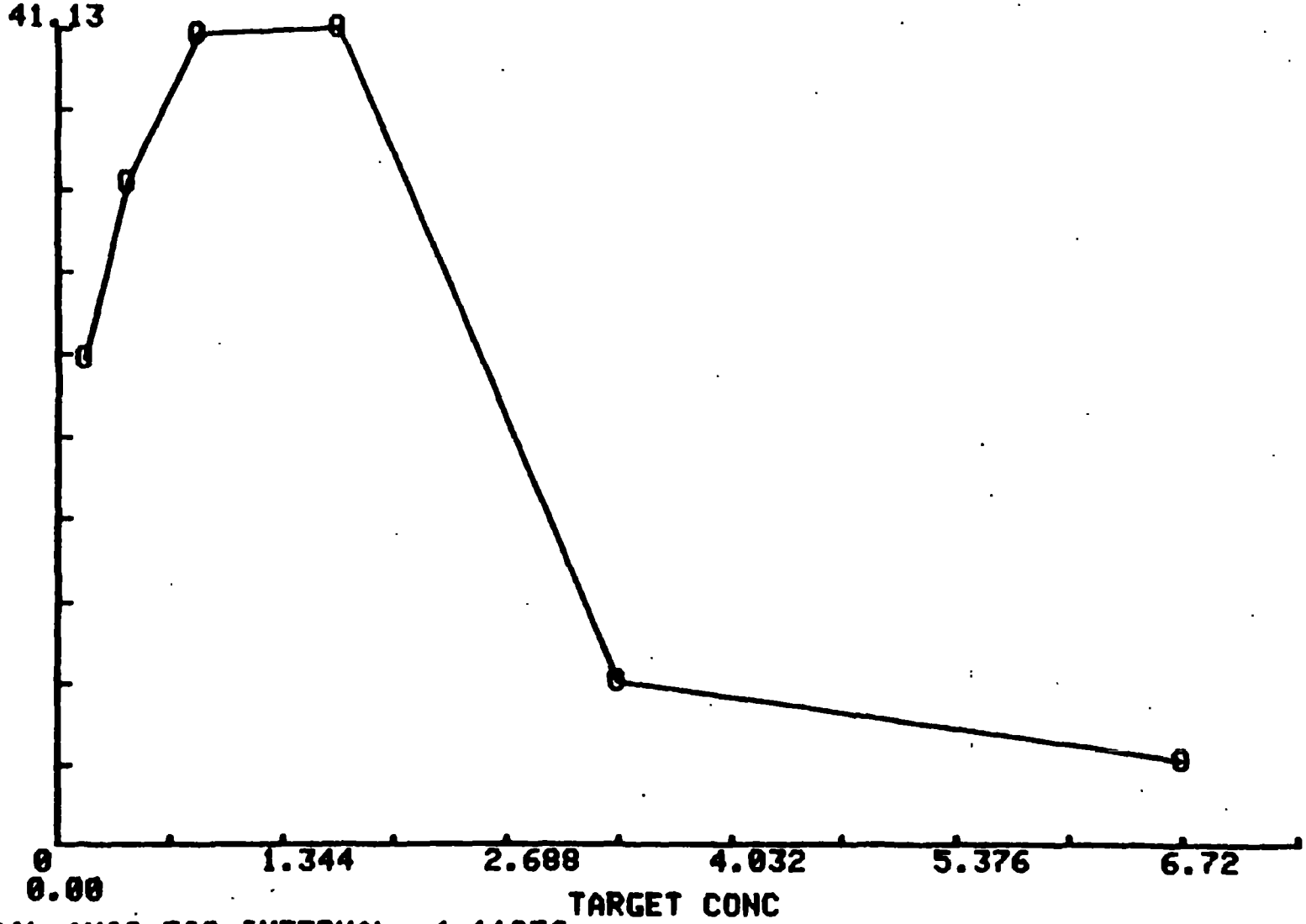
TNT IN WATER
RUNS 1 2 3
STANDARD DEVIATION



VERTICAL AXIS TIC INTERVAL= 0.0403


TNT IN WATER
RUNS 1 2 3
MEAN PERCENT INACCURACY
-13.69
0
-4.44
1.344
2.688
4.032
5.376
6.72
RGET CONC
VERTICAL AXIS TIC INTERVAL= 3.07539

TNT IN WATER
RUNS 1 2 3
PERCENT IMPRECISION



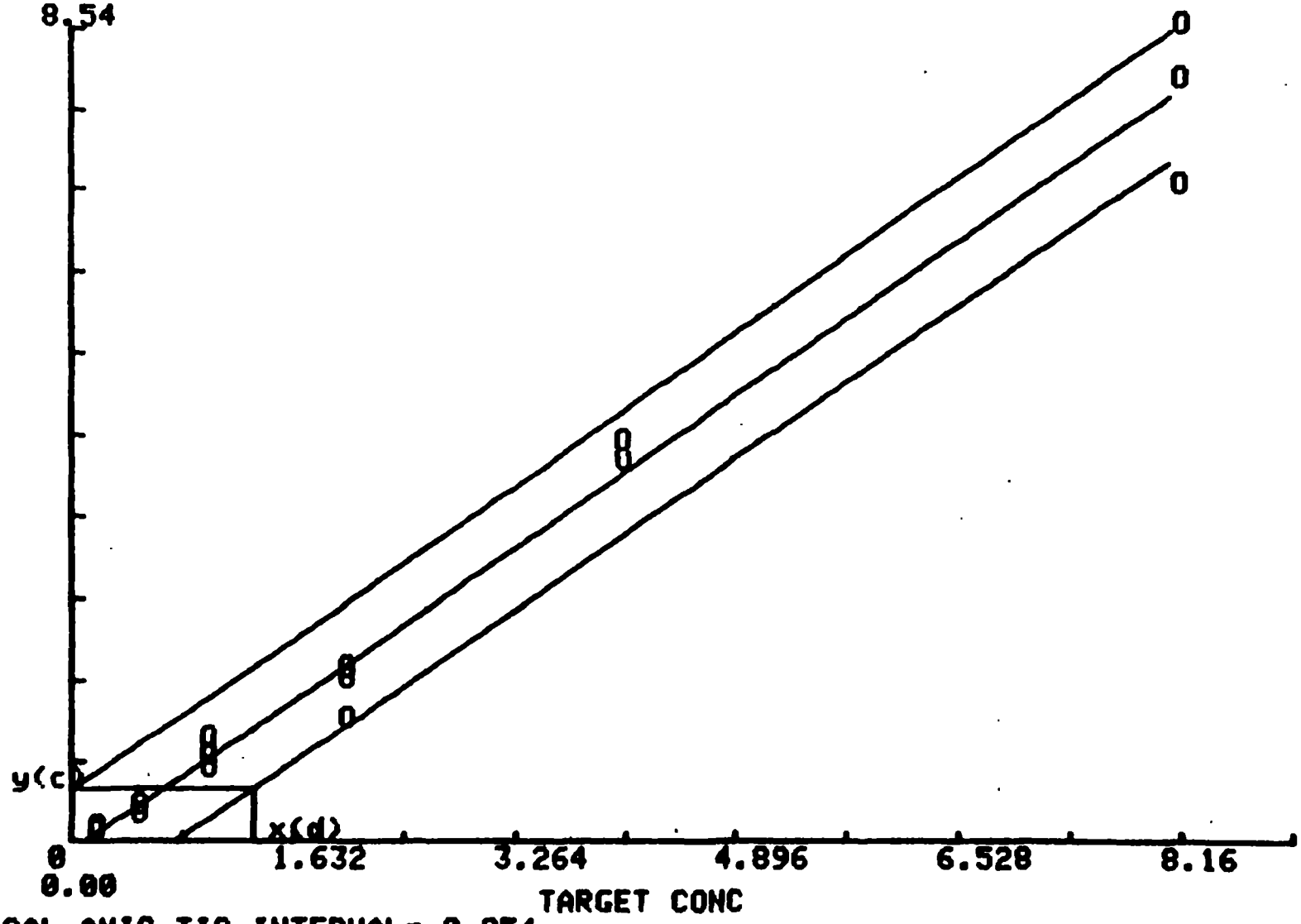
VERTICAL AXIS TIC INTERVAL= 4.11276

TETRYL IN WATER
1
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/L	Day 1 Found Conc. UG/L	Day 2 Found Conc. UG/L	Day 3 Found Conc. UG/L	Day 4 Found Conc. UG/L
0.20	0.12	0.16	0.15	
0.51	0.40	0.40	0.30	
1.02	1.10	0.80	0.93	
2.04	1.75	1.33	1.86	
4.08	4.00	4.20	4.00	
8.16	6.85	8.54	7.96	

```
TETRYL IN WATER
1
TARGET CONC
ANALYSIS OF 18 TARGET CONC-FOUND CONC POINTS

MEAN= 2.669  SD= 2.84897349935

FOUND CONC
MEAN= 2.49166666667  SD= 2.79266739453

N0. RUNS 3 TOTAL X-Y ALL RUNS 18 N0. CONCENTR 18
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.104550047125
SLOPE= 0.972730128809
R= 0.99234243377
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.12642184213
COMPUTE T
D.F.= 16
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.74588066418
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.548633296764
x(d)= 1.33116414808
```

TETRYL IN WATER
1
FOUND CONC

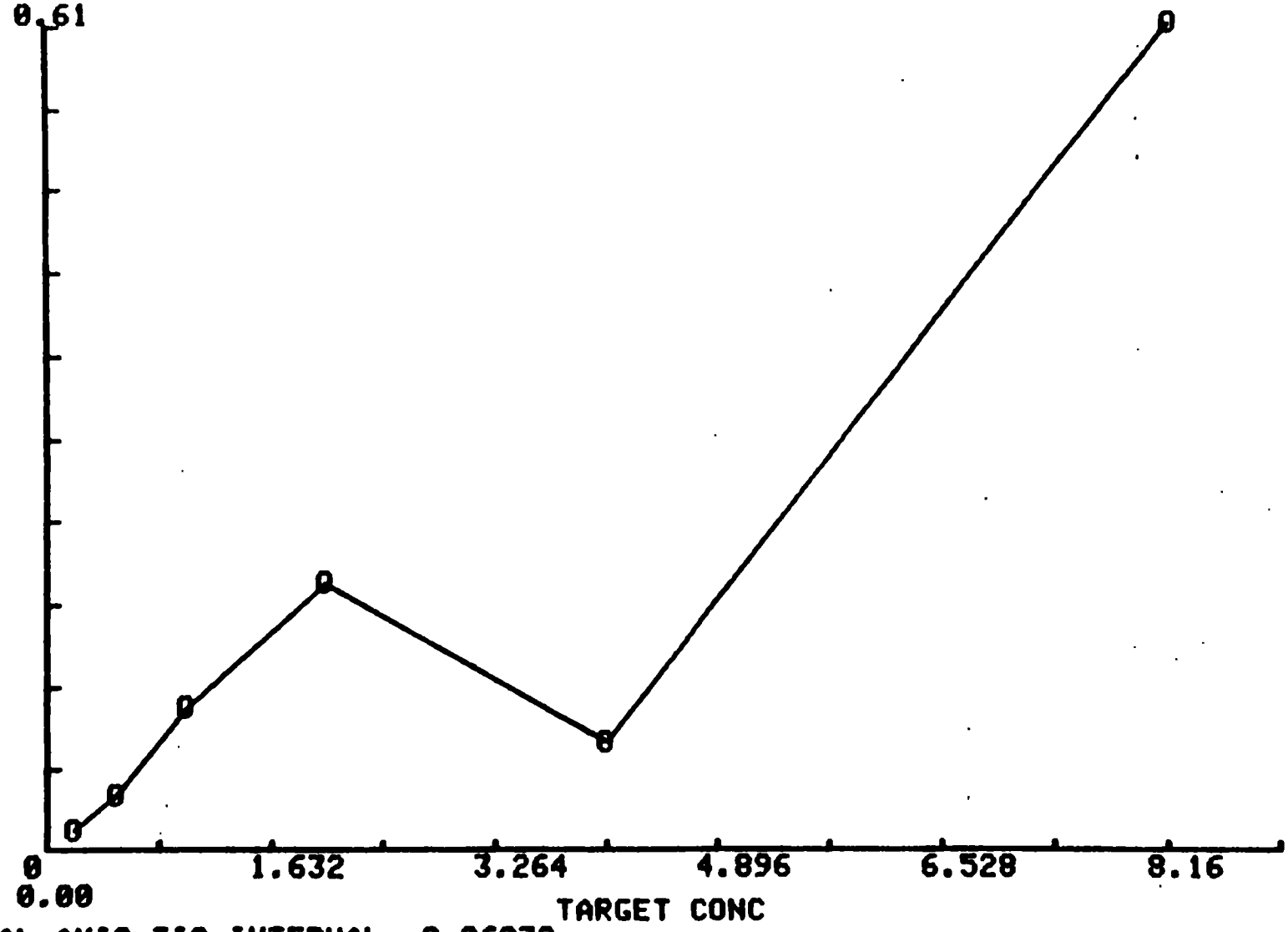


VERTICAL AXIS TIC INTERVAL= 0.854

TETRYL IN WATER
1
STATISTICAL DATA USED TO DETERMINE PERCENT
INACCURACY AND COEFFICIENT OF VARIATION

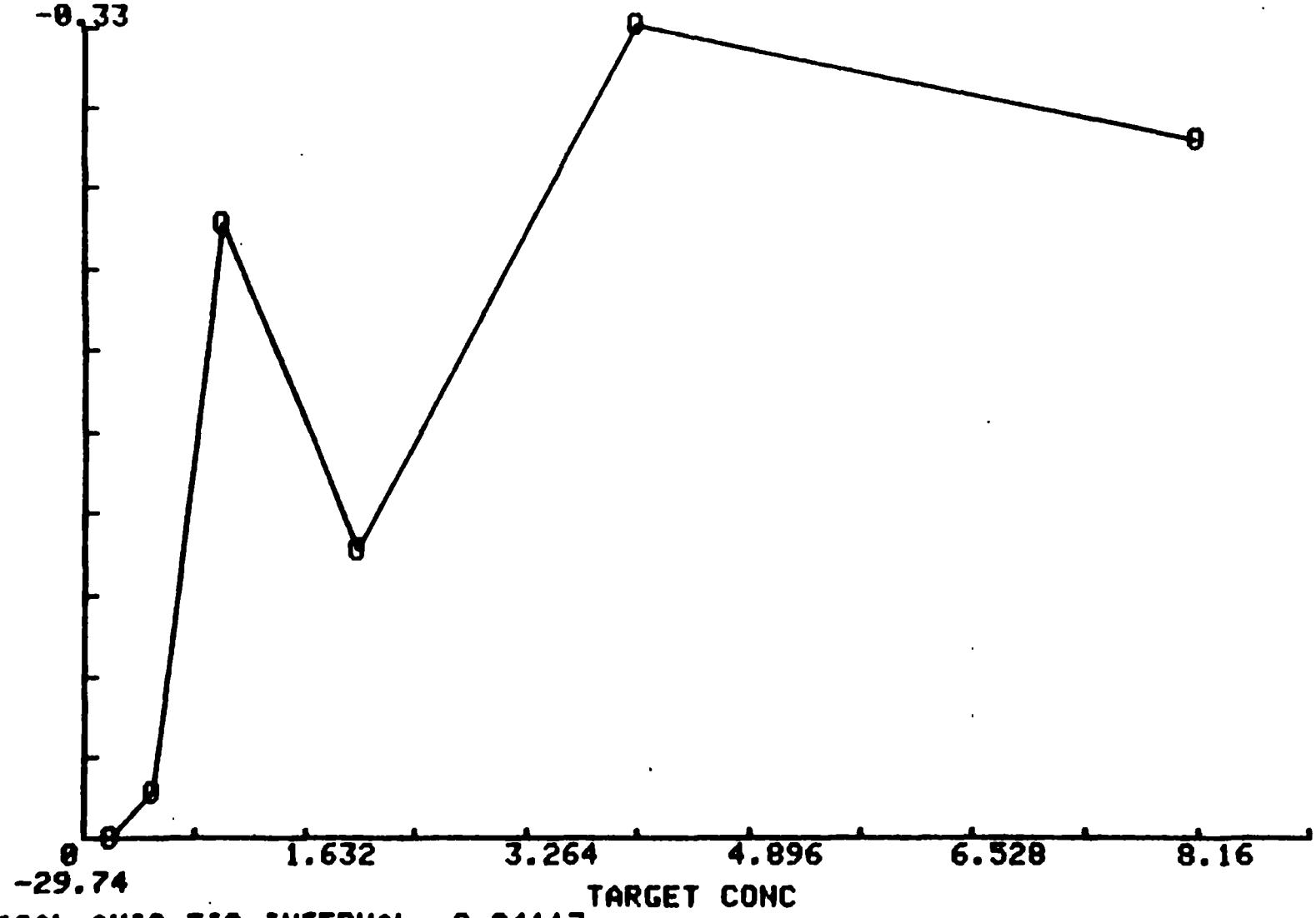
Target Conc. UG/L	Mean Found Conc. UG/L	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.20	0.14	0.01	-29.74	10.27
0.51	0.37	0.04	-28.10	11.13
1.02	0.94	0.11	-7.52	11.28
2.04	1.65	0.20	-19.28	12.01
4.08	4.07	0.08	-0.33	2.01
8.16	7.78	0.61	-4.62	7.80

TETRYL IN WATER
1
STANDARD DEVIATION



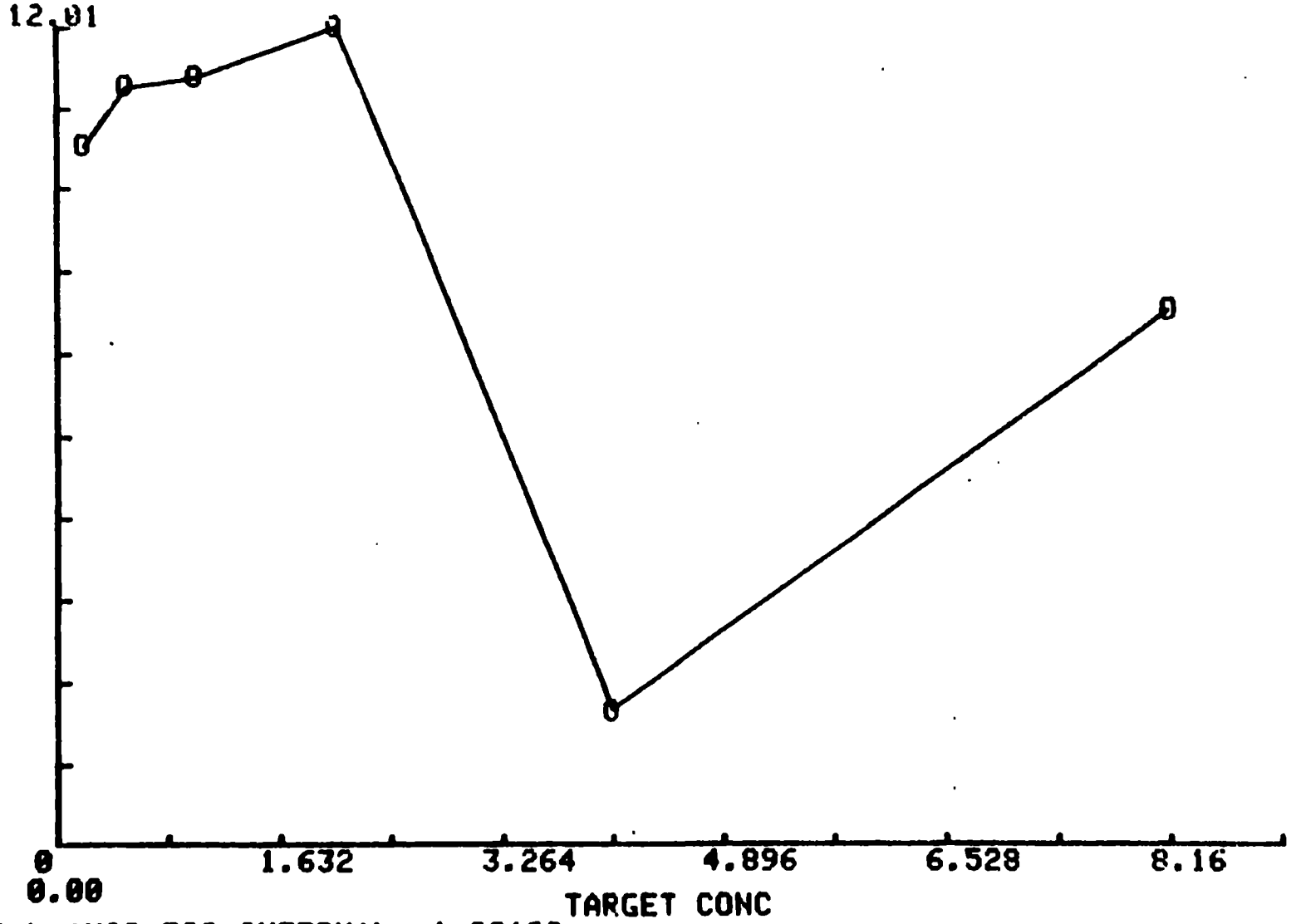
VERTICAL AXIS TIC INTERVAL= 0.06072

TETRYL IN WATER
1
MEAN PERCENT INACCURACY



VERTICAL AXIS TIC INTERVAL= 2.94117

TETRYL IN WATER
1
PERCENT IMPRECISION



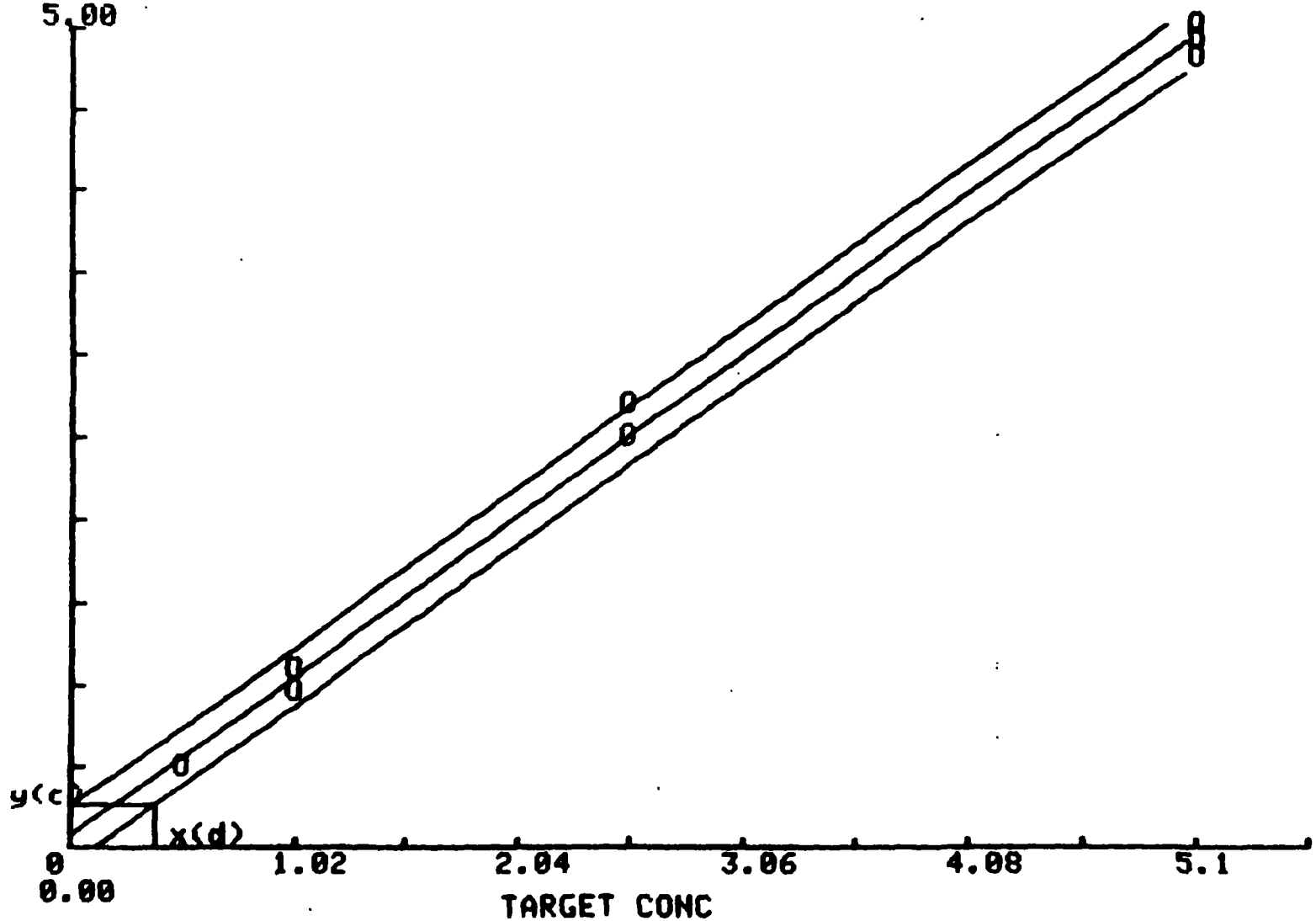
VERTICAL AXIS TIC INTERVAL= 1.20108

2,4-DNT IN SOIL
RUNS 1 2 3
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/G	Day 1 Found Conc. UG/G	Day 2 Found Conc. UG/G	Day 3 Found Conc. UG/G	Day 4 Found Conc. UG/G
0.51	0.50	0.50	0.50	
1.02	0.98	1.10	1.10	
2.55	2.50	2.50	2.70	
5.10	4.90	4.80	5.00	

```
2,4-DNT IN SOIL
RUNS 1 2 3
TARGET CONC
ANALYSIS OF 12 TARGET CONC-FOUND CONC POINTS

MEAN= 2.295  SD= 1.86437169529

FOUND CONC
MEAN= 2.25666666667  SD= 1.78019066054

NO. RUNS 3 TOTAL X-Y ALL RUNS 12 NO. CONCENTR 12
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.0678911564626
SLOPE= 0.953714819261
R= 0.998813752828
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.00826557823152
COMPUTE T
D.F.= 10
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.81245868646
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.249977885915
x(d)= 0.378559437535
```

2,4-DNT IN SOIL
RUNS 1 2 3
FOUND CONC

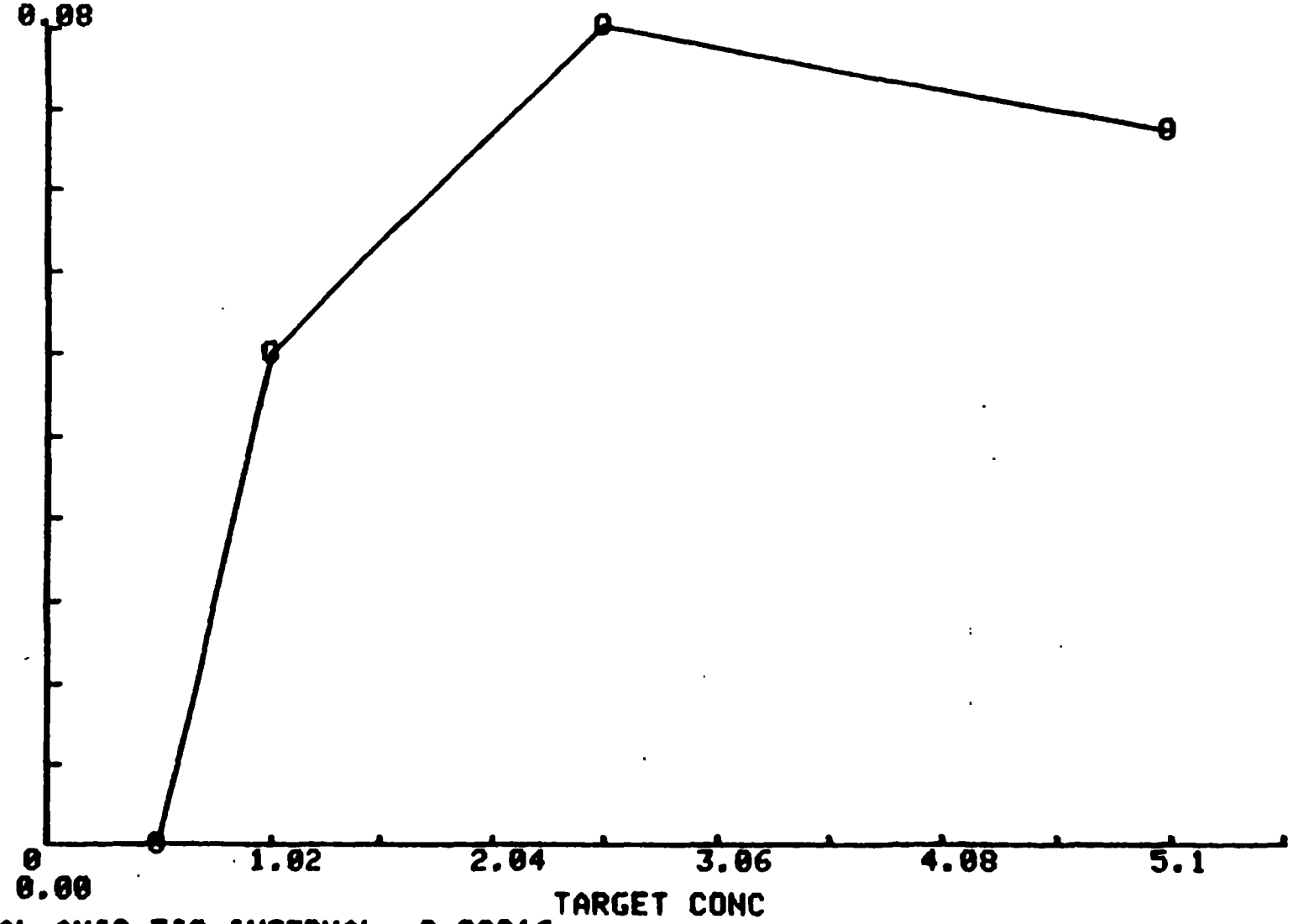


VERTICAL AXIS TIC INTERVAL= 0.5

2,4-DNT IN SOIL
RUNS 1 2 3
STATISTICAL DATA USED TO DETERMINE PERCENT INACCURACY AND COEFFICIENT OF VARIATION

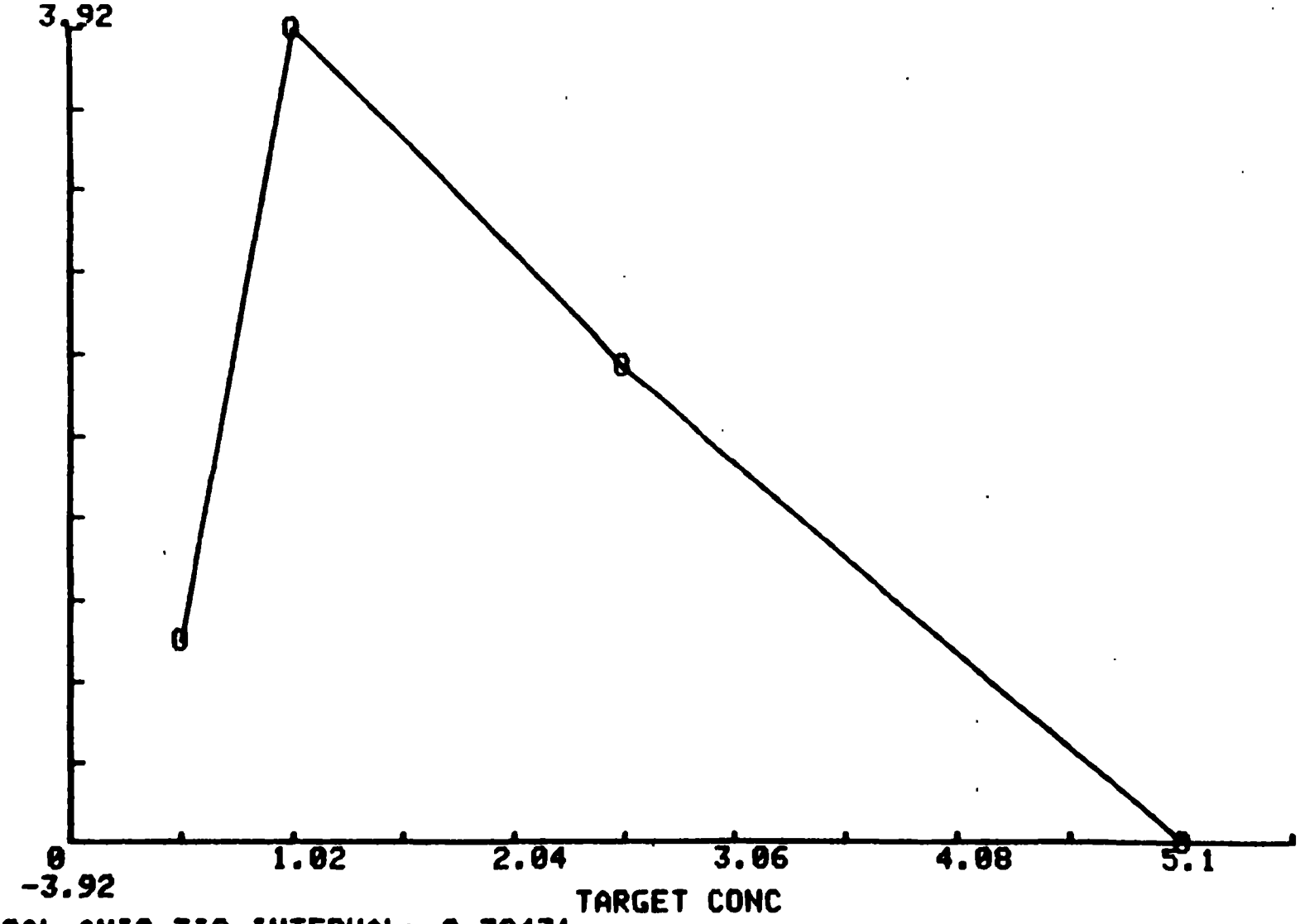
Target Conc. UG/G	Mean Found Conc. UG/G	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.51	0.50	0.00	-1.96	0.00
1.02	1.06	0.05	3.92	4.62
2.55	2.57	0.08	0.65	3.18
5.10	4.90	0.07	-3.92	1.44

2,4-DNT IN SOIL
RUNS 1 2 3
STANDARD DEVIATION



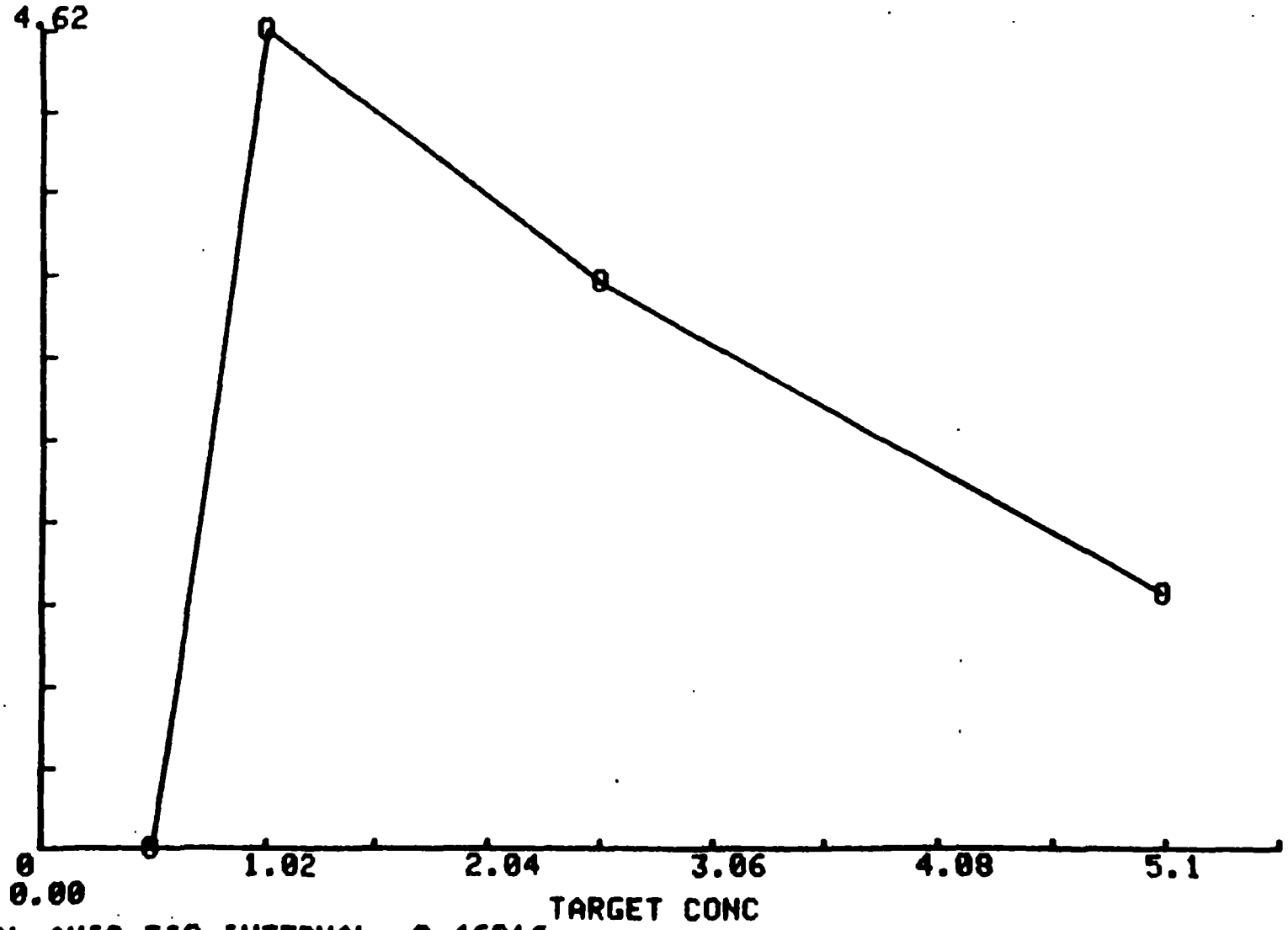
VERTICAL AXIS TIC INTERVAL= 0.00816

2,4-DNT IN SOIL
RUNS 1 2 3
MEAN PERCENT INACCURACY



VERTICAL AXIS TIC INTERVAL= 0.78431

2,4-DNT IN SOIL
RUNS 1 2 3
PERCENT IMPRECISION

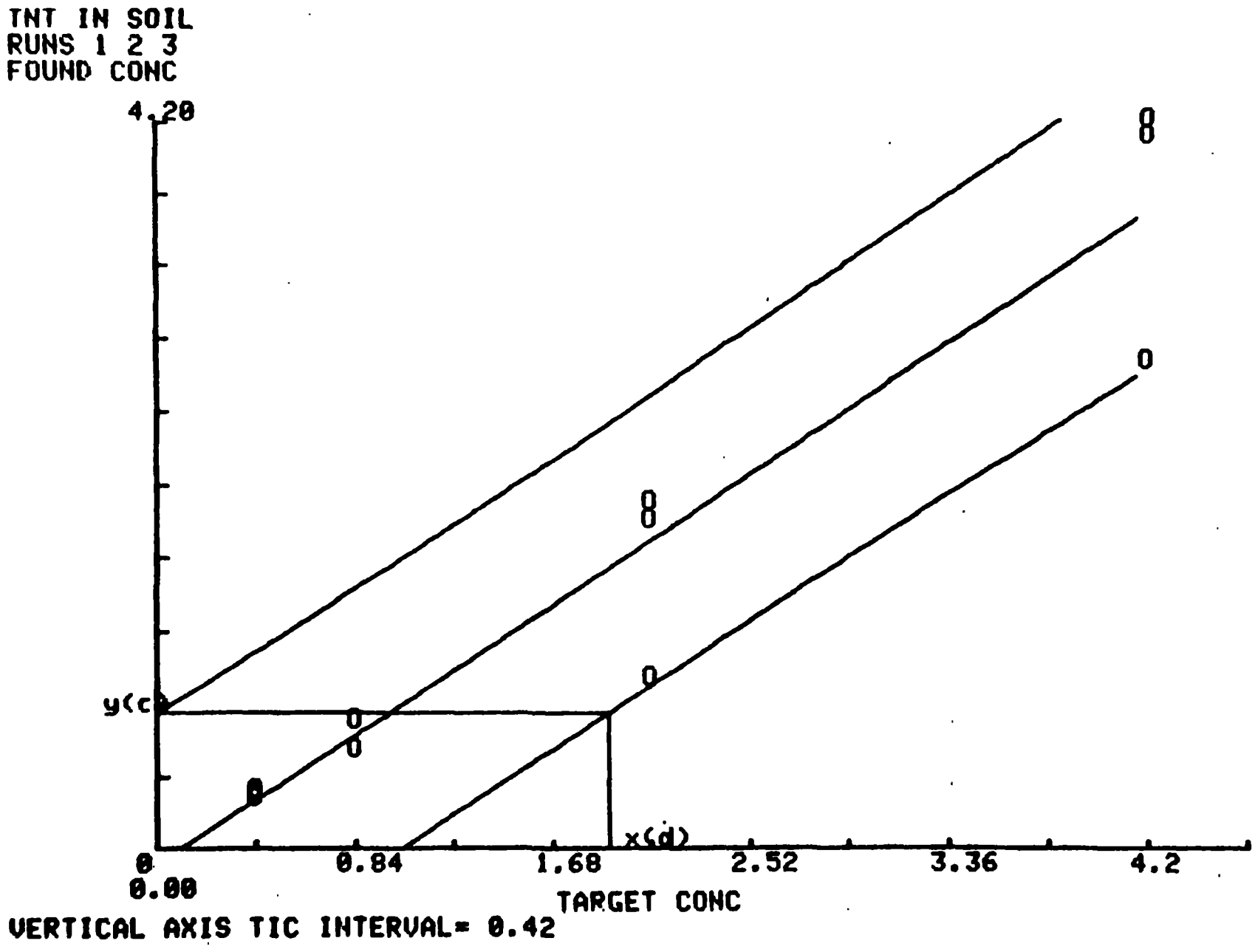


VERTICAL AXIS TIC INTERVAL= 0.46216

TNT IN SOIL
RUNS 1 2 3
COMPILATION OF TARGET CONC. VS FOUND CONC

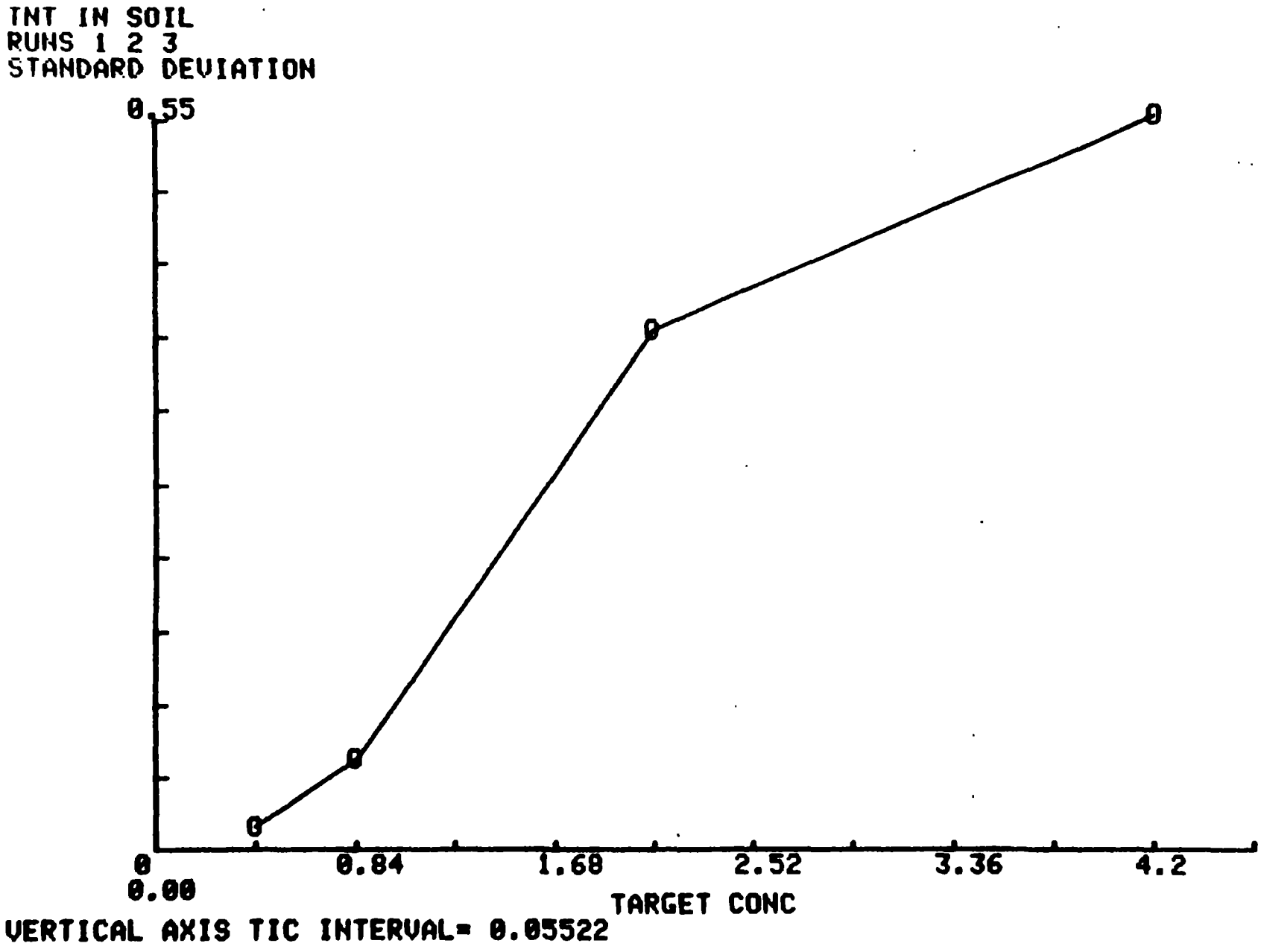
Target Conc. UG/G	Day 1 Found Conc. UG/G	Day 2 Found Conc. UG/G	Day 3 Found Conc. UG/G	Day 4 Found Conc. UG/G
0.42	0.30	0.35	0.32	
0.84	0.58	0.75	0.75	
2.10	1.00	1.90	2.00	
4.20	2.80	4.10	4.20	

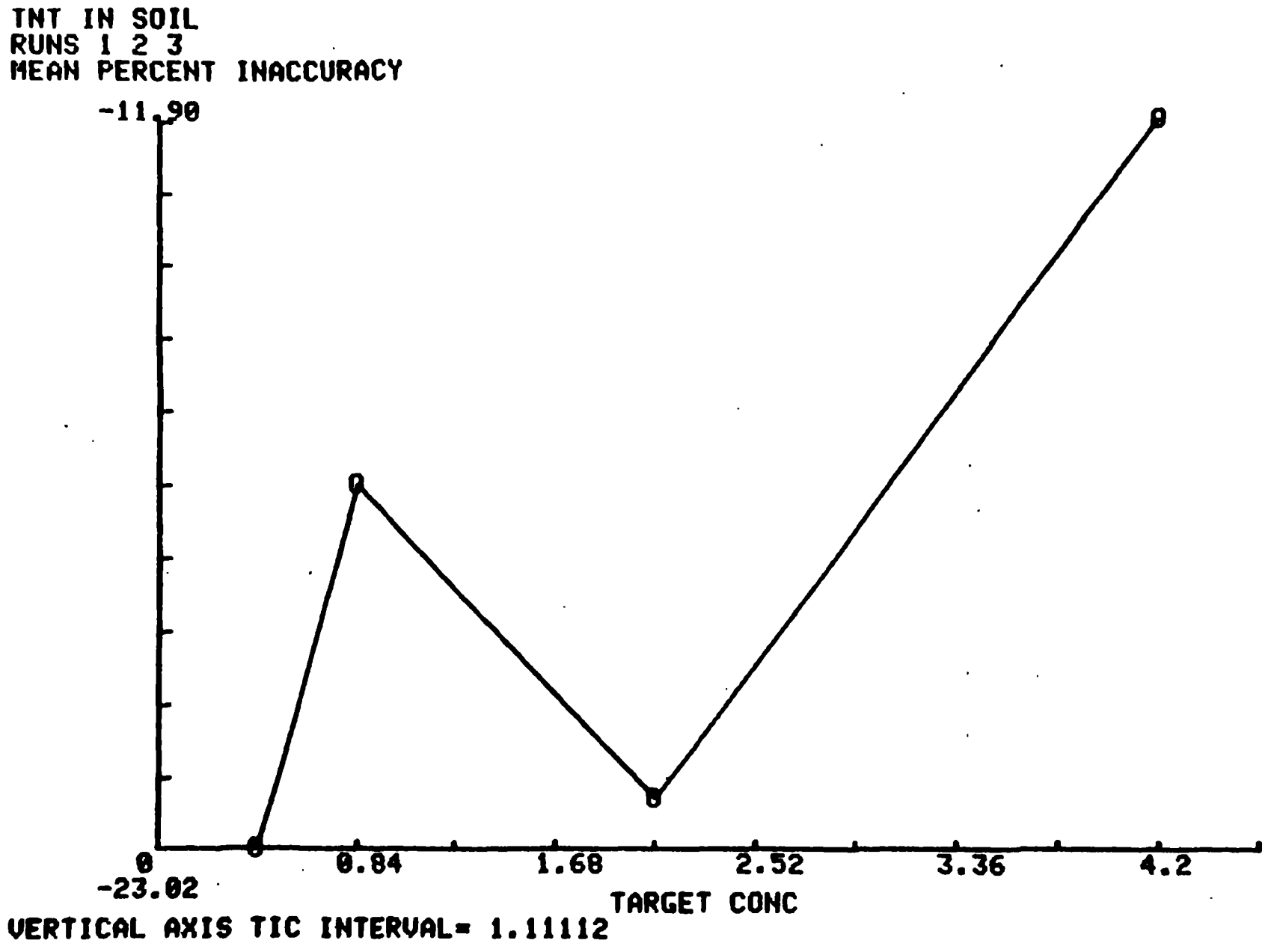
```
TNT IN SOIL
RUNS 1 2 3
TARGET CONC
ANALYSIS OF 12 TARGET CONC-FOUND CONC POINTS

MEAN= 1.89  SD= 1.53536492553

FOUND CONC
MEAN= 1.5875  SD= 1.42810825284

NO. RUNS 3 TOTAL X-Y ALL RUNS 12 NO. CONCENTR 12
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.0932653061225
SLOPE= 0.889293812763
R= 0.956083354252
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.19272207483
COMPUTE T
D.F.= 10
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.81245868646
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.785974630623
x(d)= 1.92018986336
```


TNT IN SOIL
RUNS 1 2 3
FOUND CONC
4.20
y(c)
0
0.00
0.84
1.68
2.52
3.36
4.2
x(d)
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 0.42

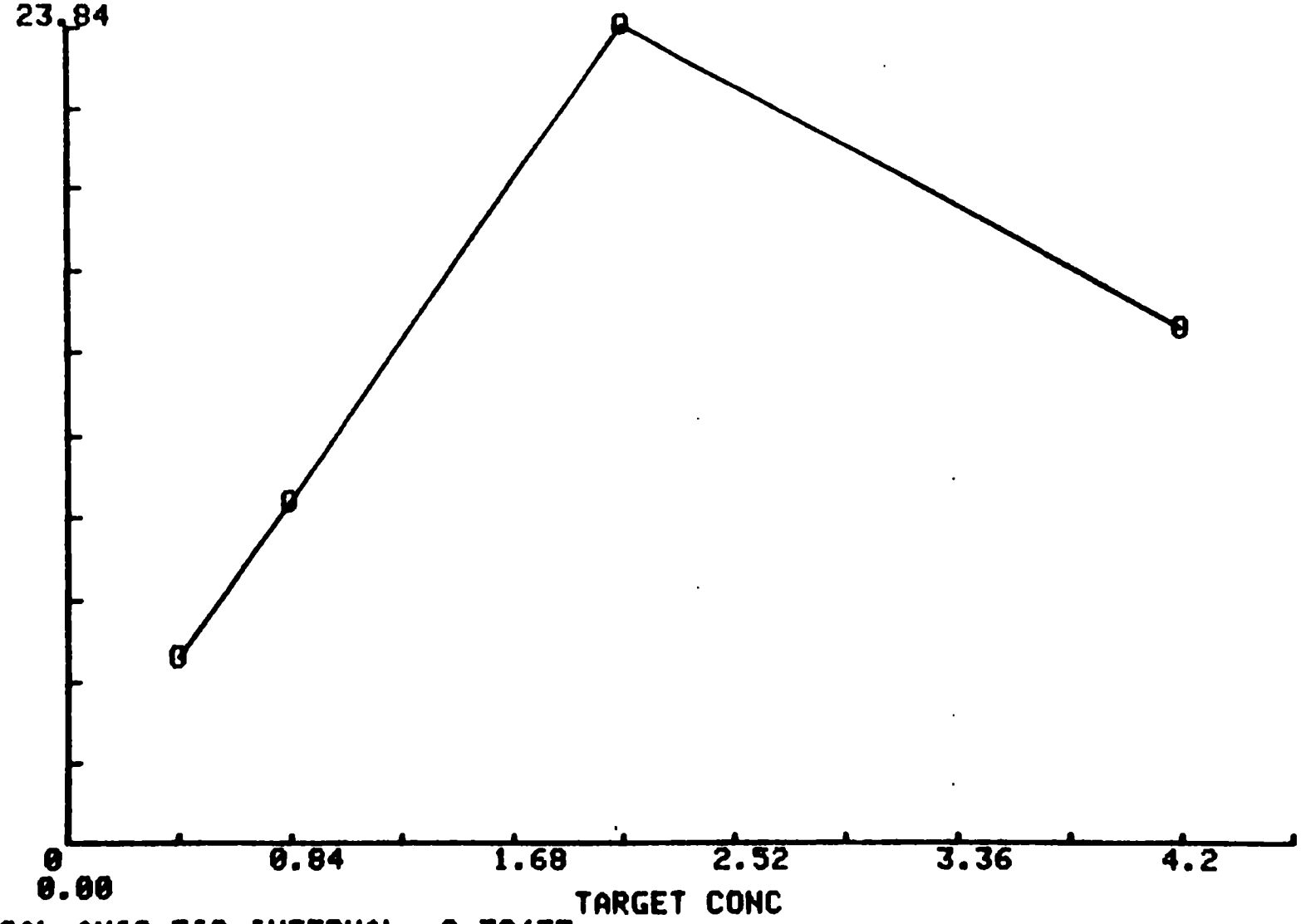
TNT IN SOIL
RUNS 1 2 3
STATISTICAL DATA USED TO DETERMINE PERCENT INACCURACY AND COEFFICIENT OF VARIATION

Target Conc. UG/G	Mean Found Conc. UG/G	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.42	0.32	0.02	-23.02	5.50
0.84	0.69	0.07	-17.46	10.01
2.10	1.63	0.39	-22.22	23.84
4.20	3.70	0.55	-11.90	14.93


INT IN SOIL
RUNS 1 2 3
STANDARD DEVIATION
0.55
0
0.00
0.84
1.68
2.52
3.36
4.2
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 0.05522


TNT IN SOIL
RUNS 1 2 3
MEAN PERCENT INACCURACY
-11.90
0
-23.02
0.84
1.68
2.52
3.36
4.2
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 1.11112

TNT IN SOIL
RUNS 1 2 3
PERCENT IMPRECISION

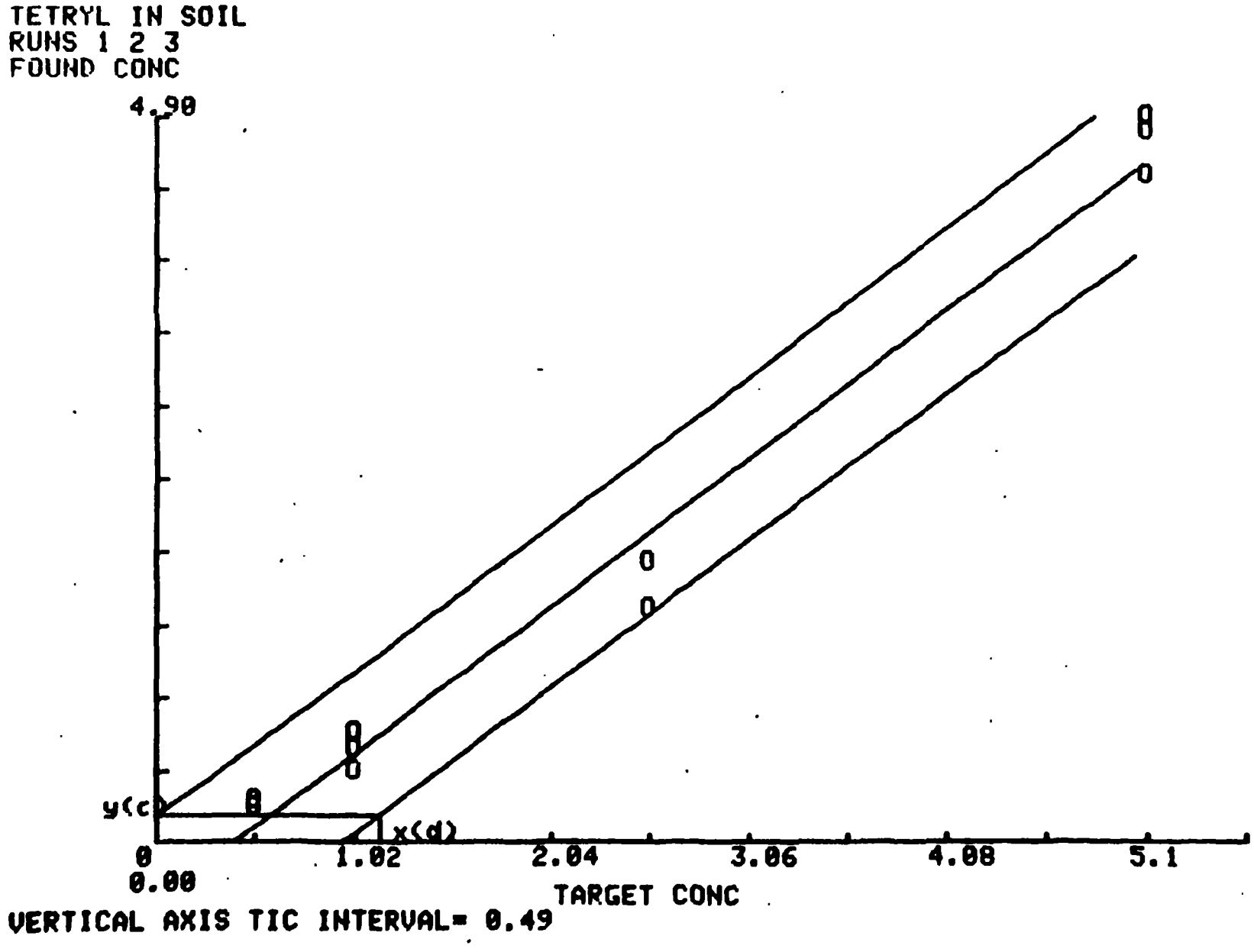


VERTICAL AXIS TIC INTERVAL= 2.38435

TETRYL IN SOIL
RUNS 1 2 3
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. UG/G	Day 1 Found Conc. UG/G	Day 2 Found Conc. UG/G	Day 3 Found Conc. UG/G	Day 4 Found Conc. UG/G
0.51	0.25	0.30	0.30	
1.02	0.50	0.65	0.75	
2.55	1.60	1.60	1.90	
5.10	4.80	4.50	4.90	

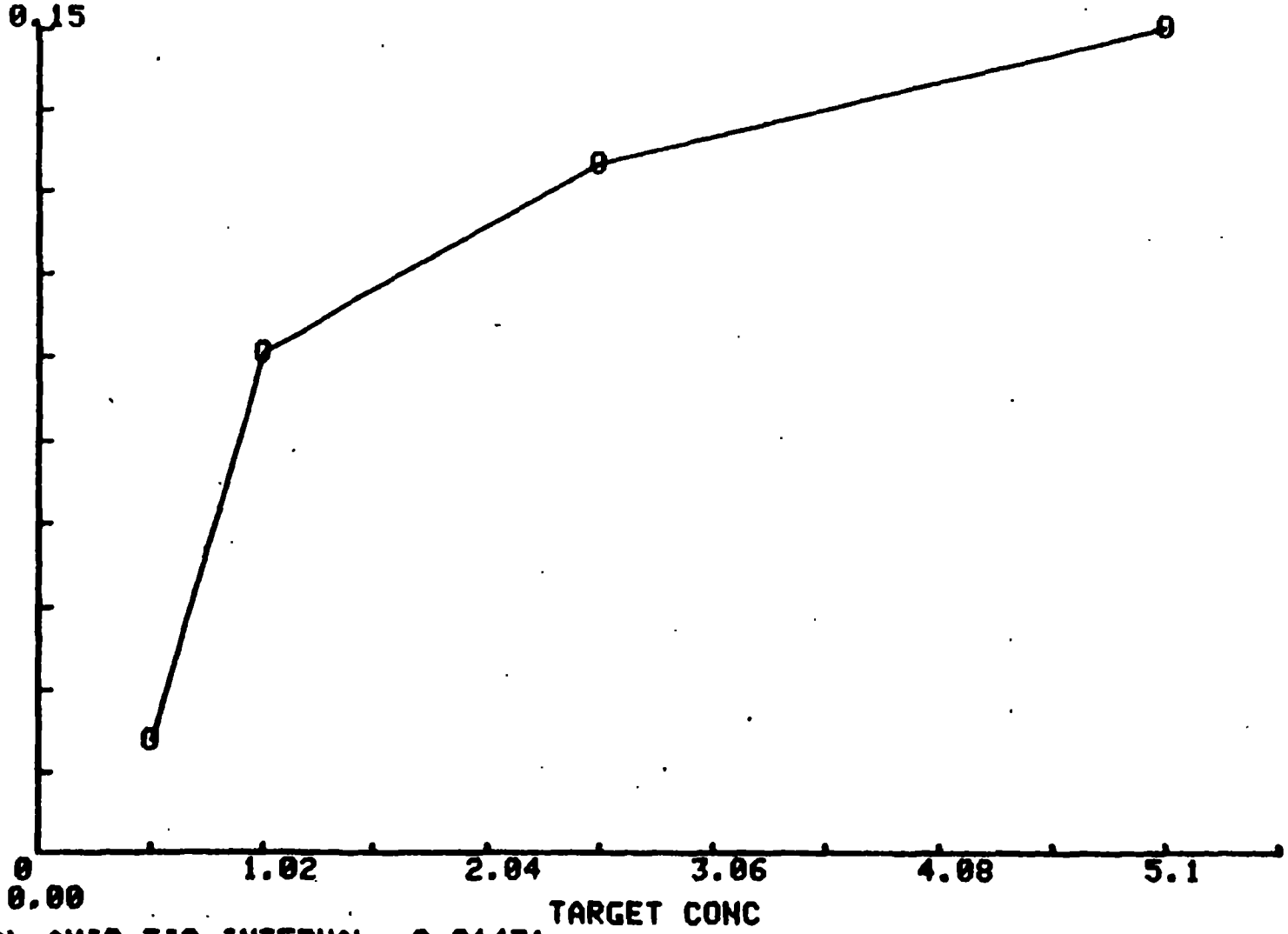
```
TETRYL IN SOIL
RUNS 1 2 3
TARGET CONC
ANALYSIS OF 12 TARGET CONC-FOUND CONC POINTS

MEAN= 2.295  SD= 1.86437169529

FOUND CONC
MEAN= 1.8375  SD= 1.83378954379

NO. RUNS 3 TOTAL X-Y ALL RUNS 12 NO. CONCENTR 12
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.394897959184
SLOPE= 0.972722422302
R= 0.988944537094
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.0813375850342
COMPUTE T
D.F.= 10
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.81245868646
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.176300874419
x(d)= 1.14902500285
```


TETRYL IN SOIL
RUNS 1 2 3
FOUND CONC
4.90
y(c)
x(d)
0
0.00
1.02
2.04
3.06
4.08
5.1
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 0.49

TETRYL IN SOIL
RUNS 1 2 3
STATISTICAL DATA USED TO DETERMINE PERCENT INACCURACY AND COEFFICIENT OF VARIATION

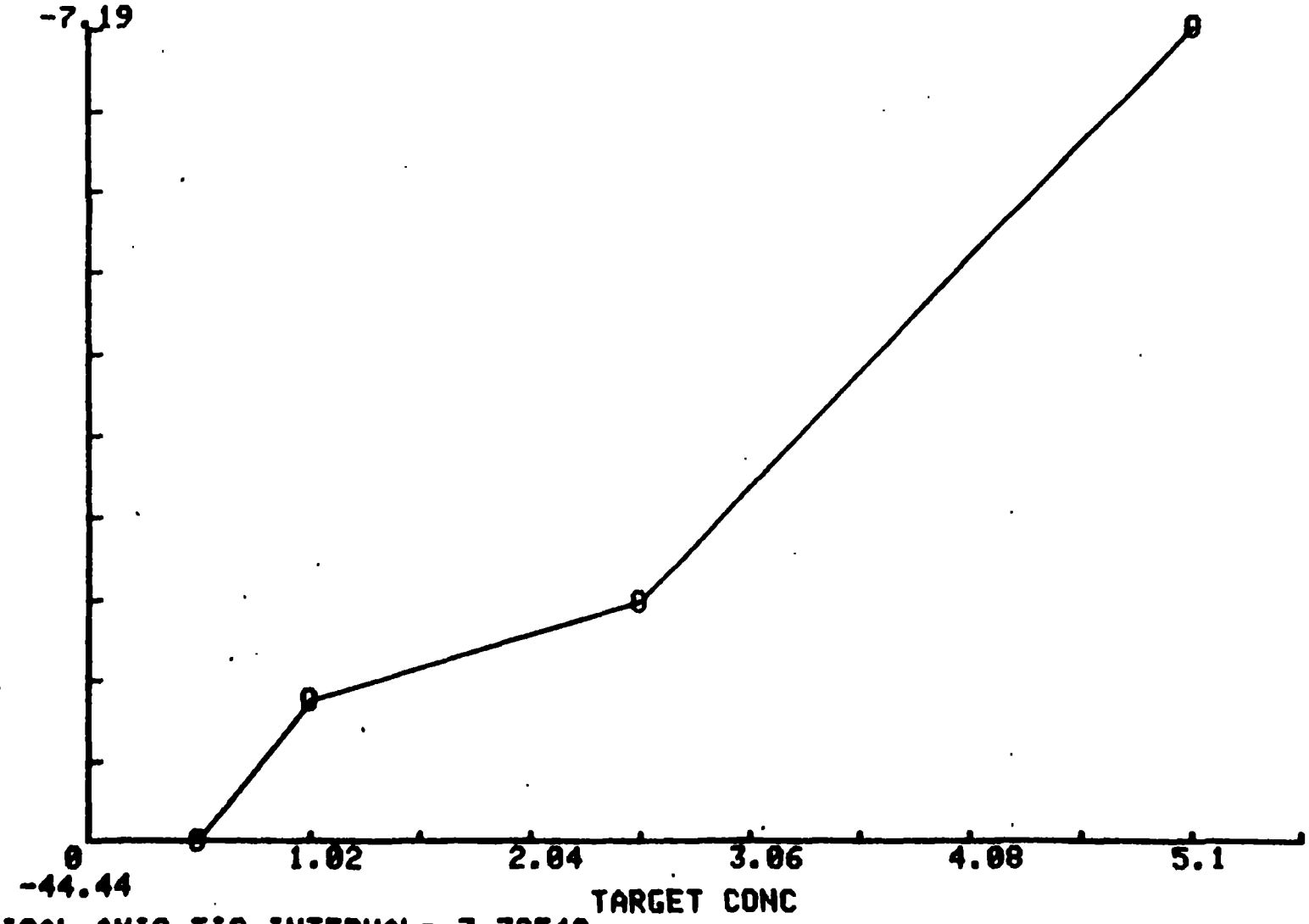
Target Conc. UG/G	Mean Found Conc. UG/G	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.51	0.28	0.02	-44.44	7.20
1.02	0.63	0.09	-37.91	14.05
2.55	1.70	0.12	-33.33	7.20
5.10	4.73	0.15	-7.19	3.11

TETRYL IN SOIL
RUNS 1 2 3
STANDARD DEVIATION



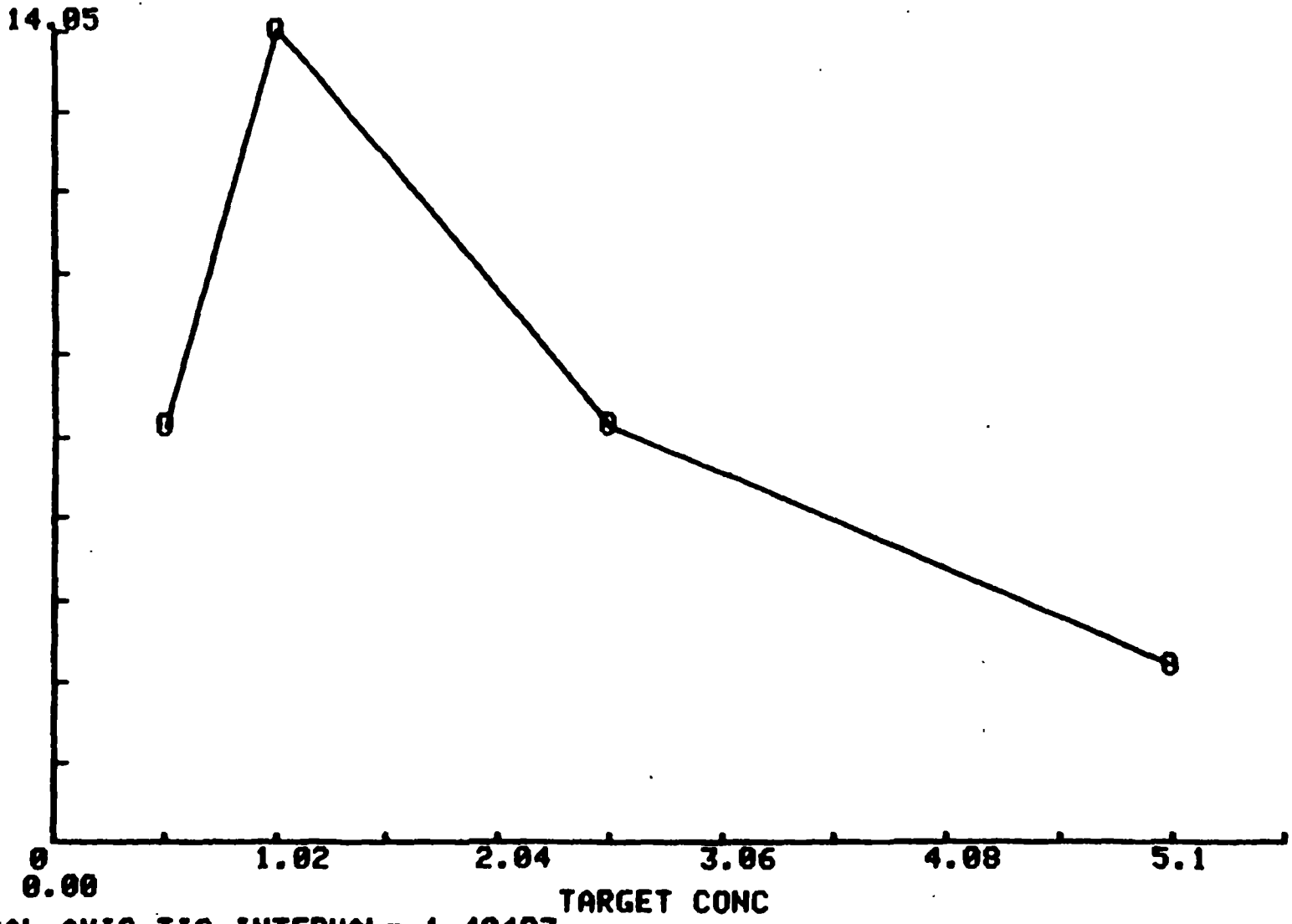
VERTICAL AXIS TIC INTERVAL= 0.01471

TETRYL IN SOIL
RUNS 1 2 3
MEAN PERCENT INACCURACY



VERTICAL AXIS TIC INTERVAL= 3.72549

TETRYL IN SOIL
RUNS 1 2 3
PERCENT IMPRECISION



VERTICAL AXIS TIC INTERVAL= 1.40487

Method No. 12

Revised December 18, 1980

DETERMINATION OF NITROCELLULOSE, NITROGLYCERINE AND PETN IN WATER

I. Application: This method is used to qualitatively determine the concentration of nitrocellulose (NC), nitroglycerine (NG) and PETN in water samples.

A. Tested Concentration Range - Response is linear from 10 to 50 mg/liter in water.

B. Sensitivity Limits - Response for 5 µg of compound is: NC = 0.089, NG = 0.17, PETN = 0.15 absorbance units.

C. Detection Limits -

Compound	Water (µg/l)
NC	9,300
NG	4,700
PETN	2,900

D. Interferences - Nitrite ion will interfere.

E. Analysis Rate - Approximately 20 samples can be analyzed by one worker in an eight hour day.

II. Chemistry

Nitrite ion is cleaved from the nitrate ester in basic solution which diazotizes procaine, in acidic solution, which in turn couples with N,N-dimethyl-1-naphthylamine to produce an azo-dye. This dye is determined from its absorbance at 510 µm.

$C_3H_5N_3O_9$ - Trinitroglycerine; glyceryl trinitrate; CAS RN-55-63-0
mp = 13°C, decomposition pt = 145° C;

$C_5H_8N_4O_{12}$ - Pentaerythritol tetranitrate CAS RN-78-11-5
mp = 140° C; explosive decomposition pt. 210° C;

$(C_6H_{12}N_5O_{16})_x$ - Nitrocellulose, soluble gun cotton, CAS RN-9004-70-0
mp = decomposes on heating.

Handling Hazards: Explosive hazard, avoid heat, shock or open flame. Toxic inhalation and skin absorption hazards exist. Do not handle NG except as a dilute solution.

III. Apparatus

A. Instrumentation - Absorbance measurements are made at 510 nM on a Bausch and Lomb Spectronic 20 spectrometer.

B. Parameters - N/A

C. Hardware/Glassware.

1. 0.1, 1, and 2 ml pipets
2. 13 x 100 mm glass test tubes
3. 10 ml volumetric flasks
4. 100 ml volumetric flasks
5. 1 cm spectrometer cell (glass)
6. water bath
7. hot plate
8. 25 µl graduated syringe
9. 8 ounce glass bottle
10. 2 dram glass vials

D. Chemicals

1. KOH, Analytical reagent grade
2. Glacial acetic acid, ACS grade
3. Acetone, ACS grade
4. N,N-dimethyl-1-naphthylamine
5. Procaine

E. Reagents

1. 10 percent KOH: Weigh 10.0 g of reagent grade potassium hydroxide into a 100 ml volumetric flask and dilute slowly with deionized water (nitrite free).

2. 20 percent KOH: Same as above except use 20.0 g of KOH.

3. 10 percent Acetic Acid: Pipet 10.0 ml of glacial acetic acid into a 100 ml volumetric flask which is partially filled with deionized water (nitrite free). Dilute to volume with deionized water.

4. 50 percent Acetic Acid: Same as above except use 50 ml of glacial acetic acid.

5. Color Developing Reagent. Weigh 0.35 g of each of procaine and N,N-dimethyl-1-naphthylamine into a 100 ml volumetric flask and dilute to volume with 50 percent acetic acid-water.

6. Working Solution of Color Reagent. Pipette 20 ml of the color developing reagent into a 100 ml volumetric flask. Dilute to volume with deionized water (nitrite free).

IV. Standards

A. Calibration Standards

1. Stock - Weigh 10.0 mg of NC, PETN, or 1 ml of a 1% NG in acetone SARM into a 10.0 ml volumetric flask and dilute to volume with acetone to obtain a 1 µg/µl solution. This solution is refrigerated when not in use.

2. Working - Prepare standard curve daily by adding 0.0, 5.0, 10.0 and 25.0 µl of 1 µg/µl stock solution in duplicate into 13 mm by 100 mm test tubes, using a 25 µl syringe. Add 0.5 ml of deionized water to each tube and mix thoroughly.

B. Control Spikes - For water samples spike as indicated for the working standards.

V. Procedure

A. Water Sample Handling/Preparation - Refrigerate the samples until ready for analysis. Prior to analysis, filter through a 0.45 micron Millipore filter and store refrigerated in a 2 dram glass vial.

B. Analysis of Samples

1. Water - Pipet 0.50 ml of water into a 13 x 100 mm test tube and add 0.50 ml of 20 percent potassium hydroxide solution. Go to step 2.

2. Mix sample well and place in boiling water bath for 30 minutes.

3. Cool the sample, add 2.0 ml of 10 percent acetic acid, and mix.

4. Add 1.0 ml of color developing reagent working solution and mix well.

5. Allow color to develop for 1.5 hour, transfer the solution to a clean, dry spectrophotometer cell and read the absorbance at 510 nm.

VI. Calculations

Construct a calibration curve of absorbance vs. quantity (µg) of the compound of interest (differing responses will be observed for NC,

PETN, and NG). Determine concentration of compound in samples by interpolating from the calibration curve.

For water: Concentration (μg/l) = μg (from graph) X 2000

For soil: Concentration (μg/l) = μg (from graph) X 100.

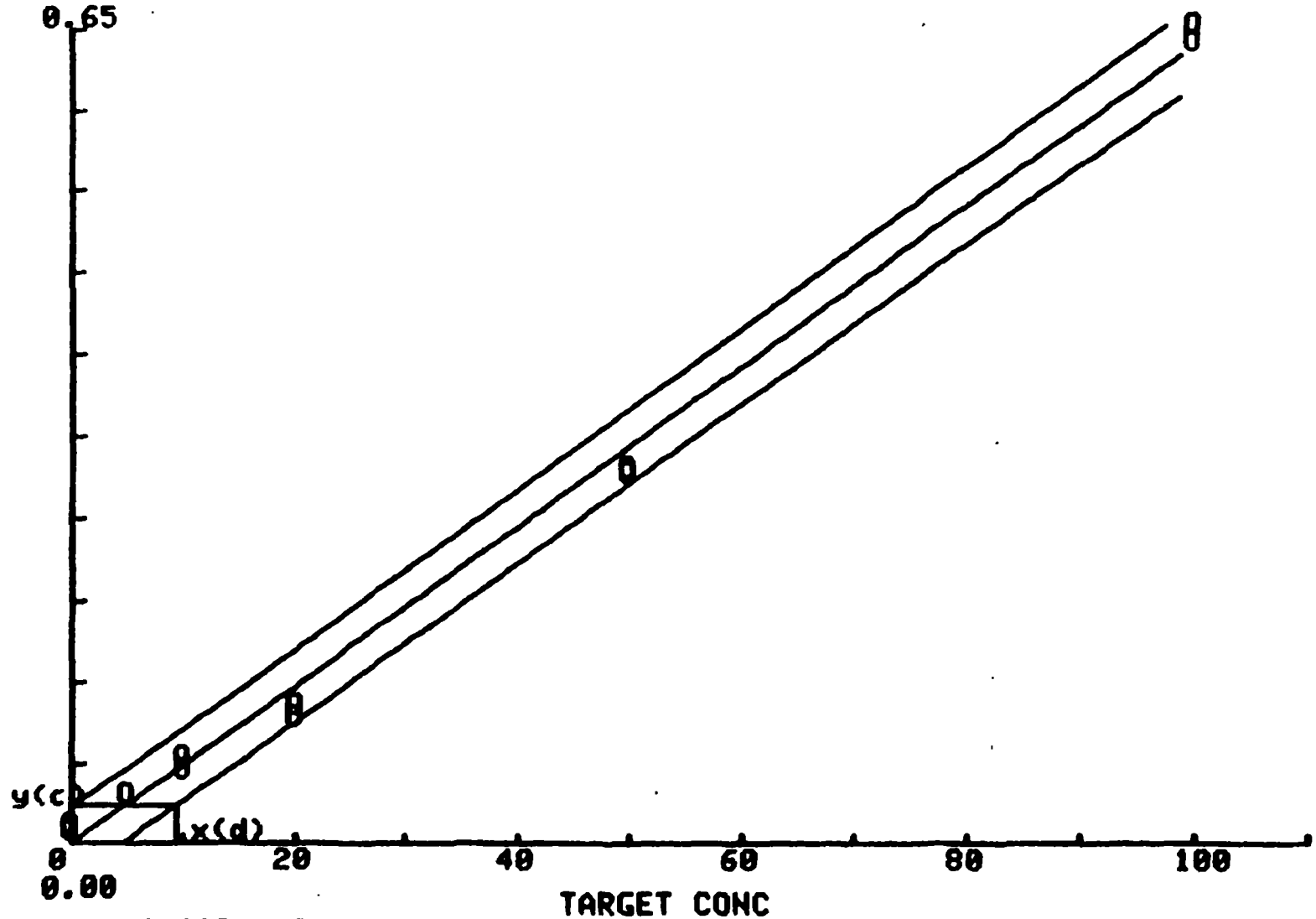
VII. REFERENCE None.

NITROCELLULOSE IN WATER
RUNS 1 2
COMPILATION OF TARGET CONC. VS PEAK AREA

Target Conc. MG/L	Day 1 Found Conc. MG/L	Day 2 Found Conc. MG/L	Day 3 Found Conc. MG/L	Day 4 Found Conc. MG/L
0.00	1.64	2.43		
5.00	6.47	6.37		
10.00	11.31	9.52		
20.00	16.46	17.72		
50.00	47.25	47.05		
100.00	101.88	101.91		

```
NITROCELLULOSE IN WATER
RUNS 1 2
TARGET CONC
ANALYSIS OF 12 TARGET CONC-PEAK AREA POINTS

MEAN= 30.8333333333  SD= 36.4837032942

PEAK AREA
MEAN= 0.193166666667  SD= 0.229348021905

NO. RUNS 2 TOTAL X-Y ALL RUNS 12 NO. CONCENTR 12
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -2.743312464E-4
SLOPE= 0.00627376209448
R= 0.998003265486
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 2.308336938E-4
COMPUTE T
D.F.= 10
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.81245868646
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.0292335894436
x(d)= 9.33791924766
```

NITROCELLULOSE IN WATER
RUNS 1 2
PEAK AREA



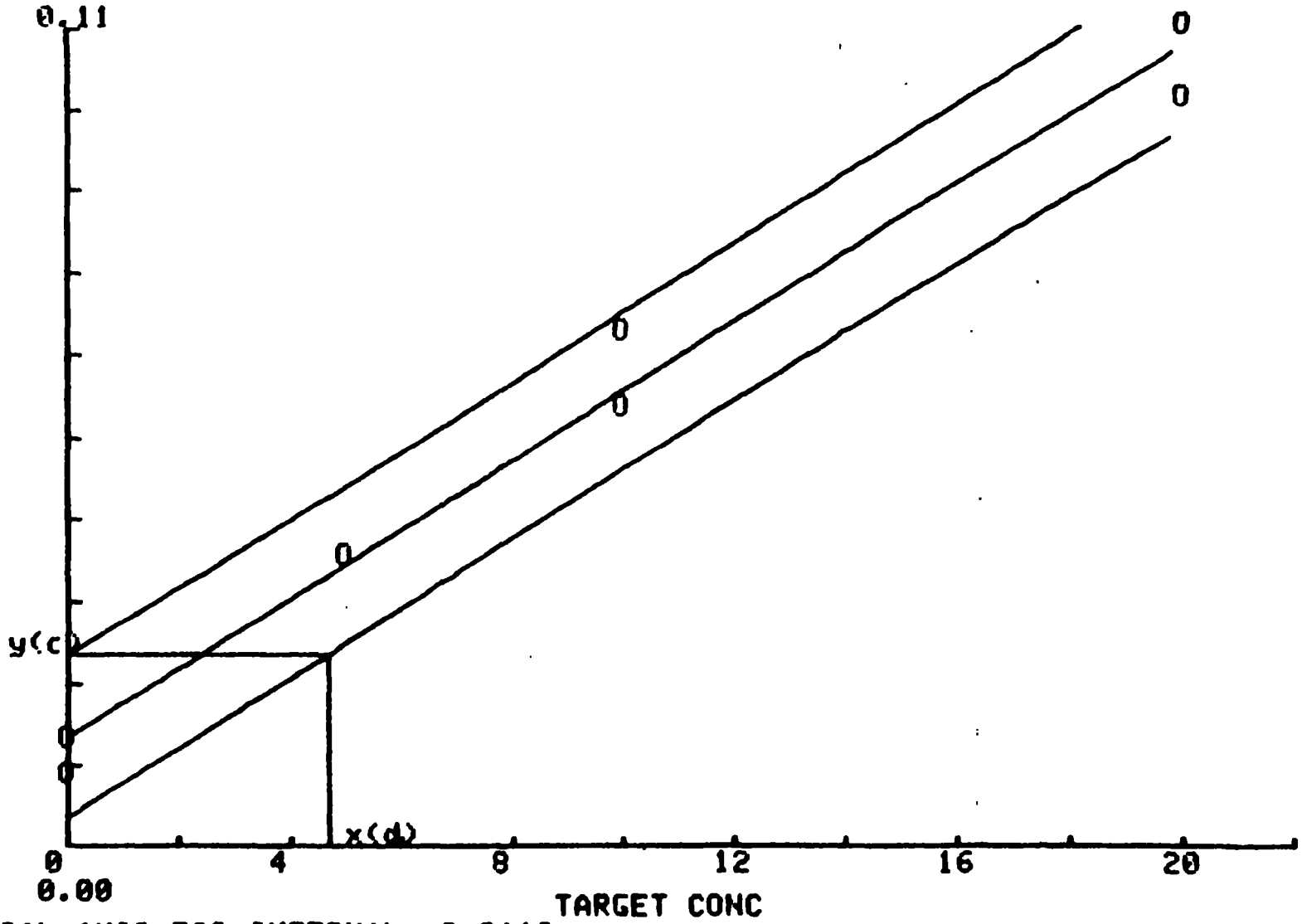
VERTICAL AXIS TIC INTERVAL= 0.0646

NITROGLYCERIN IN WATER
RUNS 1 2
COMPILATION OF TARGET CONC. VS PEAK AREA

Target Conc. MG/L	Day 1 Found Conc. MG/L	Day 2 Found Conc. MG/L	Day 3 Found Conc. MG/L	Day 4 Found Conc. MG/L
0.00	-1.23	0.08		
5.00	5.35	5.27		
10.00	11.93	9.42		
20.00	18.95	20.22		

```
NITROGLYCERIN IN WATER
RUNS 1 2
TARGET CONC
ANALYSIS OF 8 TARGET CONC-PEAK AREA POINTS

MEAN= 8.75  SD= 7.90569415042

PEAK AREA
MEAN= 0.056125  SD= 0.0373647561212

NO. RUNS 2 TOTAL X-Y ALL RUNS 8 NO. CONCENTR 8
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.0151
SLOPE= 0.00468857142857
R= 0.992015352553
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 2.590714286E-5
COMPUTE T
D.F.= 6
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.94317596321
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.0263769996195
x(d)= 4.68006454046
```

NITROGLYCERIN IN WATER
RUNS 1 2
PEAK AREA



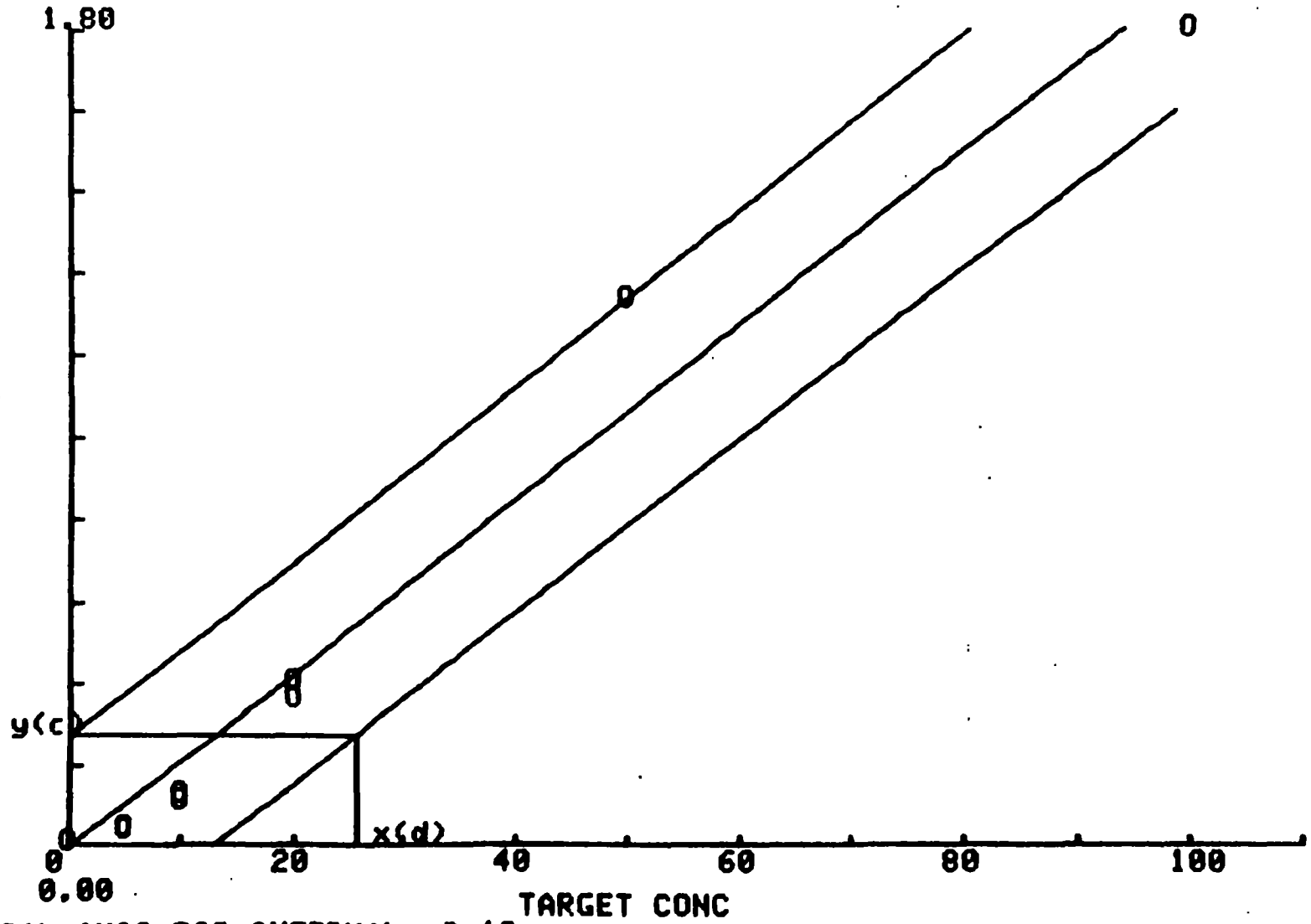
VERTICAL AXIS TIC INTERVAL= 0.0112

NITROGLYCERIN IN WATER
RUNS 1 2
COMPILATION OF TARGET CONC. VS ST PEAK AREA

Target Conc. MG/L	Day 1 Found Conc. MG/L	Day 2 Found Conc. MG/L	Day 3 Found Conc. MG/L	Day 4 Found Conc. MG/L
0.00	0.44	1.12		
5.00	2.11	2.58		
10.00	6.10	5.92		
20.00	19.26	17.85		
50.00	62.82	63.13		
100.00	94.27	94.39		

```
NITROGLYCERIN IN WATER
RUNS 1 2
TARGET CONC
ANALYSIS OF 12 TARGET CONC-ST PEAK AREA POINTS

MEAN= 30.8333333333  SD= 36.4837032942

ST PEAK AREA
MEAN= 0.585  SD= 0.708824763573

NO. RUNS 2 TOTAL X-Y ALL RUNS 12 NO. CONCENTR 12
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.00495731360273
SLOPE= 0.0191337507114
R= 0.984827449231
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.016643773819
COMPUTE T
D.F.= 10
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.81245868646
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.245604514821
x(d)= 25.8249834303
```

NITROGLYCERIN IN WATER
RUNS 1 2
ST PEAK AREA

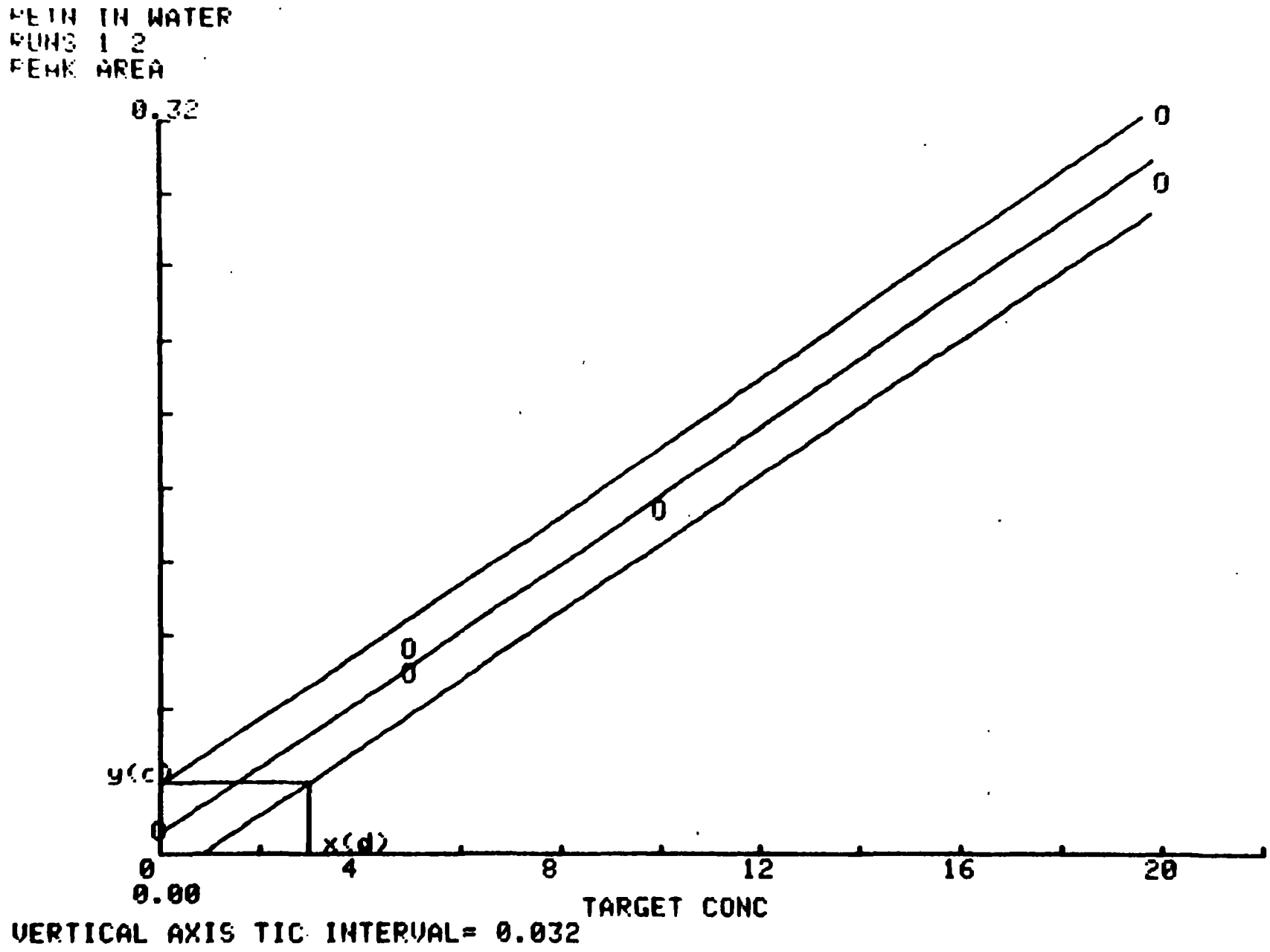


VERTICAL AXIS TIC INTERVAL= 0.18

PETN IN WATER
RUNS 1 2
COMPILATION OF TARGET CONC. VS PEAK AREA

Target Conc. MG/L	Day 1 Found Conc. MG/L	Day 2 Found Conc. MG/L	Day 3 Found Conc. MG/L	Day 4 Found Conc. MG/L
0.00	0.13	0.00		
5.00	5.33	5.00		
10.00	9.24	10.00		
20.00	20.30	20.00		

```
PETN IN WATER
RUNS 1 2
TARGET CONC
ANALYSIS OF 8 TARGET CONC-PEAK AREA POINTS

MEAN= 8.75  SD= 7.90569415042

PEAK AREA
MEAN= 0.1375  SD= 0.1164658135

NO. RUNS 2 TOTAL X-Y ALL RUNS 8 NO. CONCENTR 8
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.009
SLOPE= 0.0146857142857
R= 0.996865621198
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 9.904761905E-5
COMPUTE T
D.F.= 6
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.94317596321
1
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.0310498594706
x(d)= 2.94522299778
```

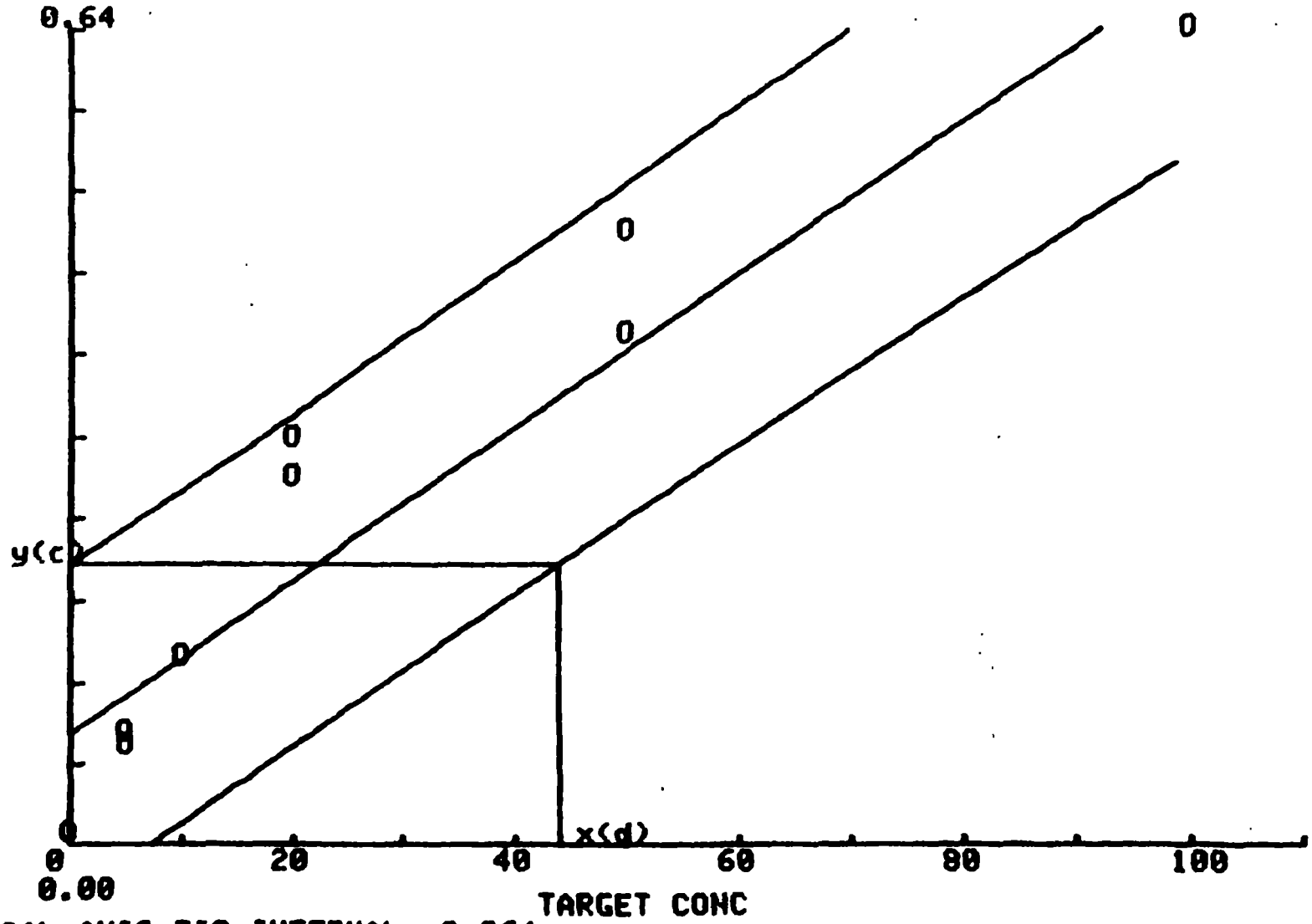

PETN IN WATER
RUNS 1 2
PEAK AREA
0.32
0
0.00
y(c)
x(d)
0
4
8
12
16
20
TARGET CONC
VERTICAL AXIS TIC INTERVAL= 0.032

PETN IN WATER
RUNS 1 2
COMPILATION OF TARGET CONC. VS PEAK AREA

Target Conc. MG/L	Day 1 Found Conc. MG/L	Day 2 Found Conc. MG/L	Day 3 Found Conc. MG/L	Day 4 Found Conc. MG/L
0.00	-13.45	-12.45		
5.00	0.26	-1.01		
10.00	10.55	10.42		
20.00	39.69	33.28		
50.00	53.40	64.31		
100.00	94.54	90.45		

```
PETH IN WATER
RUNS 1 2
TARGET CONC
ANALYSIS OF 12 TARGET CONC-PEAK AREA POINTS

MEAN= 30.8333333333  SD= 36.4837032942

PEAK AREA
MEAN= 0.271666666667  SD= 0.227669350887

N0. RUNS 2 TOTAL X-Y ALL RUNS 12 N0. CONCENTR 12
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= 0.0873335230507
SLOPE= 0.00597837222538
R= 0.958026003955
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.00468598178714
COMPUTE T
D.F.= 10
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.81245868646
REPLICATES ON UNKNOWN SAMPLE 1
y(c)= 0.220283817974
x(d)= 43.9748342347
```

PETN IN WATER
RUNS 1 2
PEAK AREA



VERTICAL AXIS TIC INTERVAL= 0.064

Method No. 13

Revised December 18, 1980

DETERMINATION OF TETRAZENE IN WATER

I. APPLICATION

This method is a quantitative procedure for determining tetrazene in water.

A. Tested Concentration Range. The tested concentration range is from 500 to 10,000 μg/l.

B. Sensitivity Limits. At the detection limit, 1 ng = 2.5×10^{-4} AU.

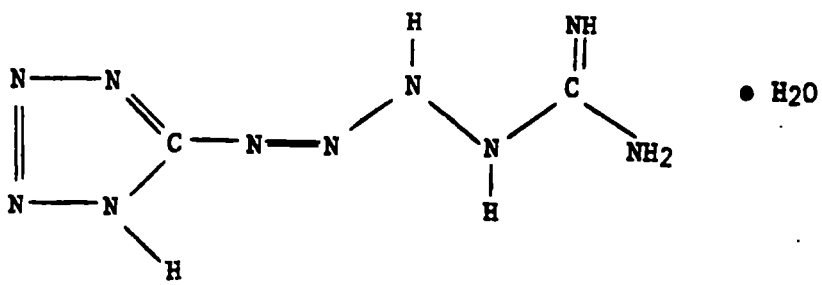
C. Detection Limits. (Calculated using the method of Hubeaux and Vox). Detection limit is 500 μg/l (lowest level standard).

D. Interferences. Compounds containing a guanidine moiety will interfere.

E. Analysis Rate. Approximately twenty samples can be analyzed by a worker in an eight hour day.

II. CHEMISTRY

Structure



CAS RN # --

Melting point -- decomposes

Boiling point -- N/A

Handling hazards -- Tetrazene is explosive especially in the dry state. The neat solid should be stored in isopropanol and only a small portion should be dried, by placing on a clean filter paper, to prepare analytical standards.

III. APPARATUS

A. Instrumentation. Bausch and Lomb Spectronic 20 spectrometer with tungsten lamp.

B. Parameters. Set spectrometer at 530 nM. Instrument zero is set using a blank sample with each set of samples.

C. Hardware/Glassware.

1. Volumetric flasks (various sizes).
2. Pipets 10 ml and 1 ml.
3. 4 dram vials with polyseal caps.
4. 100 ml graduated cylinder.
5. 8 oz screw capped bottles with Teflon lined caps.
6. Cuvettes for Spectronic 20.
7. Millipore all glass filter apparatus.
8. Millipore filters, 0.45μ, type HA, 47mm diameter.

D. Chemicals.

1. Methanol, distilled in glass, Burdick and Jackson.
2. Acetone, distilled in glass, Burdick and Jackson.
3. Distilled water, Millipore "Millie Q" or equivilent.
4. Sodium nitroprusside, analytical reagent grade.
5. Potassium ferricyanide, analytical reagent grade.
6. Sodium hydroxide, analytical reagent grade.

E. Reagents

1. Sodium Hydroxide. 10 grams in 100 ml distilled water. Store refrigerated in an eight ounce screw capped bottle.
2. Sodium Nitroprusside. 10 grams in 100 ml distilled water. Store refrigerated in a 8 ounce screw capped bottle. Prepare fresh every two weeks.
3. Potassium Ferricyanide. 10 grams in 100 ml distilled water. Store refrigerated in a 8 ounce screw capped bottle. Prepare fresh every two weeks.
4. Color Developing Reagent. Mix 10 ml portions of reagents A, B, and C with 30 ml of distilled water in a 125 ml flask. Allow to stand for 20 minutes and then mix with 60 ml of acetone. Use reagent within one hour.

IV. STANDARDS

A. Calibration Standards.

Stock. Place 10 mg of tetrazene in 100 ml volumetric flask. Fill to mark with methanol and mix well. Store refrigerated in a Teflon lined 8 oz bottle.

Working. Prepare calibration standards containing 0, 1, 2.5, 5, and 10 mg/liter in water by placing 0, 1, 2.5, 5 and 10 ml of the stock in a series of 100 ml volumetric flasks and filling to the mark with water.

B. Control Spikes. Since no extraction is involved control spikes are equivilent to working standards.

V. PROCEDURE

A. Sample Preparation. Obtain at least 50 ml of each water sample and filter through a millipore filter. Place exactly 10 ml of the filtered water sample in a screw capped vial and store refrigerated until analyzed.

B. Color Development. Pipet 1 ml of freshly prepared color developing reagent into 10 ml of the water sample, mix, and let stand for 1 hour. Run process blank and calibration standards in the same manner.

C. Sample Analysis. Set Spectronic 20 at 530 nm and allow the instrument to warm up for at least 30 minutes. Set 0 absorbance using the process blank sample. Measure the absorbance of each sample and calibration standard.

VI. CALCULATION

Construct a calibration curve from the data (concentration vs. absorbance) obtained for calibration standards and interpolate the concentration in the sample from the calibration curve. (Above 5 ppm the curve will probably be nonlinear).

Spike Recovery Data From Water

Target Value	Found Value
0	0, -0.005, +0.05, +0.05
0.5	0.5, 0.5, 0.48, 0.53
1.0	1,0, 1.0, 0.98, 1.0
2.5	2.5, 2.4, 2.6, 2.5
5.0	5.0, 4.8, 4.9, 4.9
10.0	10.0, 10.0, 9.9, 10.1

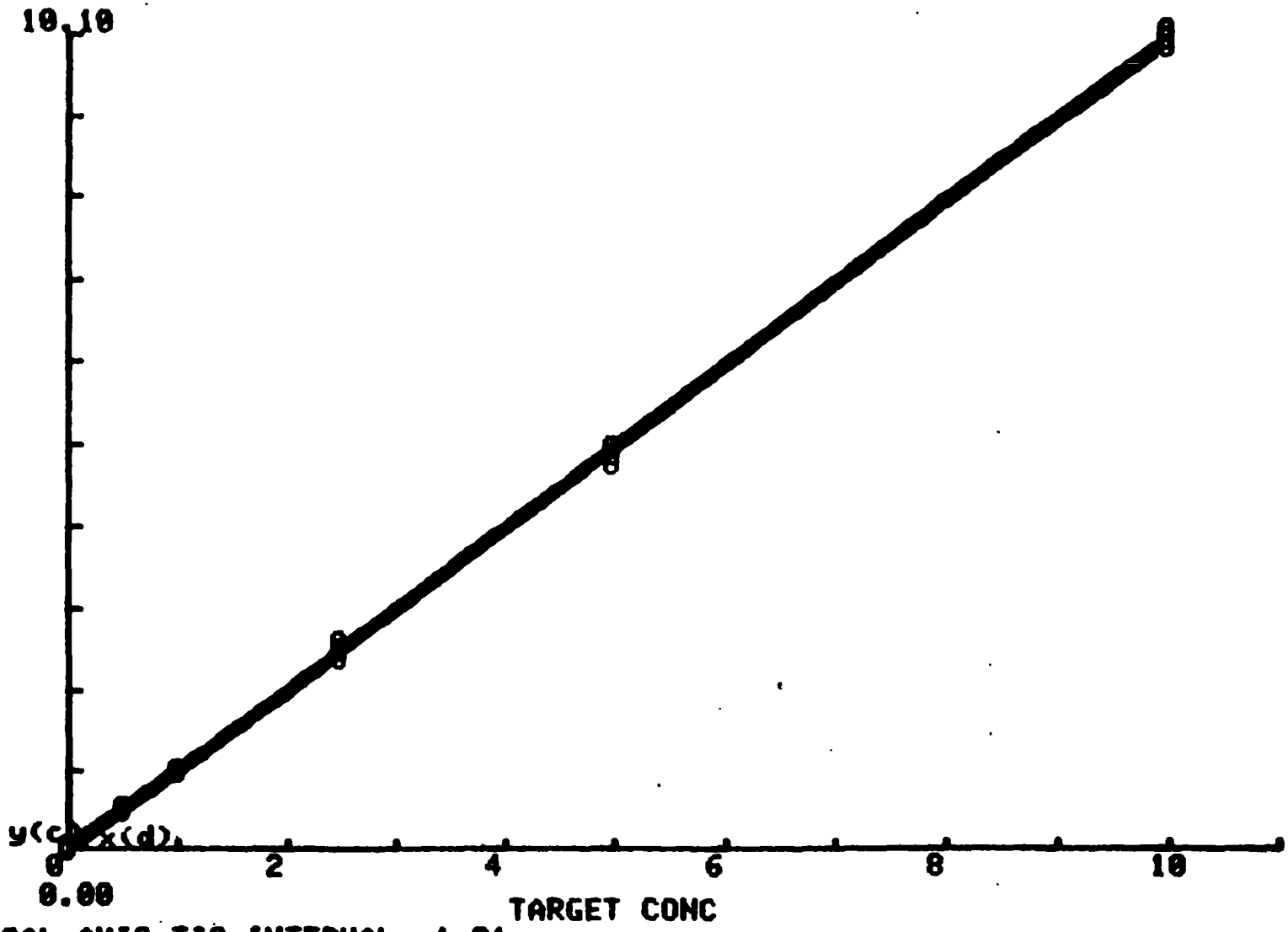
VII. REFERENCE. None

BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
COMPILATION OF TARGET CONC. VS FOUND CONC

Target Conc. MG/L	Day 1 Found Conc. MG/L	Day 2 Found Conc. MG/L	Day 3 Found Conc. MG/L	Day 4 Found Conc. MG/L
0.00	0.00	0.00	0.05	0.05
0.50	0.50	0.50	0.48	0.53
1.00	1.00	1.00	0.98	1.00
2.50	2.50	2.40	2.60	2.50
5.00	5.00	4.80	4.90	4.90
10.00	10.00	10.00	9.90	10.10

```
BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
TARGET CONC
ANALYSIS OF 24 TARGET CONC-FOUND CONC POINTS

MEAN= 3.16666666667  SD= 3.54678870881

FOUND CONC
MEAN= 3.15375  SD= 3.53473055673

NO. RUNS 4 TOTAL X-Y ALL RUNS 24 NO. CONCENTR 24
MEASURES (Y'S) EACH TARGET CONC 1

INTERCEPT= -0.0016071428571
SLOPE= 0.996428571429
R= 0.999827723656
MEAN SQR DEV OF POINTS FROM REGRESSION (ST ERROR EST)= 0.00450024350701
COMPUTE T
D.F.= 22
ENTER 2 TAIL P LEVEL (USUALLY .1, EACH CONFID BAND IS
.05 SO TOTAL P= .1)
.1
t= 1.71713909197
REPLICATES ON UNKNOWN SAMPLE 4
y(c)= 0.0641962943042
x(d)= 0.131792130263
```

BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
FOUND CONC

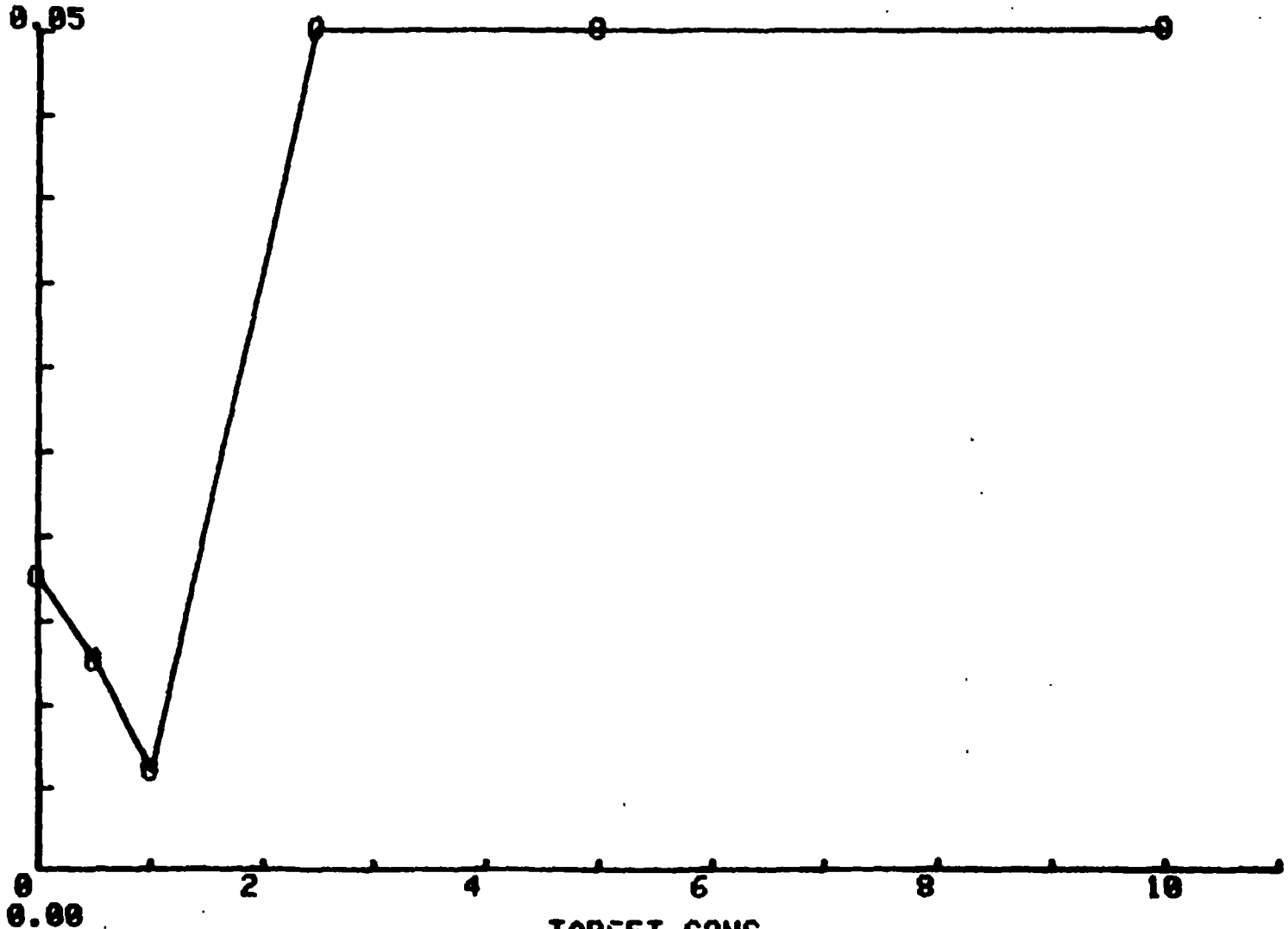


VERTICAL AXIS TIC INTERVAL= 1.01

BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
STATISTICAL DATA USED TO DETERMINE PERCENT
INACCURACY AND COEFFICIENT OF VARIATION

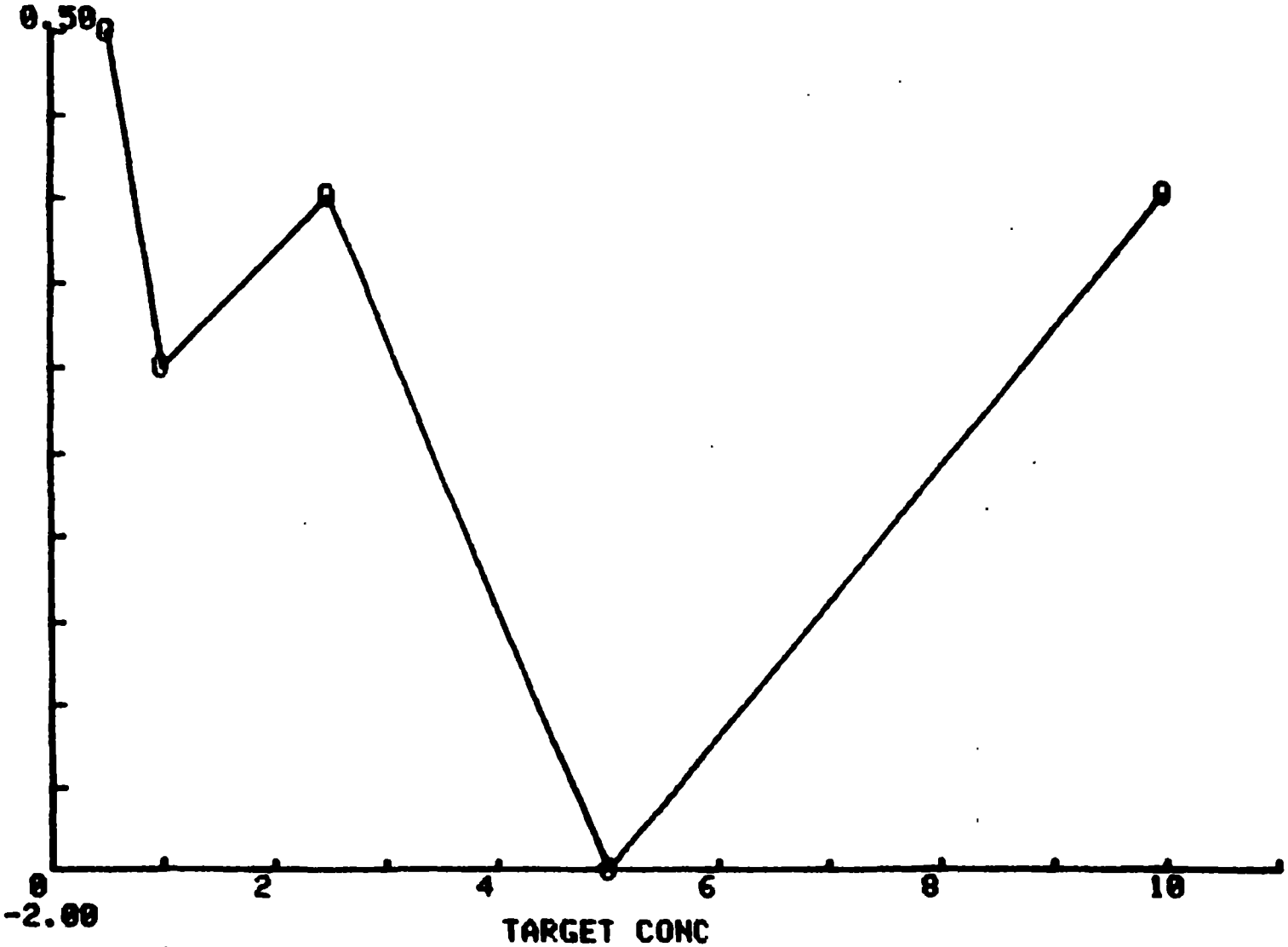
Target Conc. MG/L	Mean Found Conc. MG/L	Standard Deviation	Percent Inaccuracy	Coefficient(%) of variation
0.00	0.03	0.02		66.67
0.50	0.50	0.01	0.50	2.37
1.00	1.00	0.01	-0.50	0.58
2.50	2.50	0.05	0.00	1.89
5.00	4.90	0.05	-2.00	0.96
10.00	10.00	0.05	0.00	0.47

BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
STANDARD DEVIATION



VERTICAL AXIS TIC INTERVAL= 0.00471

BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
MEAN PERCENT INACCURACY



VERTICAL AXIS TIC INTERVAL= 0.25

STANDARD DEVIATION
BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
USE FOUND CONC
(1) 0 0.0166 (2) 0.5 0.0119

(3) 1 0.0057 (4) 2.5 0.0471

(5) 5 0.0471 (6) 10 0.0471

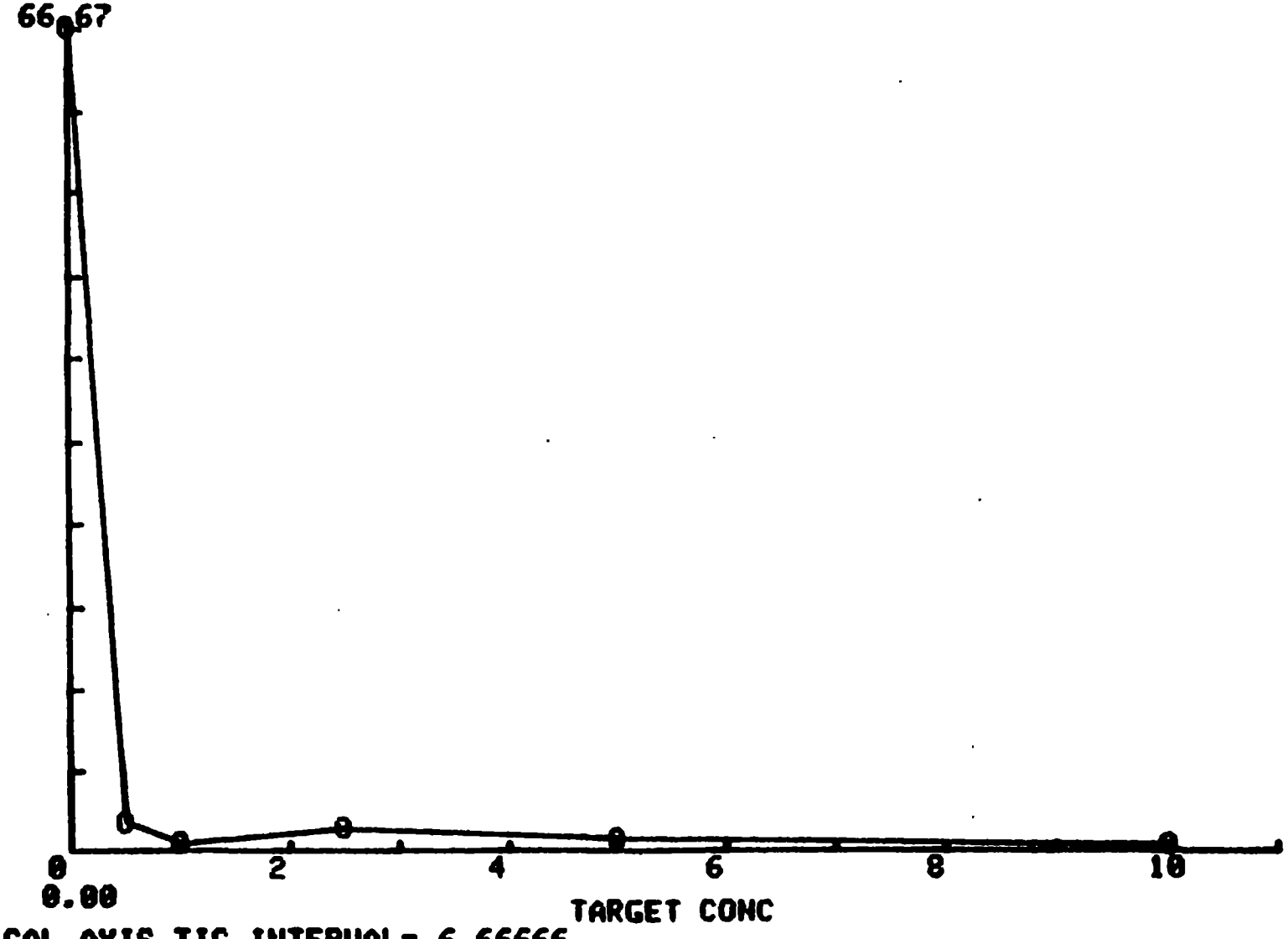
```
INDIVIDUAL PERCENT INACCURACY
BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
USE FOUND CONC
(1) 0 1.0E+300 (2) 0.5 0

(3) 1 0 (4) 2.5 0

(5) 5 0 (6) 10 0

(7) 0 1.0E+300 (8) 0.5 0

(9) 1 0 (10) 2.5 -4.0001

(11) 5 -4.0001 (12) 10 0

(13) 0 1.0E+300 (14) 0.5 -4.0001

(15) 1 -2.0001 (16) 2.5 3.9999

(17) 5 -2.0001 (18) 10 -1.0001

(19) 0 1.0E+300 (20) 0.5 5.9999

(21) 1 0 (22) 2.5 0

(23) 5 -2.0001 (24) 10 0.9999

COMPUTE MEAN PERCENT INACCURACY? Y/N Y
(1) 0 1.0E+300 (2) 0.5 0.4999

(3) 1 -0.5001 (4) 2.5 -1.0E-4

(5) 5 -2.0001 (6) 10 -1.0E-4
```

PERCENT IMPRECISION
BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
USE FOUND CONC
(1) 0 66.6666 (2) 0.5 2.3686

(3) 1 0.5802 (4) 2.5 1.8856

(5) 5 0.962 (6) 10 0.4714

BCL TETRACENE IN WATER P & A
RUNS 1 2 3 4
PERCENT IMPRECISION



VERTICAL AXIS TIC INTERVAL= 6.66666

APPENDIX G

SAMPLE STANDARD OPERATING PROCEDURE

"Demolition Plan for the 400 Area
(Explosives Manufacturing Area) of the
Frankford Arsenal

Rockwell International
Atomics International Division

SUPPORTING DOCUMENT

NUMBER	REV LTR/CHG
N5050P000001	

DOCUMENT TYPE
Operating Procedure

KEY NOUNS
Demolition, Decontamination, Frankford Arsenal

ORIGINAL ISSUE DATE

PROGRAM TITLE
Frankford Arsenal Decontamination/Cleanup Operations

DOCUMENT TITLE
Demolition Plan for the 400 Area (Explosives Manufacturing Area) of the Frankford Arsenal

GO NO.	S/A NO	PAGE 1 OF TOTAL PAGES
08505	21000	REL DATE

PREPARED BY/DATE	DEPT	MAIL ADDR
W. R. Johnson W.R. Johnson 12-19-79	731	T055
F. C. Schrag F.C. Schrag 12-19-79	731	T020

IR&D PROGRAM? YES ☐ NO ☒ IF YES, ENTER TPA NO. _____

APPROVALS

	DATE
A. F. Lillie	12/19/79
R. Brengle R. Brengle	12/19/79
W. R. McCurnin W. R. McCurnin	12/19/79

SECURITY CLASSIFICATION

(CHECK ONE BOX ONLY)

	DOE	DOD
UNCL	☒	☐
CONF	☐	☐
SECRET	☐	☐

CHECK ONE BOX ONLY
RESTRICTED DATA ☐
DEFENSE INFO ☐

AUTHORIZED CLASSIFIER _____ DATE _____

DISTRIBUTION

*	NAME	MAIL ADDR
*	A. J. Darnell	NB04
*	D. McClelland	LB13
*	J. Miller	T020
*	R. Tuttle	NB13
*	A. F. Lillie (2)	LB05
*	R. D. Gothar (7)	LA38
*	A. J. Lucas	LA34
*	J. C. Campbell	KB07
*	W. W. Kelly	KA02
*	M. Murray	KA46
*	R. G. Brengle	LB08
*	W. R. McCurnin	T020
*	J. H. Walter	T006
*	D. McKenzie	NB04
*	G. H. Hallinan	LB08
*	W. D. Kittinger	NB02
	G. W. Meyers	LA10
*	G. Colovos (2)	EMSC

716-M.90/sjd

* COMPLETE DOCUMENT
NO ASTERISK, TITLE PAGE SUMMARY OF CHANGE PAGE ONLY

ABSTRACT

Presented is a step-by-step procedure for the demolition of the 400 area of the Frankford Arsenal. There are 32 buildings, covered walkways, sumps, sewers, and concrete blast walls which will be removed. The concrete floors and macadam paving will also be removed. Below-grade foundations, pilings, and the concrete roadway are not to be removed. The excavated area will be graded. Only three of the buildings are slightly contaminated with explosive residue as reported by Battelle in Appendix A of Contract DAAK 11-79-C-0135. Included in this procedure is a list of the buildings along with the type of contaminate reported. The area is to be restored to a condition which will allow its unrestricted use (so-called 5X decon).

RESERVED FOR PROPRIETARY/LEGAL NOTICES

FORM 2344-C REV 11-77

CONTENTS

		Page
1.0	SCOPE	3
2.0	BACKGROUND	3
3.0	METHODS	4
4.0	CONTAMINANTS AND MATERIALS INVOLVED	6
5.0	EQUIPMENT AND MATERIALS	7
6.0	SAFETY PROCEDURES	8
7.0	PROCEDURES FOR DEMOLITION	9
8.0	COST AND SCHEDULE	11

FIGURES

Figure		Page
1.	Map of Frankford Arsenal	12
2.	Concept Demolition of 400 Area	17
3.	Demolition Sequence	19
4.	Remote Flame Operation	22
5.	Typical Blast Wall Cross Section	23

TABLES

Table		Page
1.	Manufacturing Operations in the 400 Area	13
2.	400 Area Buildings	15
3.	Thermal Decomposition Temperatures of Selected Explosives	20
4.	400 Area Sump and Vent Contamination	21

APPENDIX A: RESTRICTED ACCESS AREA ENTRY PERMIT 24

1.0 SCOPE

This procedure will provide for the safe demolition of structures in the 400 area of the Frankford Arsenal. All structures will be removed to the existing grade level and all materials will be removed. Surfaces potentially contaminated with explosives will be flamed to assure their cleanliness. The area will be restored for unrestricted use.

2.0 BACKGROUND

The 400 area is a 9-acre section of Frankford Arsenal (FFA) located in the southeast end of the post. The 400 area was used to manufacture primer mixes and pyrotechnic materials. Lead styphnate manufacture was started in 1944, and production continued to 1976. Table 1 is a tabulation of the manufacturing operations for each of the buildings.

The area includes 32 one- and two-room buildings, blast walls, associated drains, traps, sumps, and approximately 8,200 ft of terra cotta drain lines. The drain lines include branch waste lines from each building's sump which connect with the main 30-in. line running to the Delaware River. In addition, the old Fitler sewer line to the Delaware River runs adjacent to the 30-in. sewer line. Wash-down of process areas and decanting of vessels during operations contributed extensively to contamination of the sumps and laterals. The Battelle survey (Appendix A of Contract DAAK 11-79-C-D135) revealed that Buildings 404, 410, and 429 contained explosive residues. Some of the sumps, drains, and vents associated with the buildings were also found to contain some explosive residues.

The 400 area is shown in Figure 1 (Drawing FF 12958 enlargement, "Map of Frankford Arsenal"). A tabulation of the buildings and associated structures is presented in Table 2. Included in the table is the type of explosive contamination reported in the Battelle survey (Appendix A of Contract). Detailed drawings of the 400 area are on file at the Arsenal and are in the FF 14000 series.

3.0 METHODS

A conceptual process flow diagram for the demolition of the 400 area is presented in Figure 2. Process details are presented in Section 7.

The demolition for the 400 area consists of a scoping survey of the area for explosives to verify the Battelle results. The wooden covered walkways, along with the asbestos shingles, will be removed and treated as asbestos waste. The wooden roof of each building will be removed along with the asbestos shingles and asbestos ceiling materials. This mass of material will be treated as asbestos contaminated waste and processed for burial. The land burial facility will be GROWS, Geological Reclamation Operation and Waste Systems, Inc., Morrisville, Pennsylvania. The inside of the buildings, which include the concrete floor, floor tiles, and ceramic tile walls will be flamed. The concrete blast walls will be removed and processed to a land fill area. The buildings will be demolished and the materials will be removed and processed to a land fill area. The drains and sumps will be removed; also the concrete floor from each of the buildings will be removed and processed for land fill. The macadam paving between the buildings will be excavated and removed for land fill. The area will be backfilled with soil and final-surveyed for explosive contaminants before releasing the area for unrestricted use. After the area has been released, the perimeter fence will be removed and disposed of as scrap.

Flaming will be used for noncombustibles on the inside of the buildings and sumps to assure that all residue explosives are decomposed. Flaming will be done to raise the surface temperature of structures above the decomposition temperature of the explosive contaminates. Temperature indicating paints will be used to assure that adequate reaction temperatures are obtained. Table 3 lists the explosives which were manufactured in the 400 area, and their decomposition temperatures. Before demolition of the buildings, the vents will be removed.

After flaming, typical surfaces of Building 429A will be sampled with swipe wet with acetone. These samples will be analyzed for explosive residue as a double-check to assure that the flaming is effectively decomposing explosives.

Some of the sumps may have radioactive contamination as reported by Battelle. Table 4 gives a listing of the sumps that may be contaminated. Samples will be taken from these sumps to verify the presence of radioactive contamination. Those sumps that do not contain radioactive contamination will be treated as only containing explosive contamination. Those sumps that do have radioactive contamination will be treated for explosive contamination and then treated for radiological materials.

A few of the sumps may have heavy metal residue as reported by Battelle. These sumps will be sampled for heavy metal contamination. Those sumps that do, in fact, have heavy metal present will be treated for explosive contamination and then cleaned of heavy metal if it is still above allowable limits before they are flamed as part of the explosive residual cleanup operation.

The sumps will be pumped to remove liquid and sludge. This waste will be thermally or chemically treated to decompose the explosive residues. Flaming of the sumps will be performed before removal to assure that all explosive residue have been reacted. Temperature indicating paints will be used to assure that adequate reaction temperatures are obtained. The drains will be removed, then passed through a flame to react explosive residue. The materials from the drains and sumps will be transported to a land fill site.

Waste collected in vacuum cleaners and miscellaneous potentially contaminated materials such as work gloves, wipes, etc., will be flashed to decompose explosive residues.

A single designated working copy of this demolition plan may be changed in red (red lines) by authorized personnel as procedural changes dictate. All procedural changes must be approved by a U.S. Army Toxic and Hazardous Material Agency (USATMA) representative. These include, but are not limited to:

a) Health and Safety Engineering Coordinator (HSEC) must approve and sign those changes affecting health and safety.
b) The site director must approve and sign changes affecting the scope of the task, i.e., cost or schedule.
c) QA must approve and sign those changes affecting quality.
d) All changes must be approved by D&D operations.

Waste materials will be controlled by D&D operations management. Only haulers with state permits will be used to transport waste. Traffic will initiate material removal requests which must be approved by operations management. Each vehicle entering and leaving will be checked to assure that only materials approved on the removal request are in the vehicle and that the delivery destination is correct.

4.0 CONTAMINANTS AND MATERIALS INVOLVED

There are some contaminants and materials involved in the demolition of the 400 area that require special attention. The Battelle survey (Appendix A of the contract) reports explosive residue contamination in a few of the buildings in the 400 area. Table 2 lists the contamination reported by Battelle in the 400 area buildings. Table 3 lists the decomposition temperature for these explosives. Table 4 lists the contamination reported by Battelle in the 400 area support facilities.

For the inside of buildings having a history of explosive usage (see Table 1), a battery of five spray indicator tests will be used to screen for explosives. These spray tests are extremely useful since a large

number of surfaces can be screened rapidly. However, it should be noted that a positive result must be confirmed using a more specific assay method, since all tests of this type are subject to false positives.

Along with the explosive residues, the asbestos materials will require special handling. Asbestos materials are limited to the roofs of buildings and walkways, pipe insulation, and ceilings of all buildings. The roof tiles and transite ceiling materials are hard and fired materials which will not produce an airborne hazard. The pipe insulation is friable and may produce loose fibers. Workers will be protected from this hazard by respirators and protective clothing.

5.0 EQUIPMENT AND MATERIALS

The equipment required for demolition shall include, but not be limited to, the following:

1) Caterpillar - to remove walkways, demolish buildings
2) Wrecking ball - to demolish blast walls
3) Hyram - to demolish divider walls, floors
4) Front loader - to remove macadam, remove rubbish
5) Backhoe - to remove sewers, sumps
6) Remote boom/with torch - to flame inside buildings
7) Vacuum cleaner (nonsparking, air-powered)
8) Respirators
9) Coveralls (nonstatic cotton)
10) Safety shoes (with grounding shoe straps)
11) Hard hats
12) Safety glasses.

6.0 SAFETY PROCEDURES

Limited access to the 400 area will be maintained during all operations of demolition. Personnel shall be limited to those essential for the task; however, there shall be no less than two persons while working in or around contaminated areas.

A Restricted Access Area Entry Permit (Appendix A) initiated by Operations and issued by the Health and Safety Radiation Services will be required for all work performed in the 400 area. This permit will include procedures outlining minimum safety requirements for these hazardous areas and operations. Following review, the permit shall be signed by all personnel who are doing work covered by the permit. A copy of the permit will be posted in the work area. No entry shall be permitted without specific approval of the supervisor in charge of the area.

Air-powered, nonsparking vacuum equipment will be used for cleanup operations. The vacuum equipment will be connected to building electrical ground when operated in areas containing explosive residues. The vacuum cleaner attachments will be made of nonsparking materials, such as aluminum, and will be grounded to the vacuum cleaner. The vacuum equipment will be operated with sufficient water in the collection tank to keep the residue wet or moist at all times. The vacuum equipment will be equipped with special exhaust filters to reduce discharge of particulates in the atmosphere. Nonsparking tools will be used in areas contaminated with explosive residue. Grounding shoe straps and nonstatic cotton coveralls will be worn by personnel in cleaning up explosives residue.

The flaming operation and cleanup operations will be performed with caution when in the proximity of combustible materials. Appropriate fire prevention measures will be exercised. Fire retardant clothing will be worn by the operators during flaming operations.

All equipment operators will be required to wear eye protection and hard hats. All nonequipment operators will be required to wear the same, with the addition of safety shoes. Steel plates will be added to equipment as armor to protect the operators.

Special note should be taken for the existence of explosives residue in cracks and crevices. If such residues are found, appropriate removal procedures such as steam cleaning or high-pressure water washing techniques will be employed.

7.0 PROCEDURES FOR DEMOLITION

The following procedures are outlined for performing the demolition of the 400 area: (re: Figure 3).

1) Remove steel beams and steam pipe holders along walkway. Beams and pipes are to be processed as scrap metal.
2) Remove pipes from covered walkway. Process pipes as scrap metal. If asbestos insulation is present, the insulation and the enclosed pipe will be disposed as asbestos waste.
3) Remove covered walkways and collect all materials in one area before moving it to a landfill.
4) Removal of building roofs.
   a) Survey all interior surfaces of the roof with spray indicator.
   b) Vacuum and hand scrub surfaces that indicate presence of explosive contamination.
   c) Remove roof from each building - mechanized removal. Collect all materials in one area.
   d) Remove all materials from site and handle as asbestos waste for land burial.
5) Removal of buildings.

a) Remove all loose combustible materials from all buildings.

b) Survey the walls and floors with spray indicators. Only those buildings or portions of those buildings which contain explosive residue as shown by the indicator will be cleaned by vacuum techniques. Resurvey the area to assure that the area of the building that previously indicated the presence of explosive residue is clean to less than 1 gm/m^2 (0.1 gm/m^2 for nitroglycerin).

c) For areas of the buildings which continue to indicate the presence of explosive residue, additional cleaning will be done. Methods such as steam cleaning, washing/scrubbing or foam cleaning either separately or in combination will be used.

d) Verification to show the explosives residue has been reduced to a safe level in all buildings. If not, Procedure 5c will be repeated until analyses shows that a safe level has been reached.

6) Flame inside of buildings by remote boom torch. Temperature indicating paints will be used to show that adequate reaction temperatures are obtained. The operation will be monitored by TV and the torch operator will be protected by steel armor (Figure 4).

7) Verification sampling of typical flamed surfaces will be done to confirm that the explosives residue have been decomposed.

Materials from the following procedure steps will be collected, then processed to a land fill.

8) Demolish blast walls (typical blast wall shown in Figure 5).

9) Demolish buildings with bulldozer.
10) Demolish divider walls and concrete buildings.
11) Remove floors of buildings.
12) Remove sumps after:
    a) Pump the liquids out.
    b) Flame the inside of the sump using temperature indicating paints to show that a high enough temperature was reached to decompose explosives residue.
13) Remove sewers.
    a) Pass all sewer material through flame.
    b) Use temperature indicating paint on some selective surfaces to assure that high enough temperatures were reached to decompose explosives residue.
14) Backfill sump and sewer line excavation with soil.
15) Remove macadam.
16) Rough grading of 400 area to make level.

8.0 COST AND SCHEDULE

Demolition of the 400 area is planned for early summer after the ground has defrosted. Excavation will be much easier and liquids easier to manage after the winter freeze is over.

Cost estimates for demolition of the 400 area will be obtained from demolition contractors at part of Phase III of this contract. Current plans are to subcontract the work of the demolition phase.

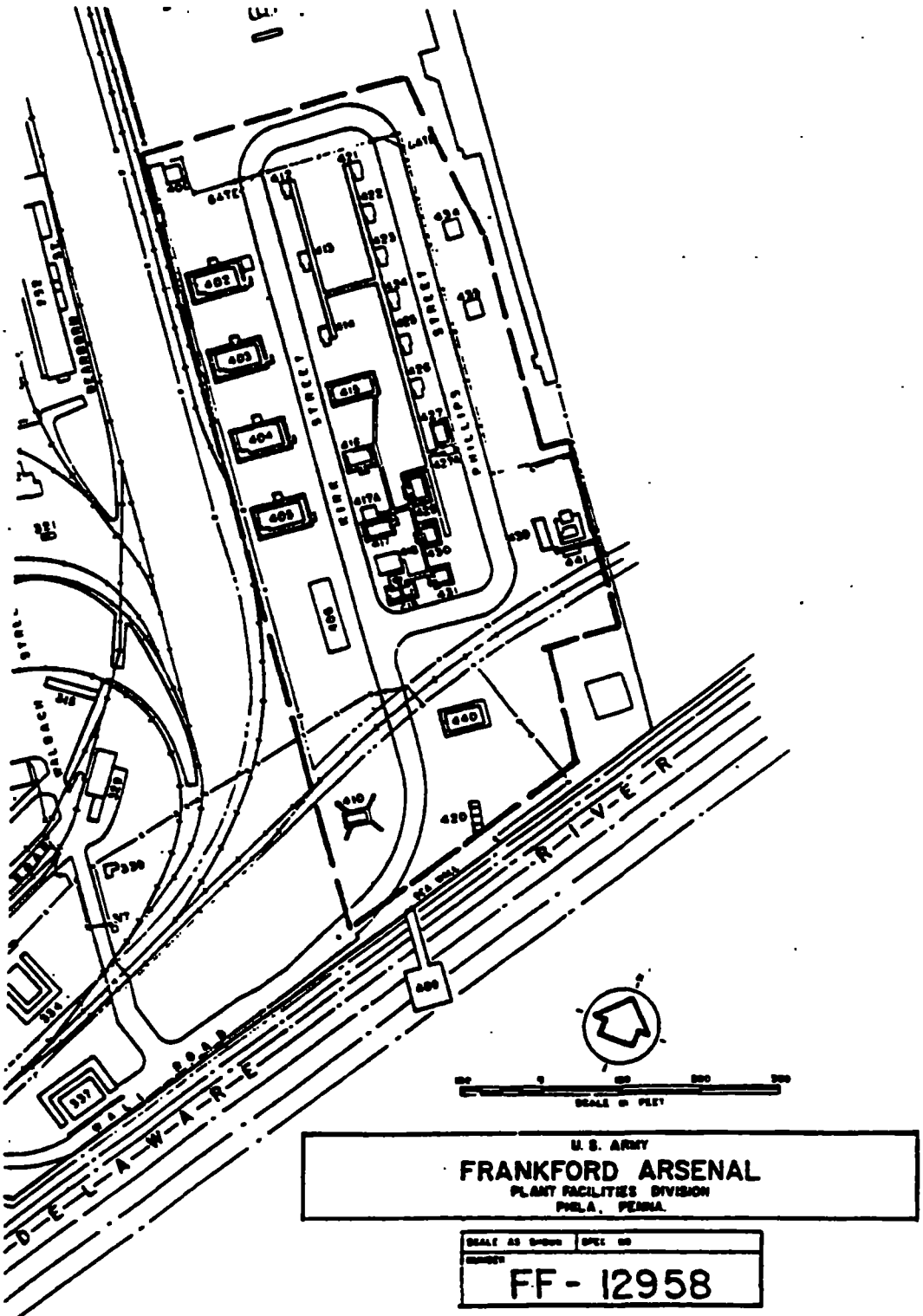


Figure 1. Map of the Frankford Arsenal

TABLE 1

MANUFACTURING OPERATIONS IN THE 400 AREA

Building	Normal Operations/Usage
402	Primer Materials Storage
403	Primer Materials Storage
404	Propellant Storage
405	Primer Materials Storage
406	Office and Personnel Activity Area
410	Primer Storage
412	Zirconium and Sodium Carbonate Storage
413	Pyrotechnics Blending
414	(1) Zirconium and Lead Dioxide Drying
	(2) Analytical Lab Support of Nitrocellulose and Nitroglycerine Process
415	(1) Sytphnic Acid Manufacturing
	(2) Styphnic Acid Storage
416	Zirconium and Lead Dioxide Mixing
417	Lead Styphnate Manufacturing
417B	Chem Storage
418	(1) Head End for Disposal of Off-Specification Lead Styphnates
	(2) Primer Mix Disposal
	(3) Zirconium, Lead Dioxide Combined with Methylent Chloride
419	Lead Styphnate and Tetrazene Slurry Blending
420	Black Powder Storage
421	TNT Storage
422	(1) Blending Experimental Delay Material
	(2) Pyrotechnic Blending
423	Pyrotechnic Pelletizing
424	Incendiary Material Drying
425	(1) Incendiary Material Drying
	(2) Pyrotechnic Storage
426	(1) Chem Storage
	(2) Pyrotechnics Storage

TABLE 1

MANUFACTURING OPERATIONS IN THE 400 AREA
(Continued)

Building	Normal Operations/Usage
427	(1) Tetrazene Manufacturing (Wet)
	(2) Pentaerythrite Tetranitrate (PETN) Weighup
427B	Chem Storage
429	Lead Styphnate Storage
430	(1) Styphnate Weighup
	(2) Tetrazene Weighup
	(3) Lead Styphnate Storage - Wet
431	(1) Black Powder Storage
	(2) Black Powder Lotting
434	Bullet and Case Breakup
435	Bullet and Case Breakup
438	Burn Pit
439	Ammo and Explosive Incineration
440	Propellant Material Storage
441	Scrap Storage

TABLE 2

400 AREA BUILDINGS

Number	With Blast Wall	With Divider Blast Wall	Type of Contamination ($\mu g/m^2$)	Concrete Dock
400	-	-	-	-
402	X	-	-	-
403	X	-	-	-
404	X	-	(NC,900,1200)	-
405	X	-	-	-
406	-	-	-	X
409	-	-	-	-
410	X	-	(PETN, 2000)	-
412	-	-	-	-
413	-	-	-	-
414	-	-	-	-
415	X	-	-	-
416	X	-	-	-
417	X	-	-	-
418	-	-	-	-
419	X	X	-	-
420	-	-	-	-
421	-	-	-	-
422	-	-	-	-
423	-	-	-	-
424	-	-	-	-
425	-	-	-	-
426	-	-	-	-
427	X	-	-	-
427A	-	-	-	-
429A & B	X	-	TNT 5000 PETN, 1200 TETR, 600 TNT 1300	

TABLE 2

400 AREA BUILDINGS
(Continued)

Number	With Blast Wall	With Divider Blast Wall	Type of Contamination ($\mu g/m^2$)	Concrete Dock
430	X	-	-	-
431	X	-	-	-
434	-	-	-	-
435	-	-	-	-
439	-	-	-	X
440	-	-	-	X
441	-	-	-	-

FIGURE 2

CONCEPT DEMOLITION OF 400 AREA

Survey Area with Explosion Meters

↓

Remove Covered Walks

↓

Remove Buildings Roofs

↓

Flame Buildings and Floors

↓

Remove Blast Walls

↓

Remove Buildings and Floors to Grade

↓

Pump the Liquids from Sumps

↓

Flame the Sumps

↓

Remove Drains and Terracata Pumps

↓

Flame the Drains

↓

FIGURE 2

CONCEPT DEMOLITION OF 400 AREA
(Continued)

↓

Remove
Sumps

↓

Remove
Macadam
Between
Buildings

↓

Backfill
Area
With
Soil

FIGURE 3

DEMOLITION SEQUENCE

EQUIPMENT	TASK	DEPOSITION		
HAND AND TORCH	REMOVE STEEL BEAMS AND STEAM HOLDERS	SCRAP		
HAND	REMOVE PIPES FROM COVERED WALK	SCRAP		
CAT	REMOVE COVERED WALKS	BURY AS ASBESTOS LAND BURIAL		
REMOTE WITH CLAM SHELL	REMOVE ROOF FROM EACH BUILDING	RUBBLE PILE ON SITE	AGE	BURY AS ASBESTOS LAND BURIAL
HAND	REMOVE DOOR AND WINDOW FRAMES	RUBBLE PILE ON SITE		BURY LAND BURIAL
REMOTE BOOM	FLAME INSIDE OF BUILDING TORCH			
WRECKING BALL HYRAM	DEMOLISH BLAST WALLS	LANDFILL		
BULLDOZER	DEMOLISH BUILDINGS	LANDFILL		
HYRAM	DEMOLISH DIVIDER WALL AND CONCRETE BUILDINGS	LANDFILL		
HYRAM	REMOVE FLOORS	LANDFILL		
	PUMP LIQUIDS FROM SUMPS			
	FLAME THE INSIDE OF SUMPS			
FRONT LOADER	REMOVE SEWERS	LANDFILL		
	FLAME SEWER MATERIALS			
BACK HOE	REMOVE SUMPS	LANDFILL		
HYRAM	BACKFILL WITH SOIL			

TABLE 3

THERMAL DECOMPOSITION TEMPERATURES OF SELECTED EXPLOSIVES*

Explosive	Decomposition Temperature (°C)	(°F)	Type of Reaction (5-s Test)
Nitrocellulose (NC)			
12.6% Nitrogen	170	338	Decomposes
13.45% Nitrogen	230	446	Decomposes
Nitroglycerine (NG)	222	432	Explodes
Pentaerythritol Tetranitrite (PETN)	235	455	Decomposes
Tetryl (TETR)	257	495	Ignites
Cyclonite (RDX)	260	500	Decomposes
Lead Styphnate	282	540	Explodes
Tetranitroresorcinol (TNR)	No data given		
Trinitrotoluene (TNT)	320-335	608-635	Explodes (confined)
	470	878	Decomposes (unconfined)

*Data from "Engineering Design Handbook, Explosive Series, Properties of Explosives of Military Interest," AMCP 706-177, Headquarters, U.S. Army Material Command, January 1977

TABLE 4

400 AREA SUMP AND VENT CONTAMINATION*

Building	Explosive Residue	Heavy Metal Residue	Radiological Contamination	Vent Heavy Metal
402		X	X	
403	X		X	
404			X	
405		X	X	X
410				X
412			X	X
413		X	X	X
414		X	X	X
415	X		X	X
416				X
417	X	X		
418	X	X	X	
419	X	X	X	
421			X	X
422		X	X	X
423			X	
424			X	
425			X	X
426			X	
427	X		X	
430**			X	
431			X	
434			X	
435			X	
439			X	

*Reported by Battelle

**Sewer from Building 430 is contaminated by radiological material.

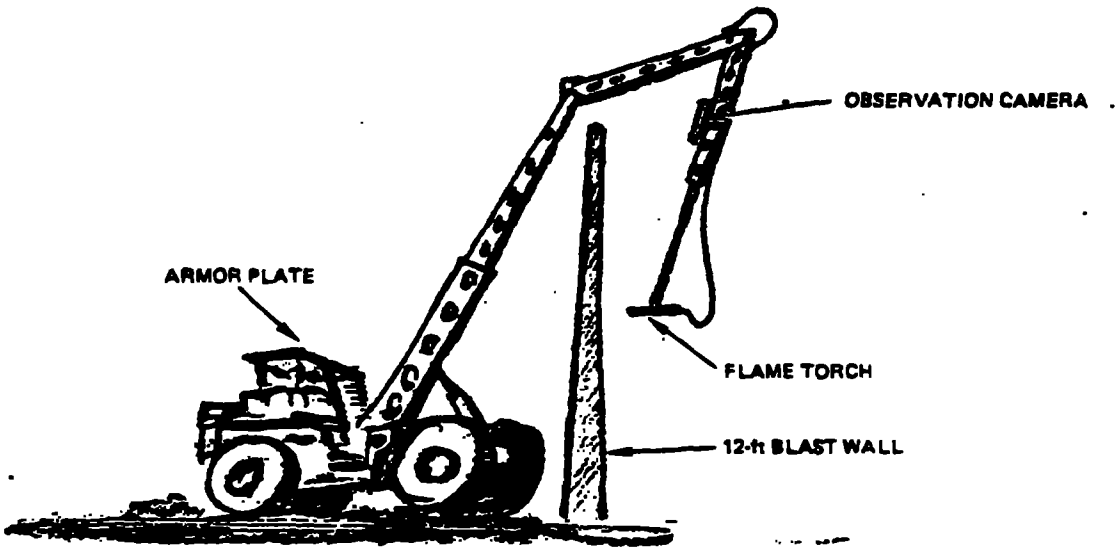


Figure 4. Remote Flame Machine

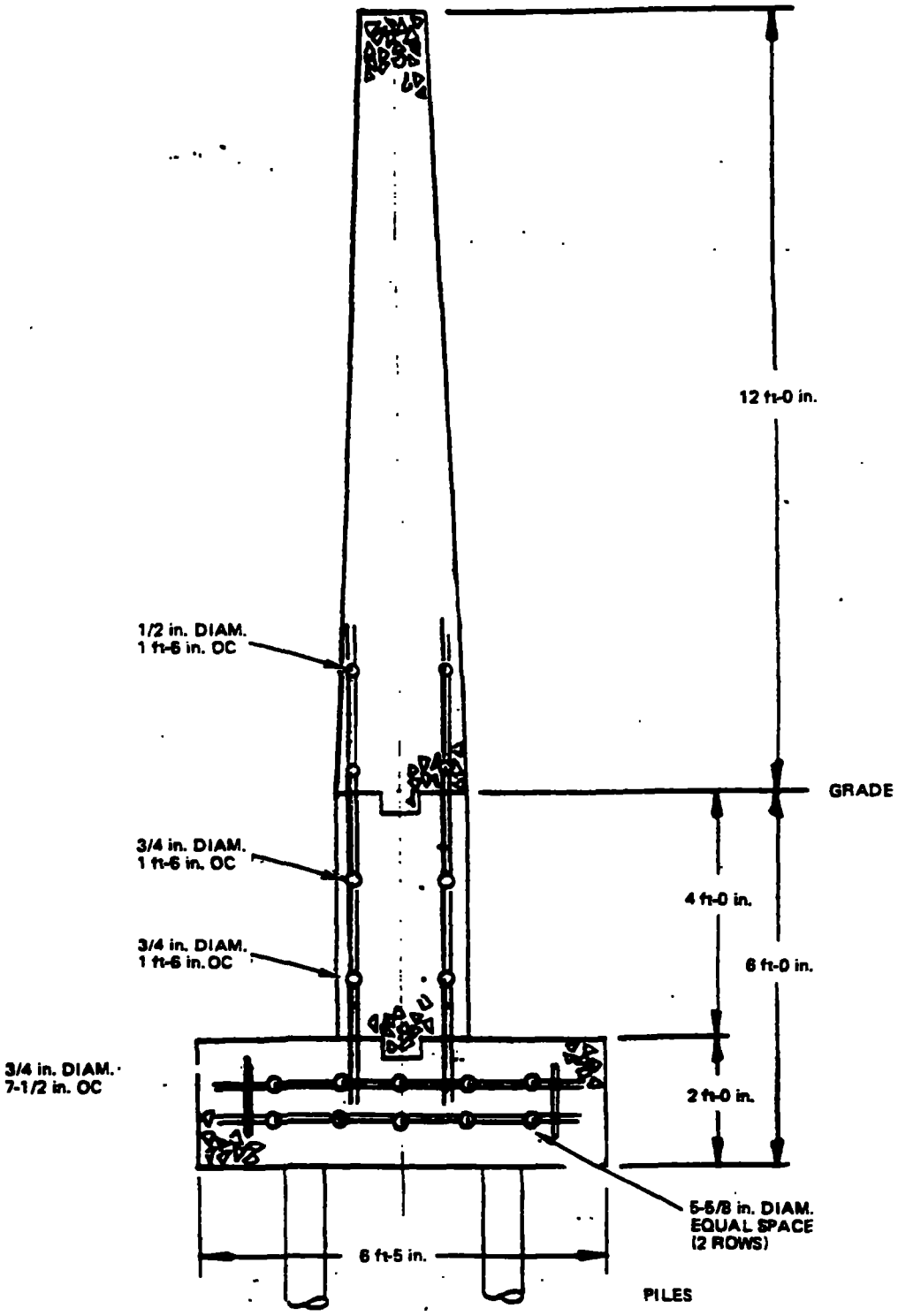


Figure 5. Typical Blast Wall Cross Section

RESTRICTED ACCESS AREA ENTRY PERMIT

No.

UNIT AUTHORIZING OR PERFORMING WORK

REQUESTED BY _____ DEPT _____

JOB LOCATION _____

BEFORE STARTING WORK, SAFETY, SUPERVISION OF GROUP AUTHORIZING OR PERFORMING WORK, AND SUPERVISION OF WORK AREA MUST BE NOTIFIED

JOB DESCRIPTION _____

REFERENCE PROCEDURE, WORK REQUEST, JOB ORDER, ETC. _____

DATE OF REQUEST _____ WORK TO BEGIN _____ WORK TO END _____

SAFETY AND ORIGINATOR

NAME AND IDENTIFICATION OF PERSONS COVERED BY THIS FORM

NAME	NON-ROCKWELL AFFILIATION	INITIAL	NAME	NON-ROCKWELL AFFILIATION	INITIAL

SAFETY

PROTECTIVE EQUIPMENT REQUIRED

HANDS
- ☐ CANVAS GLOVES
- ☐ NEOPRENE GLOVES
- ☐ PVC GLOVES
- ☐ SURGEON'S GLOVES
- ☐ LEATHER GLOVES
- ☐ GAUNTLET TYPE

BODY
- ☐ COVERALLS
- ☐ LAB COAT
- ☐ SURGEON'S CAP
- ☐ HOOD

- ☐ ACID APRON
- ☐ GONAD SHIELD
- ☐ HARD HAT
  - ☐ PHENOLIC
  - ☐ FACE SHIELD
- ☐ EYE PROTECTION
  - ☐ SAFETY GLASSES
  - ☐ JONES GOGGLES
- ☐ EAR PROTECTION
  - ☐ EAR PLUGS
  - ☐ EAR MUFFS
- ☐ SAFETY HARNESS
- ☐ SAFETY BELT

FEET
- ☐ TOE GUARDS
- ☐ CANVAS COVERS
- ☐ PLASTIC COVERS
- ☐ BOOTS
- ☐ LEGGINGS

RESPIRATORY PROTECTION
- ☐ SCBA
- ☐ AIRLINE RESPIRATOR
- ☐ FULL-FACE RESPIRATOR
- ☐ HALF-FACE RESPIRATOR
- ☐ ULTRA FILTER
- ☐ COMBINATION CANISTER
- ☐ ORGANIC VAPOR
- ☐ ACID GAS

PERSONNEL MONITORING EQUIPMENT –
- ☐ BETA-GAMMA FILM BADGE
- ☐ NEUTRON FILM BADGE
- ☐ BETA-GAMMA DOSIMETER
- ☐ NEUTRON DOSIMETER
- ☐ EXTREMITY MONITORING
- ☐ PERSONAL AIR SAMPLER
- ☐ SURVEY METER

SPECIAL REQUIREMENTS –
- ☐ PERSONAL SURVEY
- ☐ TOOL SURVEY
- ☐ WELDING PERMIT
- ☐ CONFINED SPACE PROCEDURES
- ☐ OXY DEFICIENCY TEST
  _____ % O_2
- ☐ COMBUSTIBLE ATMOSPHERE
  _____ % LEL
- ☐ TOXIC ATMOSPHERE TEST
  _____ % TLV
- ☐ STANDBY REQUIRED
- ☐ FIRE PROTECTION

RADIATION MEASUREMENTS

BETA _____ mrem/hr
GAMMA _____ mrem/hr
NEUTRON _____ mrem/hr
TOTAL _____ mrem/hr

SURFACE CONTAMINATION

_____ dpm/100 cm^2

AIRBORNE RADIOACTIVITY CONCENTRATION

_____ μCi/mL

SPECIAL INSTRUCTIONS _____

APPROVALS

APPROVALS FOR PERFORMING WORK

SUPERVISOR OF AREA WHERE WORK WILL BE PERFORMED _____ DATE _____

SUPERVISOR OF GROUP AUTHORIZING OR PERFORMING WORK _____ DATE _____

SAFETY _____ DATE _____ PERMIT EXPIRES _____

ALL PERSONS COVERED BY THIS PERMIT MUST INITIAL AFTER SAFETY INSTRUCTIONS HAVE BEEN GIVEN

AREA SUPERVISOR

APPENDIX A: RESTRICTED ACCESS AREA ENTRY PERMIT

CASU Library & Information Services
1222 Spruce Street
St. Louis, MO 63103-2822
(314) 539-6110

PB86-107307

Archeological Overview and Management Plan for the St. Louis Army Ammunition Plant St. Louis County, Missouri

Woodward-Clyde Consultants, Walnut Creek, CA

Prepared for

National Park Service, Atlanta, GA

1 Apr 85

U.S. Department of Commerce
National Technical Information Service

PB86-107307

Final
Report No. 36
April 1, 1985

An Archeological Overview and Management Plan for the St. Louis Army Ammunition Plant, St. Louis County, Missouri

Under Contract CX-5000-3-0771
with the

National Park Service
U.S. Department of Interior
Atlanta, Georgia 30303

for the
U.S. Army Materiel Development and
Readiness Command

by

Barbara Stafford, Harold Hassen,
Edward Jelks, Keith L. Barr,
Marjorie Schroeder
Center for American Archeology
Kampsville, Illinois 62053

Prepared under the Supervision of

Ruthann Knudson

Ruthann Knudson, WCC Principal Investigator

Woodward-Clyde Consultants
One Walnut Creek Center
100 Pringle Avenue, Walnut Creek, CA 94596

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
US DEPARTMENT OF COMMERCE
SPRINGFIELD VA 22161

50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO.

2.

3. Recipient's Accession No. 307/AS

4. Title and Subtitle
An Archeological Overview and Management Plan for the St. Louis Army Ammunition Plant, St. Louis County, Missouri

5. Report Date
April 1, 1985

6.

7. Author(s)
B. Stafford, H. Hassen, E. Jelks, K. Barr, M. Schroeder

8. Performing Organization Rept. No.
DARCOM report #36

9. Performing Organization Name and Address
Woodward-Clyde Consultants
One Walnut Creek Center
100 Pringle Avenue
Walnut Creek, CA 94596

subcontractor:
Center for American Archeology
P. O. Box 22
Kampsville, IL 62053

10. Project/Task/Work Unit No.
60903A/0001-1

11. Contract(C) or Grant(G) No.
(C) CX-5000-3-0771
(G)

12. Sponsoring Organization Name and Address
U. S. Department of the Interior
National Park Service
Russell Federal Building, 75 Spring Street SW
Atlanta, GA 30303

13. Type of Report & Period Covered
FINAL

14.

15. Supplementary Notes This report was prepared as part of the DARCOM Historical/Archeological Survey (DHAS), an inter-agency technical services program to develop facility-specific archeological overviews and management plans for the U. S. Army Materiel Development and Readiness Command (DARCOM).

16. Abstract (Limit: 200 words)

The St. Louis Army Ammunition Plant (AAP) is a facility of the U. S. Department of the Army DARCOM (Materiel Development and Readiness Command), with responsibilities for the management of the prehistoric and historic archeological resources that are retained within the installation lands. This report summarizes the archeological resources presently identified on the installation, the culture history of the area that provides a context for the interpretation and evaluation of those resources, an assessment of the total archeological resource base likely to be found on installation lands, and recommendations for the future management of those resources within the overall context of DARCOM missions and public responsibilities. No archeological investigations have been conducted on the St. Louis AAP and no sites are presently known to exist within facility boundaries. The entire surface of the AAP has been impacted by modern construction; however, subsurface archeological deposits may exist. If construction occurs on the facility, proposed impact areas will need further review of any archeological materials and their mitigation needs.

17. Document Analysis a. Descriptors
Archeological Management
Army Installation Management
Environmental Assessment

reference: Thesaurus of Engineering and Scientific Terms

b. Identifiers/Open-Ended Terms
Cultural Resource Management
Missouri History
Missouri Prehistory

c. COSATI Field/Group 5f

18. Availability Statement.
Available for public release.

19. Security Class (This Report)
Unclassified

20. Security Class (This Page)
Unclassified

21. No. of Pages
[illegible]

22. Price
[illegible]

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

MANAGEMENT SUMMARY

The St. Louis Army Ammunition Plant (AAP) is a facility of the U. S. Department of the Army DARCOM (Materiel Development and Readiness Command), with responsibilities for the management of the prehistoric and historic archeological resources that are retained within the installation lands. This report is a summary of the archeological resources presently identified on the installation, the culture history of the area that provides a context for the interpretation and evaluation of those resources, an assessment of the total archeological resource base likely to be found on installation lands, and recommendations for the future management of those resources within the overall context of DARCOM missions and public responsibilities.

No archeological investigations have been conducted on the St. Louis AAP and no sites are known to exist within the facility boundaries. The entire surface of the facility has been impacted by modern construction; however, subsurface archeological deposits may exist. If construction occurs on the facility, proposed impact areas will need further review of any archeological materials and their mitigation needs.

PREPARERS AND QUALIFICATIONS

Barbara D. Stafford is the principal author of this report. She holds a BS summa cum laude in Sociology (minors in Anthropology and Psychology), and an MA and PhD in Anthropology. She has participated in archeological investigations across the United States and in Europe. Presently, she is a Research Archeologist with the Center for American Archeology, serving as a Principal Investigator.

Harold Hassen is a contributing author and Project Director. He holds a BA, MA and PhD in Anthropology. He has participated in archeological investigations in the midwestern U. S., and currently holds the position of Research Archeologist with the Center for American Archeology, serving as a Principal Investigator. He has been directing projects in cultural resource management for the past five years, and is certified by the Society of Professional Archeologists in field and archival research.

Edward B. Jelks is a contributing author. He holds a BA in English and an MA and PhD in Anthropology. He has participated in extensive archeological investigations throughout the U. S., emphasizing historic resources. He is certified by the Society of Professional Archeologists in field, collections, and archival research; administration; museology; teaching; and historical archeology. He has held administrative positions since 1951 with federal, state and university facilities. Currently he holds the position of Professor at Illinois State University.

Keith L. Barr is a contributing author. He holds a BS in History and an MS in Archeology with an emphasis in historical archeology. He has

participated in archeological investigations in the Midwest and is currently affiliated with the Midwestern Archeological Research Center at Illinois State University.

Marjorie B. Schroeder is a contributing author. She holds a BS in Botany and is completing an MS in that subject. She has participated in ethnobotanical investigations in the Midwest and is currently employed by the Center for American Archeology.

ACKNOWLEDGEMENTS

A number of people have been extremely generous with their time and effort in the preparation of this management report. Among these are Ms. Meryl Humphreys at the St. Louis facility; and Mr. James Batura and Ms. Frieda Vereecken-Odell of the Center for American Archeology. Ruth Sperry, Ruth Kissell and Beverly Sexauer typed and edited the initial manuscript draft.

Additional thanks go to Dr. Mark R. Barnes, NPS, SERO; Mr. Jake Hoffman, RMRO, NPS; and the Missouri SHPO, for reviewing the draft; and Ms. Susan Cleveland, Contracting Officer, NPS, SERO.

Final report editing and production, including graphics, has been completed by Woodward-Clyde Consultants, with editorial review (particularly of management recommendations) and text preparation completed by Dr. Ruthann Knudson and Ms. Betty Schmucker. Woodward-Clyde Consultants appreciates the assistance of Ms. Gail Snyder O'Dea of St. Louis, who consulted extensive archival sources in St. Louis and at the SHPO's office in Jefferson City, MO, for information regarding the prehistory and history of St. Louis and the AAP area.

TABLE OF CONTENTS

Page

NTIS FORM ii

MANAGEMENT SUMMARY iii

PREPARERS AND QUALIFICATIONS iv

ACKNOWLEDGEMENTS vi

LIST OF TABLES ix

LIST OF FIGURES x

FOREWORD xi

1.0 INTRODUCTION 1-1

1.1 Purpose and Need 1-3
1.2 The St. Louis Army Ammunition Plant 1-5
1.3 Summary of Previous Archeological Work Conducted on the St. Louis AAP 1-5
1.4 The Sociocultural Context of the Archeological Resources on the St. Louis AAP 1-5

2.0 AN OVERVIEW OF THE CULTURAL AND RELEVANT NATURAL HISTORY OF THE ST. LOUIS AAP 2-1

2.1 The Physical Environment 2-1

2.1.1 Earth Resources 2-1
2.1.2 Water Resources 2-2
2.1.3 Modern Climate 2-2
2.1.4 Plant Resources 2-3
2.1.5 Animal Resources 2-3
2.1.6 Paleoenvironment 2-3

2.2 The Cultural Environment 2-4

2.2.1 Prehistory 2-8
2.2.2 Ethnohistory 2-9
2.2.3 History 2-10

2.3 Archeological Research Directions 2-13

TABLE OF CONTENTS (continued)

		Page
	2.3.1 Regional Concerns	2-13
	2.3.2 Installation-Specific Archeological Research Directions	2-15
3.0	AN ASSESSMENT OF ARCHEOLOGICAL RESOURCE PRESERVATION AND SURVEY ADEQUACY	3-1
	3.1 Environmental Constraints to Site Preservation	3-1
	3.2 Historic and Recent Land Use Patterns	3-1
	3.3 Previous Cultural Resource Investigations; Coverage and Intensity	3-4
	3.4 Summary Assessment of Data Adequacy, Gaps	3-4
4.0	KNOWN ARCHEOLOGICAL RESOURCES ON THE ST. LOUIS AAP	4-1
5.0	AN ASSESSMENT OF THE SIGNIFICANCE OF THE ARCHEOLOGICAL RESOURCE BASE ON THE ST. LOUIS AAP	5-1
6.0	A RECOMMENDED ARCHEOLOGICAL MANAGEMENT PLAN FOR THE ST. LOUIS AAP	6-1
	6.1 Facility Master Plans and Proposed Projects	6-1
	6.2 Appropriate Archeological Management Goals within the St. Louis AAP's Master Plan	6-1
	6.2.1 General Facility Planning	6-1
	6.2.2 Project-Specific Resource Protection or Treatment Options	6-3
	6.2.3 A Summary of Recommended Management Directions and Priorities for Effective Compliance and Program Management	6-4
	6.3 Estimated Scopes of Work and Cost Levels for Presently Identifiable Management Needs	6-5
7.0	SUMMARY	7-1
8.0	BIBLIOGRAPHY	8-1
	8.1 Primary Sources and References Cited	8-1
	8.2 Other Pertinent Literature	8-4

LIST OF TABLES

Table		Page
2-1	A SUMMARY OF THE CULTURAL CHRONOLOGY OF THE AREA OF THE ST. LOUIS AAP	2-5
3-1	A SUMMARY OF HISTORIC AND MODERN GROUND DISTURBANCE THAT MIGHT LIMIT THE PRESENT ARCHEOLOGICAL RESOURCE BASE ON THE ST. LOUIS AAP	3-2

LIST OF FIGURES

Figure		Page
1-1	MAP OF THE GENERAL VICINITY OF THE ST. LOUIS AAP	1-2
1-2	MASTER BASE MAP OF THE ST. LOUIS AAP	1-6
3-1	MAP OF AREAS OF HISTORIC AND/OR MODERN GROUND DISTURBANCE THAT MIGHT LIMIT THE PRESENT ARCHEOLOGICAL RESOURCE BASE ON THE ST. LOUIS AAP	3-3

FOREWORD

As a federal agency with large public land holdings, the U. S. Army is responsible for the stewardship of a variety of natural and cultural resources that are part of its installations' landscapes. The Army's Materiel Development and Readiness Command (DARCOM) presently manages a nationwide network of 65 installations and 101 subinstallations and separate units, which range in size from one acre to over one million acres. As part of its programs of environmental and property management, DARCOM has requested that the U. S. Department of the Interior's National Park Service provide technical guidance to develop programs for managing installation cultural resources.

NPS is thus conducting the DARCOM Historical/Archeological Survey (DHAS), which has two major disciplinary elements. The architectural review and planning function is being directed by the Service's Historic American Buildings Survey (HABS), while the prehistoric and historic archeological resource assessment and planning function is the responsibility of the Service's Interagency Resource Division (IRD). IRD has contracted with Woodward-Clyde Consultants (WCC) for the development of guidelines for the DARCOM archeological management planning effort, and for the completion of 41 overviews and plans throughout the United States. WCC has in turn subcontracted the technical studies to several regional subcontractors, with final editorial review of reports and preparation of text and illustrations handled by WCC.

This overview and recommended management plan for the archeological resources of the St. Louis Army Ammunition Plant was prepared by the

Center for American Archeology, Kampsville, Illinois, under subcontract to WCC. It follows the guidance of "A Work Plan for the Development of Archeological Overviews and Management Plans for Selected U. S. Department of the Army DARCOM Facilities," prepared by Ruthann Knudson, David J. Fee, and Steven E. James as Report No. 1 under the WCC DARCOM contract. A complete list of DHAS project reports is available from the National Park Service, Washington, DC.

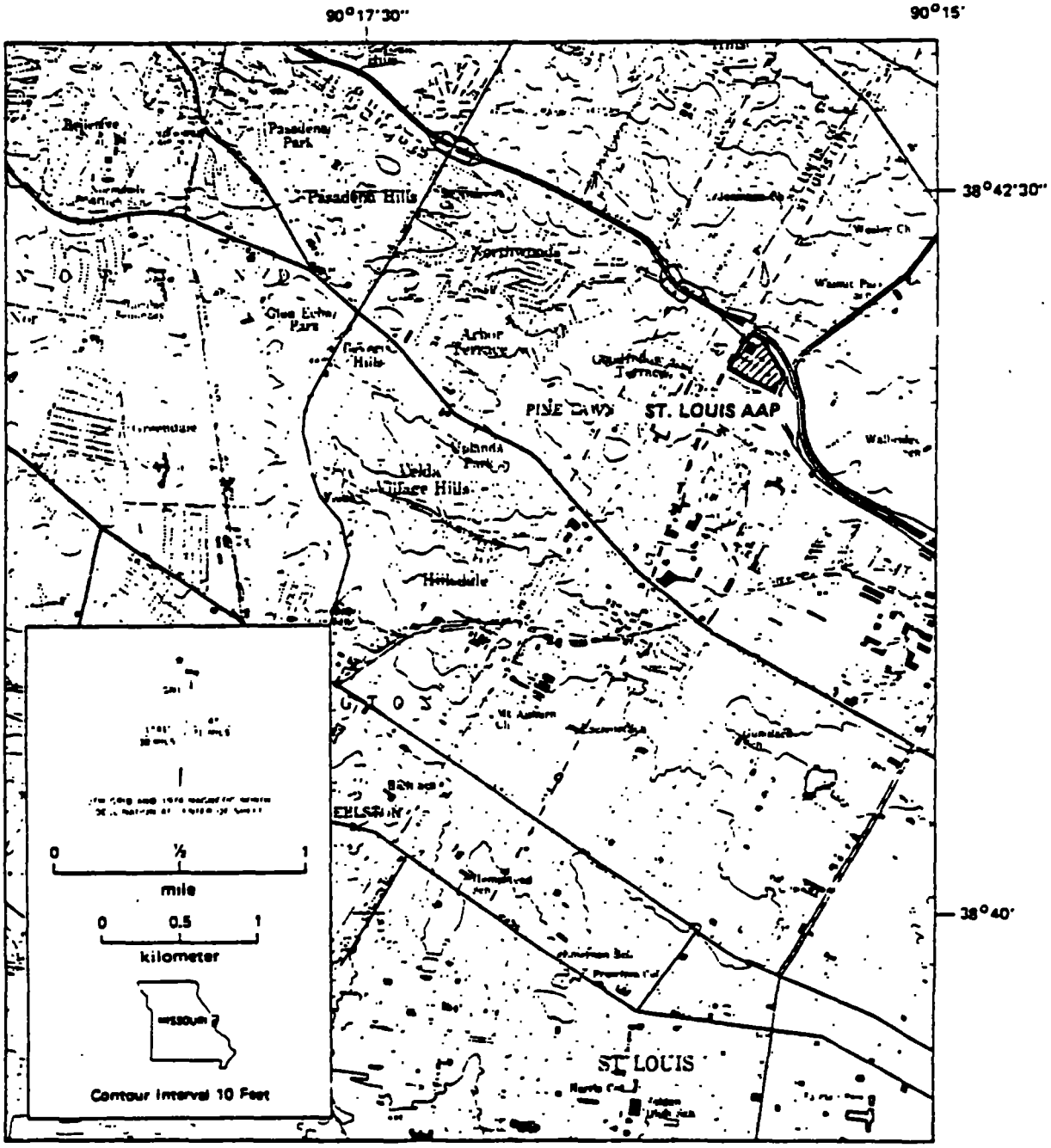
The DHAS program marks a significant threshold in American cultural resource management. It provides guidance that is nationally applicable, is appropriately directed to meeting DARCOM resource management needs within the context of the Army's military mission, and is developed in complement to the state Resource Protection Planning Process (the RP3 process, through State Historic Preservation Offices). All of us participating in this effort, particularly in the development of this report, are pleased to have had this opportunity. Woodward-Clyde Consultants appreciates the technical and contractual guidance provided by the National Park Service in this effort, from the Atlanta and Washington, DC offices and also from other specialists in NPS regional offices in Philadelphia, Denver, and San Francisco.

Woodward-Clyde Consultants

Ruthann Knudson

1.0
INTRODUCTION

The following report is an overview of and recommended management plan for the prehistoric and historic archeological resources that are presently known or likely to occur on the St. Louis Army Ammunition Plant (AAP) in St. Louis City, Missouri, just south of the community of Pine Lawn (Figure 1-1). This facility is an installation of the U. S. Department of the Army DARCOM (Materiel Development and Readiness Command), which as a reservation of public land has responsibilities for the stewardship of the cultural resources that are located on it. The assessments and recommendations reported here are part of a larger command-wide cultural resource management program (the DARCOM Historical/Archeological Survey, or DHAS), which is being conducted for DARCOM by the U. S. Department of the Interior's National Park Service. The following is that portion of the facility-specific survey that is focused on the prehistoric and historic resource base of the St. Louis Army Ammunition Plant, and was developed in accordance with the Level A requirements as set forth in the archeological project Work Plan (Knudson, Fee, and James 1983). Because there are no presently recorded or archivally-determined potential archeological sites on the St. Louis AAP, the required Sections 4.0 and 5.0 are minimal statements only in this report. A companion historic architectural study is in preparation under a contract with the National Park Service's Historic American Buildings Survey (HABS) (William Brenner, personal communication 1984). In addition, an archeological overview and management plan has been developed for the U. S. Army's St. Louis Army Support Center (ASC) (Stafford et al. 1985), just one to two miles east of the St. Louis AAP in the Mississippi River floodplain on the Illinois side of the river.



Note: Base map is the Clayton, MO, 7.5 minute topographic quad (1964, photorevised 1968 and 1974)

Figure 1-1. MAP OF THE GENERAL VICINITY OF THE ST. LOUIS AAP

This section introduces the St. Louis AAP archeological overview and management planning effort. Federal regulations requiring such work and effort are briefly summarized. Also included are brief introductions to the St. Louis facility, the lack of previous archeological work there, and the sociocultural context of the archeological resources that might merit management consideration.

1.1 PURPOSE AND NEED

A corpus of Federal laws and regulations mandate cultural resources management on DARCOM facilities. Briefly these are:

- The National Historic Preservation Act of 1966 as amended (80 Stat. 915, 94 Stat. 2987; 16 USC 470), with requirements to,

  - inventory, evaluate, and where appropriate nominate to the National Register of Historic Places all archeological properties under agency ownership or control (Sec. 110(a)(2))

  - prior to the approval of any ground-disturbing undertaking, take into account the project's effect on any National Register-listed or eligible property; afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the proposed project (Sec. 106)

  - complete an appropriate data recovery program on an eligible or listed National Register archeological site prior to its being heavily damaged or destroyed (Sec. 110(b), as reported by the House Committee on Interior and Insular Affairs [96th Congress, 2nd Session, House Report No. 96-1457, p. 36-37])

- Executive Order 11593 (36 FR 8921), whose requirements for inventory, evaluation, and nomination, and for the recovery of property information before site demolition, are codified in the 1980 amended National Historic Preservation Act

- The Archeological and Historic Preservation Act of 1974 (88 Stat. 174, 16 USC 469), which requires that notice of an agency project that will destroy a significant archeological site be provided to the Secretary of the Interior; either the Secretary or the notifying agency may support survey or data recovery programs to preserve the resource's information values .

- The Archeological Resources Protection Act of 1979 (93 Stat. 721, 16 USC 470aa; this supersedes the Antiquities Act of 1906 [93 Stat. 225, 16 USC 432-43]), with provisions that effectively mean that

  - The Secretary of the Army may issue excavation permits for archeological resources on DARCOM lands (Sec. 4)

  - No one can damage an archeological resource on DARCOM lands without a permit, or suffer criminal (Sec. 6) or civil penalties (Sec. 7)

- 36 CFR 800, "Protection of Historic and Cultural Properties" (44 FR 6068, as amended in May 1982); these regulations from the Advisory Council on Historic Preservation set forth procedures for compliance with Section 106 of the National Historic Preservation Act

- Regulations from the Department of the Interior for determining site eligibility for the National Register of Historic Places (36 CFR 60, 36 CFR 63), and standards for data recovery (proposed 36 CFR 66)

- United States Department of the Army procedures and standards for preserving historic properties (32 CFR 650.181-650.193; Technical Manual 5-801-1; Technical Note 78-17; Army Regulation 420-40); and procedures for implementing the Archaeological Resources Protection Act (32 CFR 229).

These procedures should be integrated with planning and management to insure continuous compliance during operations and management at each facility. This can best be achieved by an understanding of the procedures implied by the regulations and an awareness of the cultural resources potential at each facility.

1.2 THE ST. LOUIS ARMY AMMUNITION PLANT

The 21-acre (8.5 ha) St. Louis Army Ammunition Plant is located at 4800 Goodfellow Boulevard, St. Louis, Missouri. The installation is now a separate military facility and was originally the northernmost part of the 276 acres (112 ha) St. Louis Ordnance Plant and was commissioned 5 May 1941. Currently, it is operated by the Donovan Construction Company of Minneapolis, Minnesota, and has as its sole mission 105 mm ammunition production. The entire facility has been impacted by construction of buildings or parking lots, with small open areas scattered throughout (Figure 1-2).

1.3 SUMMARY OF PREVIOUS ARCHEOLOGICAL WORK CONDUCTED ON THE ST LOUIS AAP

No archeological work has been conducted on the St. Louis AAP and no archeological sites are known to exist within the facility boundaries. Since 100 percent of the facility has been impacted through some sort of ground disturbance, it is doubtful that any surficial archeological sites remain on the AAP. However, the existence of subsurface archeological deposits is possible.

1.4 THE SOCIOCULTURAL CONTEXT OF THE ARCHEOLOGICAL RESOURCES ON THE ST. LOUIS AAP

The documentary evidence suggests that the St. Louis AAP is located in an area that was developed early in the historic period. Had there been surficial archeological remains of interest to the Native American community, they most certainly would have been destroyed by nineteenth-

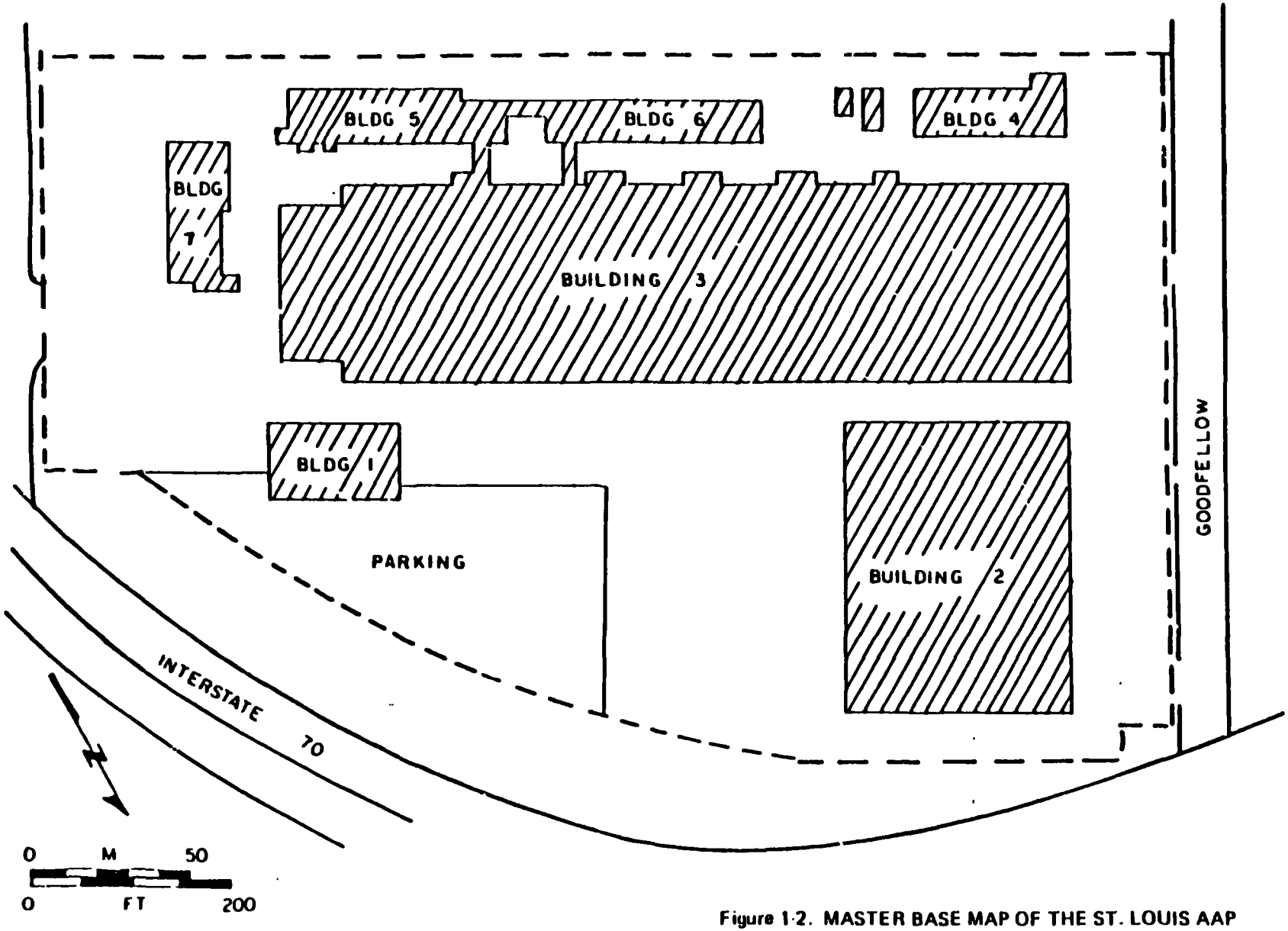


Figure 1-2. MASTER BASE MAP OF THE ST. LOUIS AAP

and early twentieth-century Euroamerican activities. Surficial, and probably most buried Historic Euroamerican cultural resources, probably were obliterated by the construction of the present facility. The possibility that subsurface remains may still be intact could be verified only by testing beneath the plant buildings and paved grounds. If any archeological resources were to remain on the St. Louis facility, their major value would probably lie in their significance to scientific researchers.

2.0
AN OVERVIEW OF THE CULTURAL AND RELEVANT NATURAL HISTORY OF THE ST. LOUIS AAP

A discussion of the physical and cultural environment of the area of the St. Louis AAP is presented to provide baseline data for incorporation of known land use, assessments of the cultural and natural environments, and archeological site information into a program of effective management of installation resources. Integration of all these types of data enables the management of any existing archeological resources within the facility boundaries. In addition, the archeological research directions pertinent to the region are discussed. A more detailed overview of the cultural and natural history of the AAP vicinity is available in Nixon, Hamilton, and Kling (1982).

2.1 THE PHYSICAL ENVIRONMENT

This section describes the modern earth, water, climatic, plant and animal resources that were probably available for human use during the historic period. These data can be used as a baseline against which paleoenvironmental resources may be inferred.

2.1.1 Earth Resources

The St. Louis AAP lies in the Lincoln Hills Section of the Central Lowland physiographic division (Fenneman 1938; Harris 1983). The AAP area is approximately one mile west of the Mississippi River floodplain, thus only one to two miles west of to the American Bottom of Illinois, on the Mississippi River. The topography in the vicinity of the facility is generally level upland, with Pleistocene-age loess deposits that have

subsequently been dissected by modern drainages that reflect the underlying limestone bedrock erosional features. The predominant bedrock in the hilly uplands is the Burlington Keokuk limestone with included chert deposits. Drainage is toward the Mississippi River.

Soil maps for St. Louis City and St. Louis County (Benham 1982) indicate that all the soils in the vicinity of the St. Louis AAP are Urban land units. The Urban land unit is characterized by an 85-percent surface covering of asphalt, concrete, buildings, or other impervious materials. Much of the area has been cut and filled, ranging in depths up to six feet. Nixon, Browman, and Hamilton (1984:15), summarizing other studies, note that the forested uplands generally have deep (80-100 feet thick) loess deposits with soils and paleosols formed in them.

2.1.2 Water Resources

The St. Louis AAP is located two to three miles west of the juncture of the Chain of Rocks Canal and the Mississippi River (river mile 184). There are neither ponds nor tributary streams on the facility grounds at present.

2.1.3 Modern Climate

The pattern of climate in St. Louis County (Benham 1982) is cold winters with average January temperatures of 33°F. (.6°C) and long, hot summers with an average temperature of 77°F. (25°C) in July. Two years in ten will have maximum temperatures higher than 101°F. (38.3°C) and minimum temperatures lower than -7°F. (-26.7°C). The last freezing temperature in spring is usually April 20th; the first freezing temperature in the fall is usually October 17th. The total annual precipitation is 33.8 inches (86 cm). Sixty percent of the precipitation usually falls in April through September. Two years out of ten the rainfall for the same period is less than 16 inches (41 cm). Average seasonal snowfall is 18 inches (46 cm), average relative humidity in midafternoon is about 60 percent.

2.1.4 Plant Resources

Vegetation zones in the vicinity of the American Bottom tend to be linearly arranged (Emerson and McElrath 1983). The pre-settlement bottomlands near the facility on the edge of the Mississippi River were occupied by cottonwood, willow, birch, and sycamore, and by stands of silver maple, hackberry, and pecan. Slough, pond, and lake edges supported black willow, ash, and box elder with lotus, cattails, arrowhead, rushes, and sedges standing in or near the water. Higher ground was occupied by a mixed forest of oak, elm, and ash with associated species consisting of sycamore, pecan, kingnut hickory, mulberry, and honey locust, a woodland-brush context primarily (Benchley 1976:1). Lowland prairie occurred in some areas. The prairies around the facility in the uplands on the western side of the Mississippi River were probably a poor source of plant foods for people; on the other hand, the open grown oak and hickory trees on the margin of the prairie and the forest would produce acorn and nut masts at many times the rate of interior forest trees. Gill (1952a:294) noted that there "were groves and springs and pond" in an area that probably was west of, and may have included, the land of the St. Louis AAP.

2.1.5 Animal Resources

Regional presettlement faunal resources probably consisted of large and small mammals, such as deer, rabbit, muskrat, bison (after AD 1000), squirrel, raccoon, beaver, groundhog, opposum, and skunk; reptiles and shellfish and several species of fish. The location of the facility adjacent to the American Bottom, a major flyway of waterfowl, affords a large number of migratory birds available seasonally and also provides niches for several permanent species (Emerson and McElrath 1983:224).

2.1.6 Paleoenvironment

Data for reconstructing the paleoenvironment of the region prior to 16,500 BP is based on pollen cores from the western Ozarks (King 1975). The vegetation type of the mid-Wisconsinan interstade, from 40,000 BP to about 25,000 BP was open pine-parkland. At the onset of the late

Wisconsinan full glacial period (20,000-16,500 BP) the vegetation type shifted from pine dominated forest to spruce boreal forest. At the end of this same period there was a decrease in spruce pollen and an increase in thermophilous deciduous tree pollen. The pollen record at Chatsworth bog in east-central Illinois (King 1981), dates the decline of spruce pollen after 13,800 BP as temperatures slowly increased and black ash expanded onto wet lowlands. Continued warming temperatures from 11,600 to 10,600 BP allowed the development of other temperate deciduous species with oak, hickory, and maple on the uplands and birch, alder, elm, and ash on the lower, wetter areas. By 10,600 BP to 8300 BP further warming and drying effected the complete transition to oak-dominated deciduous forest, with accompanying increases in elm, ironwood, oak and hickory. The forest cover in the lowlands has persisted into the present, but an increase in herbaceous pollen in 8300 BP is interpreted as an expansion of prairie species into the drier uplands in Illinois.

Pollen records from Old Field Swamp in southeast Missouri are available for dates after 9000 years BP (King and Allen 1977). As at Chatsworth Bog, the trend of increased warmth and/or dryness is evidenced in the pollen record at Old Field Swamp; this is seen in the decrease in pollen of species associated with open-water swamps and the increase in grass community species by 8700 BP. Between 8700 and 5000 BP drought conditions were sufficient to cause the remaining swamp vegetation to be replaced by grasses and herbs. However, after 5000 years BP, pollen percentages at Old Field indicate renewed development of arboreal vegetation in the bottomlands.

2.2 THE CULTURAL ENVIRONMENT

An overview of the cultural chronology of the St. Louis AAP and surrounding region, within a radius of approximately 100 miles (160 km), is presented in Table 2-1. This discussion is brief because modern disturbance has eliminated the possibility of any surface archeological remains still present on the AAP. However, subsurface cultural deposits

Table 2-1. A SUMMARY OF THE CULTURAL CHRONOLOGY OF THE AREA OF THE ST. LOUIS AAP

Cultural Unit					
Tradition	Period or Phase	Date[a]	General Settlement Patterns	General Subsistence Systems	Kinds of Archaeologic[illegible] Remains Representative of Period
American	Late Industrial	AD 1884 to Present	Small farms consolidated into large farms; small towns diminish as automobile transportation creates access to regional centers for marketing goods	Agriculture and livestock raising	Dominance of American manufactured goods; automatic machine-made bottles, decal decorated ceramics, plastic disposable packaging
	Early Industrial	AD 1884 to AD 1850	New markets for agricultural produce and access to manufactured goods; in 1852, the first locomotive was run in St. Louis which opened new markets west of the Mississippi River	Agriculture and livestock raising	English handpainted, transfer-printed, and annular wares dominate at the beginning of the period with English white ironstone dominating at the end of this period; clay marbles, semi-automatic mold-blown bottles, canning jars with metal rims and glass liners, machine-cut nails
	Homestead	AD 1850 to AD 1830	American settlement and German immigration rapidly increased the population; beginnings of transportation networks and industrial and urban centers with steam power	Agriculture and livestock raising	Log and post and beam structures during early part of period; by end of period ballon frame being built; English ceramics dominate: whitewares with decoration such as handpainted, slip-banded, etc.; hand-forged nails (early) to machine-cut (late); free-blown glass containers
	Frontier	AD 1830 to AD 1803	With the Louisiana Purchase, America gains control of the region with a slight infiltration of American settlers into the region; French as well as British traders still occupy region; population increases after the War of 1812; historic Native American groups, such as as the Osage, Peoria, and Missouri occupy the region	Hunting, gathering, trading, and limited agriculture	Log and post and beam structures; English creamware and pearlware ceramics; hand-wrought nails; free-blown bottles; kettle brass; trade silver; glass beads
Colonial	European Competition	AD 1803 to AD 1754	Spanish, French, and English compete for the loyalty of Native American groups and furs they collect; a shift in settlement patterns in that a number of independent traders establish more permanent trading centers	Hunting, gathering, trading, and limited agriculture	French faience ceramics and English salt-glazed and creamware ceramics, free-blown bottles, gun-flints, metal knives, hand-forged nails, kettle brass, glass beads, trade silver

Table 2-1. A SUMMARY OF THE CULTURAL CHRONOLOGY OF THE AREA OF THE ST. LOUIS AAP (continued)

Cultural Unit					
Tradition	Period or Phase	Date[a]	General Settlement Patterns	General Subsistence Systems	Kinds of Archeological Remains Representative of Period
Colonial (cont)	Early Exploration	AD 1754 to AD 1673	First Europeans into area were French explorers followed by fur traders and missionaries; sites left by them would be short-term camps along rivers; later outposts were established in the same vicinity; Native American groups were the Osage, Missouri, Kansas, and Peoria who had semi-permanent summer villages and winter hunting camps	Hunting, gathering, trading (French); corn and bean agriculture; trading, hunting, gathering (Native American)	Small temporary log structures, cache pits, faience ceramics, free-blown glass containers, glass beads, kettle brass, iron knives, gun parts and gunflints (French); small villages with house remains, pit features, middens, stone tools, French trade goods such as glass beads, brass kettles, steel knives and axes, silver ornaments, guns (Native American)
Mississippian	Late	AD 1600 to AD 1300	Agricultural villages after decline of Cahokia	Subsistence based on bison, deer, small mammals, fishing, plant collecting and corn, beans and squash; subsistence determined by local availability	Few diagnostic artifacts recovered; Oneota artifacts present, but may represent trade items
	Early	AD 1300 to AD 1000	Population increase with permanently occupied settlements acting as socio-political centers (e.g., Cahokia) for surrounding villages, hamlets, farmsteads and camps	Intensive cultivation of maize, beans, and squash; or cultivation of seed crops and tobacco; hunting and gathering still practiced	Large sites with community buildings erected on mounds with smaller towns and farmsteads surrounding (e.g., Cahokia); wide variety of artifactual remains including stone pipes, negative painted ceramics, salt pans, chert hoes, shell tempered pottery, and small triangular projectile points
Woodland	Late-Late Bluff	AD 1000 to AD 800	Continuation of villages, agricultural and non-agricultural sites; towns and platform mounds probable; increased population	Maize cultivation in addition to cultivation of species in earlier times with more intentensive exploitation of seeds, aquatics	Diagnostic artifacts include triangular points, Mill Creek chert hoes; stumpware; cord-marked jars and bowls
	Late-Early Bluff	AD 800 to AD 300	Population consolidation occupying small seasonal or base camps, habitation sites, mortuary sites (burial mounds); village sites restricted to bluff tops and terraces	Probable maize cultivation; intensive utilization of seeds, aquatics	Diverse ceramic styles, small triangular points; diagnostic ceramics include cordmarked jars and bowls with rounded or tapered lips

Table 2-1. A SUMMARY OF THE CULTURAL CHRONOLOGY OF THE AREA OF THE ST. LOUIS AAP (concluded)

Cultural Unit					
Tradition	Period or Phase	Date[a]	General Settlement Patterns	General Subsistence Systems	Kinds of Archeological Remains Representative of Period
Woodland (cont)	Middle	AD 300 to 300 BC	Population increase with small seasonal or base camps, habitation sites, earthwork, and mortuary related sites located in full spectrum of ecological zones	Dependence on cultivated plants (starchy and oily seeded species: squash, bottle gourd); hunting particularly deer); gathering of wild plants; trade in exotic items	Habitation sites with variable numbers of structures and pit features; large mortuary-related sites including mounds and charnel houses; small, seasonally occupied sites dependent upon available plant and animal resources
	Early	200 BC to 1000 BC	Small seasonal or base camps with possible increased sedentism; villages; mortuary site and burial mounds	Hunting and gathering; increased reliance on plant resources	First evidence for ceramic technology; diagnostic ceramics include Marion Thick, Schultz Thick, Fayette Thick Stemmed and side-notched points; diagnostics include Kramer, Liverpool Stemmed, and Dickson; increased evidence for mortuary behavior
Archaic	Late	1000 BC to 4000 BC	Small seasonal or base camps with increased exploitation of locally occurring resources, particularly aquatics; shell mounds; sites located throughout uplands, terraces and levees; mortuary related sites possible in mounds on bluffs bordering river valleys	Hunting and gathering of small game animals; use of nut and aquatic resources in cooler, moister environmental conditions	Lithic scatters with a variety of projectile points; ground stone; general purpose tool kits; heavy concentrations of artifacts possible in some locations
	Early & Middle	4000 BC to 8000 BC	Small seasonal or base camps in riverine and forest areas; probably semi-permanent or repeatedly occupied special activity sites and utilization of rock-shelters increased; in addition to site types found in Paleo-Indian, isolated burials and open campsites are found	Hunting and gathering of smaller game animals, more diversified economy, increase in use of vegetal foods, exploitation of more local resources during Hypsithermal	Lithic scatters with ground stone, side-notched and stemmed points, side-notched scrapers; utilization of local cherts
Paleo-Indian		10,000 BC to 8000 BC	Low population density located in small seasonal encampments or base camps	Utilization of megafauna (mastodon, mammoth, bison, muskox, giant beaver); utilization of smaller animals; gathering	Diagnostic projectile points include large fluted points and large, unfluted lanceolate points: points may occur as isolated finds

[a] Dates for prehistoric periods based on Kelly; Linder, and Cartmell (1979); references for historic information include Gerlach (1976), Peterson (1949), and Primm (1981).

may be preserved beneath the ground disturbance area. Sites dating from the Paleo-Indian to protohistoric and historic Indian groups have been recorded within this region of Missouri. Prehistoric site types are varied and range from single activity loci to large village sites and towns to mortuary areas.

2.2.1 Prehistory

The St. Louis AAP is located adjacent to the American Bottom archeological region which has been the site of intensive archeological investigations (Bareis and Porter 1984). Four prehistoric traditions are recognized within east-central Ilinois: Paleo-Indian, Archaic, Woodland, and Mississippian. See Table 2-2 for a detailed discussion of each.

The earliest inhabitants of the St. Louis area were Paleo-Indian big game hunters and gatherers (Benchley 1976). Population density appears to have been extremely low at this time (10,000 to 8000 BC). Possible Paleo-Indian finds on the facility would likely be limited to isolated artifacts (probably representing hunting losses).

Population increased during the Archaic tradition (8000 to 1000 BC) with small base or seasonal camps being used. The economic base of the Archaic hunters and gatherers became more diversified with the use of more vegetal foods, nuts, and aquatic resources.

Population again increased during the Woodland tradition (1000 BC to AD 1000). Ceramics were first manufactured during the Early Woodland period, while dependence on cultivated plants occurred during the Middle Woodland period and maize was grown in Late Woodland times. A Late Woodland habitation site was recorded in O'Fallon Park, which is approximately two miles east of the AAP along the edge of the Mississippi Valley bluffs (Browman, Horn, and Clark 1977).

The St. Louis area is noted for large towns with community buildings erected on mounds and surrounded by farming hamlets which were occupied

during the Mississippian tradition (AD 1000 to 1600). Mississippian tradition populations were primarily supported by maize, bean, and squash agriculture. Cahokia, 6.5 air miles southeast of St. Louis, is one of the best known socio-political centers dating to the Mississippian tradition. Population in the American Bottom region at that time is estimated to have been about 50,000, with some 30,000 living in Cahokia alone (Pfeiffer 1977:425).

Within the City of St. Louis, there were at least three "large earthen mounds," one at least 20 feet high and 50 or more feet long (Faherty 1978:56, lower illustration), and thus the city was called "Mound City" (see also Gill 1952b). A more detailed description of the mounds was compiled by Bushnell (1904), including over a dozen in present-day Forest Park and several probably in Sherman Park. All of these are at about 500 feet elevation. In various places the mounds included burials, and in others just charcoal and ceramic and lithic artifacts were associated; the latter were interpreted as the remains of collapsed earthen lodges, rather than burial mounds (Bushnell 1904:15). Hamilton and Nixon (1984) have located all of the Bushness sites on U. S. Geological Survey topographic quadrangles. Kent, Nelson, and Harl (1980:16) note that the most common prehistoric materials reported in the City of St. Louis area date from 5000 BC to AD 1450.

2.2.2 Ethnohistory

Western Illinois and eastern Missouri were occupied during the ethnohistoric period by the Illinois Indians (Callender 1978:673-680; Bauxar 1978:594-601). Sites of this period consist of semi-permanent summer villages, summer hunting camps, and winter camps, with summer villages situated along riverbanks (Callender 1978:674). Subsistence pursuits included agriculture, hunting, fishing, and gathering (Callender 1978:674). In the early nineteenth century William Rogers Clark, on behalf of the U. S. Government, signed Castor Hill treaties with the Cahokia, Tamarois, Kaskaskia, and Peoria tribes (the Illinois nation) (Gill 1952a:295).

There is no known specific documentation of any village or other historic Native American site in the vicinity of the St. Louis AAP.

2.2.3 History

Three cultural traditions are recognized during the historic period for the St. Louis region: Historic Native American, Colonial, and American. The Historic Native American tradition would be represented archeologically by remains left behind by any of the Native American groups that may have lived in the region between the late seventeenth and the mid-nineteenth centuries. The Colonial and American traditions comprise cultural resources attributable to peoples of Euroamerican origin that date before and after the American Revolution, respectively. The Colonial Tradition is divided into an Early Exploration Period and a European Competition Period. Within the American Tradition, four periods are recognized: Frontier, Homestead, Early Industrial, and Late Industrial. See Table 2-1 for a more detailed discussion.

The Joliet and Marquette expedition in 1673 marked the beginning of the historic period in the St. Louis area. This period saw early French exploration of and missionary expeditions into the Illinois Country, and in 1682 LaSalle claimed the entire Mississippi basin for France, naming it Louisiana (Primm 1981:3). In order to fortify their imperial claims the French built a string of forts between their St. Lawrence bases and the Mississippi Valley. Fort St. Louis, erected in 1682, was the first French outpost established in the project vicinity. Later the villages of Kaskaskia and Cahokia were founded, and the outposts at Fort de Chartres and Ste. Genevieve soon followed (Primm 1981:3-4).

The intercolonial struggle between France and Great Britain for control of North America resulted in France's relinquishing the Louisiana territory west of the Mississippi to Spain and the land east of the river to Great Britain under terms of the Treaty of Paris in 1763. French settlers abandoned the settlements east of the Mississippi River and began to extend their settlements on the west bank. St. Louis was

established as a town in 1764 after the Spanish took possession, but remained essentially French in character (Gerlach 1976:11; Peterson 1949:2). In 1770 the Spanish began to exert control over the area, as they were mainly concerned with exploiting the frontier and protecting the area from the English and the growing American competition and expansion. The American Revolution heightened antagonism between Spain and England who continued to compete after the war for Native American alliance, hoping to gain a monopoly of the thriving fur trade.

Sometime late in the eighteenth century the land in the vicinity of (and perhaps including) the AAP was assigned by the Spanish government to the family of Joseph Alvarez Hortiz (Gill 1952a:294), who subsequently sold the acreage to one Pierre Choteau. Choteau subsequently sold the land, perhaps including the modern AAP, to William Rogers Clark (Gill 1952a:294-295; 1952c:54) who used the land as a Indian camping area while negotiating treaties.

The most serious issue confronting the Spanish rulers was the relatively slow pace of development. In order to rectify the situation, the Spanish governor induced Americans to emigrate from Illinois through dispensation of land grants. St. Louis now began its transformation from an outpost of European nations into an American frontier town.

With the Louisiana Purchase in 1803, the region came under American control but St. Louis grew slowly. The town, still an urban outpost on the far western frontier, was shaped more by traditional French factors than by development due to accession by the United States. Immigration into Missouri increased rapidly within the next decade; the immigrants were predominately American settlers who tended to settle along the Missouri River (Gerlach 1976:24). American troops stationed at Fort Bellefontaine on the Missouri River remained in the area after the War of 1812, and by 1830 the population of Missouri was more than 90 percent American (Gerlach 1976:26).

During the Homestead period most of Missouri's American settlers, many of whom were slave-owning farmers, were from Tennessee, Kentucky, and Virginia. They tended to settle along the Missouri River and other waterways that provided direct access to the St. Louis market (Gerlach 1976:29-32). German immigration reached a high point in the state at this time; the town and its outlying areas were marked by a proliferation of German parishes and parochial schools. The second largest immigrant group was the Irish. St. Louis grew as a transportation center, becoming a major collecting point for the entire state's agricultural products as well as a center for the army's western operations. In 1837 St. Louis received a small appropriation from Congress to stabilize its harbor, which resulted in increased river trade with other American states and European countries (Primm 1981:156).

The basic settlement pattern of the preceding Homestead Period continued into the Early Industrial period, but the density of farmstead distribution became greater due to a general population increase. The railroad and river connections allowed St. Louis to grow rapidly as a manufacturing point. Food processing, sugar refining, and meat packing dominated the city's early industrial economy (Primm 1981:201). To broaden its industrial base, St. Louis began a shift from water transport to railroad traffic. River trade remained essentially stable early in the period but it rapidly declined as the railroads expanded.

By the mid 1880s St. Louis had made the transition from a commercial city dependent on the river, to a mature, diversified, industrial metropolis. St. Louis had become a city that had a large, discrete, industrial and residential section as well as satellite communities in the metropolitan region. A shift from the heavy industries of the previous period to newer and lighter domestic industries, such as dress manufacturing, furniture making, and book publishing, occurred at this time.

2.3 ARCHEOLOGICAL RESEARCH DIRECTIONS

2.3.1 Regional Concerns

A preliminary master plan for archeological resource protection has been completed for Missouri (Environmental Systems Analysis, Inc., and others 1983) with the state divided up into geographical management units and cultural study units with the following cultural units: Paleo-Indian; Early, Middle, and Late Archaic; Woodland; and Mississippian. Based on this and other work, a research design applicable to the St. Louis AAP archeological resources can be developed.

Paleo-Indian research in the St. Louis area has been sporadic because of the isolated nature of the archeological remains. During the Archaic period, it appears that the distribution of grasslands expanded in western Illinois and eastern Missouri. Archaic hunters and gatherers may have responded by abandoning upland regions and locating sites in floodplain areas; evidence of such adaptations may be retained in archeological sites on the St. Louis facility. In addition to changes in settlement location, resource exploitation, and mobility, later Archaic peoples participated in more visible mortuary behavior and trade. These patterns were elaborated and intensified during the post-Archaic Woodland and Mississippian traditions. Investigations of regional Archaic sites can provide a baseline against which to analyze later changes in prehistoric patterns of resource exploitation and in other religious, economic, and social behavior.

One of the major research questions relating to Early Woodland sites is the development and effect of ceramic production on other prehistoric cultural systems. In addition, cultural-ecological adaptations and social and religious patterns previously evident during the Archaic seem to have been intensified. It has been postulated that Early Woodland people lived in semi-permanent villages or hamlets and used the natural resources according to a wide, seasonal round of exploitation (Munson 1982). Middle Woodland sites located in Illinois were related to a

larger socio-religious-political unit known as Hopewell. There was an apparent increase in mortuary-related behavior (i.e., more burial mounds) during the Middle Woodland. Corn, squash, amaranth, and chenopod horticulture occurred during the Middle Woodland in surrounding areas, and its effects on the sites of this region is an important research consideration that might be able to be addressed.

During the Late Woodland period economic and social changes are apparent in the present archeological record. These consist of the increased use of aquatic resources and seeds, and a decrease in artifactual and social complexity. Investigations of any such sites present in this region may be critical in understanding the transition between Middle Woodland cultural complexity and succeeding Mississippian developments.

The height of prehistoric complexity in the central Midwest was reached during the Mississippian period. Permanent Mississippian towns such as Cahokia were located in the immediate vicinity of and perhaps even within (Bushnell 1904) present-day St. Louis. In addition, smaller towns and hamlets surrounded these large socio-political centers. Maize, beans, squash, seed, crops, and tobacco were cultivated, though hunting and gathering were still practiced. Archeological investigations of Mississippian sites are critical to the understanding of a large socio-political-religious unit and interactions with smaller villages and hamlets.

Due to the presence of Cahokia, a large Mississippian town several miles east of the facility, portions of the American Bottom have been subjected to more intensive archeological investigations (see Fortier 1981:88-89 for an overview of this work; Fowler 1969; Fowler and Hall 1975). Also, the FAI-270 surveys and excavations conducted by the University of Illinois (Kelly, Lindner, and Cartmall 1979) have increased the archeological data base for this area (Bareis and Porter 1984) and an overview of the archeological resources of metropolitan St. Louis has

been completed (Benchley 1975) as well as a recent overview of the resources of the River des Peres drainage basin (Nixon, Hamilton, and Kling 1982).

Contact with early traders and trappers produced a profound change in the social, political, and economic adaptations of Native Americans in the region in the seventeenth and eighteenth centuries. As a result of these early explorations and later settlements, disease, trade goods, and different economic pursuits were introduced. In addition, inter-tribal hostilities may have been accentuated. The relationship between early Euroamericans and Native Americans may be examined within the St. Louis area. Proto-historic or early historic Native American sites are as yet undocumented in the study facility.

Historic archeological research can be extremely varied. Major questions for regional investigation may include the following: the impact of early trapping and trading on Native American populations and on European political rivalries; the use of rivers and later of railroads for transport, and its effect on surrounding industry and populations; the early settlement of the area and subsequent economic changes resulting from technological advances in agriculture and mining; and the effect of a decreased mining activity on the area and the development of St. Louis as a modern commerce center.

2.3.2 Installation-Specific Archeological Research Directions

No prehistoric or historic sites are presently known to exist on the St. Louis AAP; if any are found their research values should reflect any of the regional concerns (see 2.3.1).

3.0 AN ASSESSMENT OF ARCHEOLOGICAL RESOURCE PRESERVATION AND SURVEY ADEQUACY

In this section the environmental and historic constraints that may limit the amount and kind of archeological site preservation are considered in this chapter as they apply to the St. Louis AAP, along with an assessment of the coverage of previously conducted archeological surveys. In addition, assessment is also made about the adequacy of data collection, and any gaps that may exist are documented.

3.1 ENVIRONMENTAL CONSTRAINTS TO SITE PRESERVATION

Historic and recent modifications of the St. Louis AAP are likely to have removed or obliterated any intact surface archeological remains. Buried archeological deposits may exist beneath paved or construction areas of the facility.

3.2 HISTORIC AND RECENT LAND USE PATTERNS

Prior to federal purchase the St. Louis AAP was platted as a residential subdivision and was purchased from individual land owners, but there are no historic documents available which indicate the presence of individual residences prior to 1941 (Margaret Beavers, personal communication 1984). In addition, no buildings exist on the facility that were built prior to the 1940s (Meryl Humphreys, personal communication 1984).

A summary of all ground disturbance information for the St. Louis facility is presented in Table 3-1 and Figure 3-1. The entire facility

Table 3 1. A SUMMARY OF HISTORIC AND/OR MODERN GROUND DISTURBANCE THAT MIGHT LIMIT THE PRESENT ARCHEOLOGICAL RESOURCE BASE ON THE ST. LOUIS AAP

GDA No.	Type of Disturbance	Date Conducted (yr)	Reference	Area Disturbed (acres)	Estimated Depth Below Surface (ft)	Ratio of Disturbed to Total Area	Location of Disturbed Area: UTM Northing	UTM Easting	Legal Reference[a] Township	Range	Section	USGS Quad Map[b]	Coincidental Sites
1	Plant Buildings, Parking lot	1941-1944	DARCOM Activity Brochure	21	0-10 av. 6	1:1	4286600 4286600 4286830 4286490	738300 737900 738100 738240	--	--	--	CT54	

[a] St. Louis proper has no township/range information.

[b] CT54 - Clayton, MO, 7.5 min. sheet (1954, photorevised 1968 and 1974).

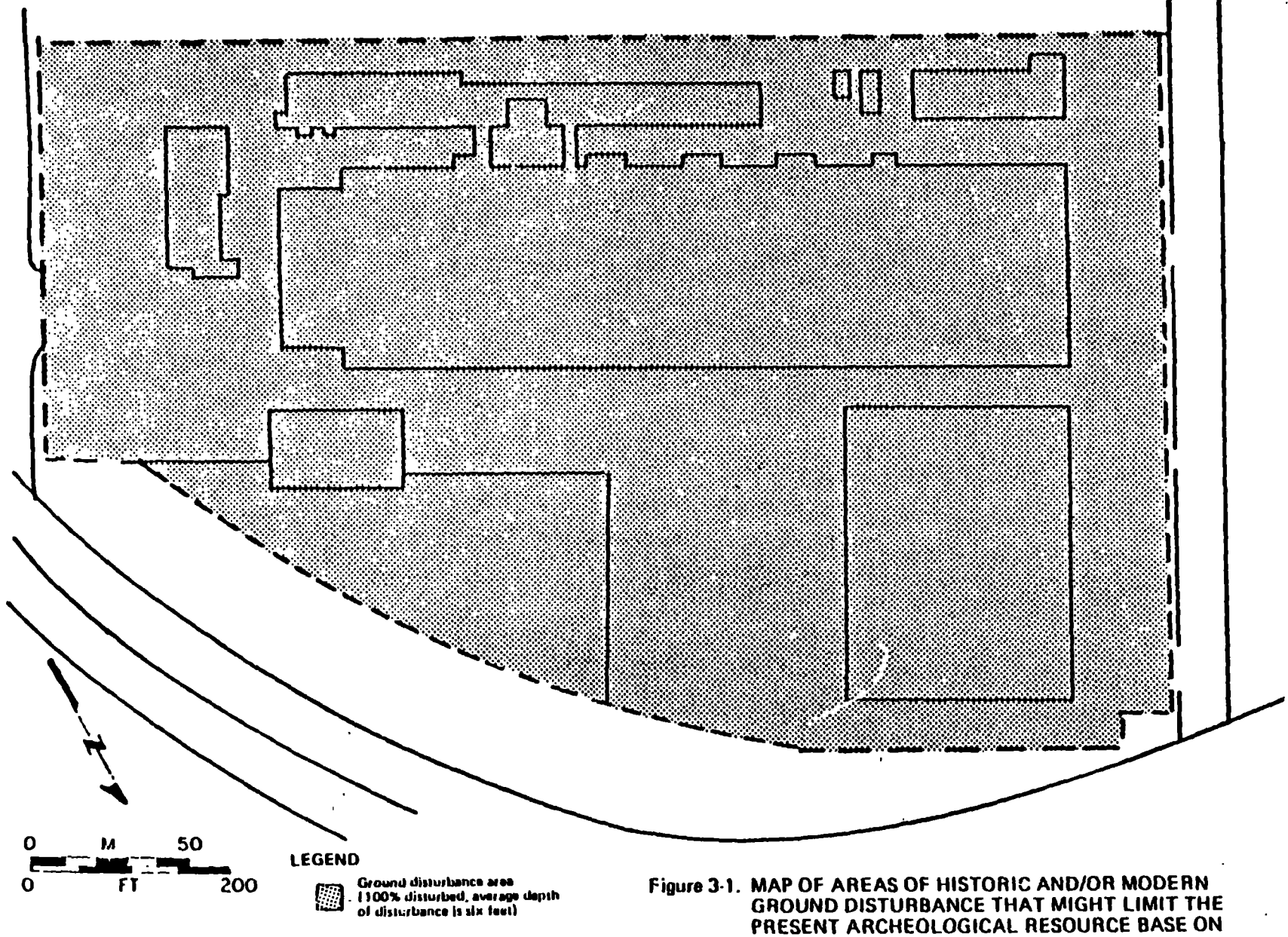


Figure 3-1. MAP OF AREAS OF HISTORIC AND/OR MODERN GROUND DISTURBANCE THAT MIGHT LIMIT THE PRESENT ARCHEOLOGICAL RESOURCE BASE ON THE ST. LOUIS AAP

appears to have been impacted by plant buildings and parking lots with an estimated ratio of disturbed to total area of 90 to 100 percent. Depth of ground disturbance within the facility varies between 0 and 10 feet, with an average of six feet.

3.3 PREVIOUS CULTURAL RESOURCE INVESTIGATIONS; COVERAGE AND INTENSITY

No archeological surveys were conducted on the St. Louis AAP prior to its construction in 1941, nor have any been conducted to date. No archeological sites are presently known to exist within the facility boundaries. A survey of the historic architectural resources on the AAP is in progress (William Brenner, personal communication 1984). However, within the past few years there have been several field or desk cultural resource management projects addressing lands within a few miles of the AAP (e.g., Browman 1980; Browman, Horn, and Clark 1977; Hamilton and Nixon 1984; Nixon, Hamilton, and Kling 1983).

3.4 SUMMARY ASESSMENT OF ARCHEOLOGICAL DATA ADEQUACY AND GAPS

The lack of information on archeological resources on the St. Louis AAP is due to a lack of survey and to the all-encompassing nature of the apparent ground disturbance on the facility such that surficial survey is difficult.

4.0
KNOWN ARCHEOLOGICAL RESOURCES ON THE ST. LOUIS AAP

There are no known or identifiable potential archeological sites on the St. Louis AAP at present. "Potential" sites would be those identified in the historic archives or rumored to exist, but not yet field-identified. Nixon, Hamilton, and Kling (1982:18) note that there is some evidence of Late Woodland or Early Mississippian remains on the bluff tops overlooking river valleys in the St. Louis area. The St. Louis AAP is not along such a bluffline, but is on the south side of a prehistoric drainageway and at the same elevation as prehistoric materials found in Forest Park, Sherman Park, and O'Fallon Park.

The facility is located on a modern surface in an upland topographic situation. Construction and modification of the St. Louis AAP has removed any surface historic remains to a depth of up to 10 feet (3.05 m). Subsurface cultural deposits may be preserved beneath paved areas or areas with minimal disturbance.

5.0
AN ASSESSMENT OF THE SIGNIFICANCE OF THE ARCHEOLOGICAL RESOURCE BASE ON THE ST. LOUIS AAP

No archeological sites are known on the St. Louis AAP, even though significant prehistoric and historic sites exist in the vicinity. The surface of the facility appears to have been totally impacted by modern construction or paving, though intact soils may remain beneath. These soils could still contain prehistoric or historic archeological materials.

It is recommended that the St. Louis AAP facility personnel develop a close coordination with the Missouri SHPO in the event of any future development project at the facility.

6.0 A RECOMMENDED ARCHEOLOGICAL MANAGEMENT PLAN FOR THE ST. LOUIS AAP

6.1 FACILITY MASTER PLANS AND PROPOSED IMPACTS

No long-term planning document is available for the St. Louis AAP. Facility personnel state that no further construction or modification is planned there (Meryl Humphreys, personal communication 1984).

6.2 APPROPRIATE ARCHEOLOGICAL MANAGEMENT GOALS WITHIN THE ST. LOUIS AAP'S MASTER PLAN

6.2.1 General Facility Planning

This report documents the lack of any presently known archeological investigations on the St. Louis AAP, but the possibility that significant prehistoric or historic buried materials may be retained there. This information can be used as the basis for developing an archival and field inventory program to demonstrate the absence of sites on the facility, or the presence and hence the need for the preparation of a Historic Preservation Plan (HPP) to be implemented on the facility.

Army Regulation 420-40, drafted pursuant to the National Historic Preservation Act, and 36 CFR 800 (Section 1.1), require that each DARCOM facility have a Historic Preservation Plan (HPP) or have documentation on file indicating whether there are any known archeological resources appropriate to such management planning. At present, there is no such negative declaration or Plan.

The Department of the Army Regulation 420-40 prescribes Army policy, procedures, and responsibilities for compliance with the National Historic Preservation Act of 1966, as amended; for the maintenance of state-of-the-art standards for preservation, personnel and projects; and for accomplishment of the historic preservation program. As outlined in those regulations, an HPP has the following objectives:

- Integration of historic preservation requirements with the planning and execution of military undertakings such as training and construction and real property or land use decisions

- Implementation of a legally acceptable compliance procedure with the Advisory Council on Historic Preservation (ACHP) and State Historic Preservation Officer (SHPO)

- Outline priorities for acquiring additional information to determine if there may be additional projects not yet located or identified

- Establishment of a procedure for the evaluation of historic properties

- Ranking of facility projects by their potential to damage historic properties

- Provision of guidelines for the management of historic properties

- Provision of historic and archeological data for the installation's information systems

- Identification of funding, staffing, and milestones needed to implement the plan.

This document provides the necessary information for meeting these

objectives for archeological resources on the St. Louis AAP. The information provided here can be used to determine if any activities of the on-going facility mission (or any special mission) will damage or have adverse effects on any "likely to occur" archeological resources; it thus can be used to develop alternatives for the mitigation of those effects. Consultation with the SHPO and ACHP about the preservation program as outlined in the HPP will ensure compliance with the historic preservation laws and regulations outlined in Section 1.0. Further, it will integrate preservation considerations into general facility and future project planning in a timely and cost-effective manner.

6.2.2 Project-Specific Resource Protection or Treatment Options

No archeological sites have been documented on the St. Louis AAP. The entire surface of the facility has been impacted by construction and/or paving. Thus, any future ground-disturbing activities in the AAP is unlikely to need pre-construction review of its potential adverse impacts to significant archeological resources (the exception might be deep new excavation into previously undisturbed deposits beneath moverd buildings, structures, or paving). However, new ground-disturbing construction in AAP land would be a federal undertaking requiring compliance with Section 106 of the National Historic Preservation Act (see Section 1.1 of this report). Section 106 requires that DARCOM consult with the Missouri SHPO and the federal Advisory Council on Historic Preservation about the effects of such an undertaking on significant archeological sites. Without a SHPO-accepted facility preservation plan, it is DARCOM's responsibility to either complete such an evaluation and consultation program for each project or to have on file documentation of the completion of adequate survey and evaluation so as to confirm the absence or lack of significance of any archeological site that might be affected by the proposed activity. Such project-specific evaluation and preservation programs require consultation with several federal agencies, and are frequently time-consuming. However, such a project-specific program can usually be expedited if the appropriate preservation planning or negative declaration has been completed and reviewed by the SHPO.

In the event the installation has accomplished its Section 106 procedures and finds a previously unidentifiable resource during its ground disturbance and/or construction phase, it will effect compliance using 36 CFR 800.7 procedures, as follows:

- Notification will be accomplished by the facility of the emergency discovery to the Departmental Consulting Archeologist (DCA), who is responsible for making an investigation within 48 hours, to determine the importance of the resource, and defining appropriate mitigation measures

- Consultation with the Missouri State Historic Preservation Officer (SHPO), DARCOM, National Park Service (Rocky Mountain Regional Office, Denver, Colorado), and the National Register, will be accomplished by the DCA or DCA's designee

- If the site is evaluated as being important by the DCA or DCA's designee, the Department of the Army is responsible for implementing and funding the mitigation measures.

6.2.3 A Summary of Recommended Management Directions and Priorities for Effective Compliance and Program Management

As discussed in 6.2.1, there is presently no documentation of known or potential cultural resources on the St. Louis AAP, nor is there a negative declaration to this effect on file. This report should serve as the basis for such a declaration, following consultation with the Missouri SHPO and the ACHP in Denver, Colorado.

It is possible that intact subsurface cultural resources remain on the AAP. Presently, no construction is planned on the facility, but should archeological materials be encountered in any future ground-disturbing process, construction should halt until consultation and evaluation with the Departmental Consulting Archeologist (DCA) can

determine the importance of the materials. If deemed important, the Army should then implement appropriate measures as recommended by the DCA.

6.3 ESTIMATED SCOPE OF WORK AND COST LEVELS FOR PRESENTLY IDENTIFIABLE MANAGEMENT NEEDS

Because no management work outside of DARCOM in-house activities should be required, the Section 6.2.2 resource protection options are recommended to incur no contractor costs.

7.0
SUMMARY

As a manager of public lands, the St. Louis AAP has responsibilities for the management of the natural and cultural resources held on those lands, for the general benefit of the American people. This report documents the lack of known or archivally-determined potential archeological resources on the facility and recommends compliance procedures if any archeological resources are identified that could be impacted by any future construction.

No construction is planned for the St. Louis AAP that would modify the current surface of the facility. To date the entire facility is covered by the manufacturing and administrative buildings and parking lots. However, intact subsurface deposits may remain beneath the parking area and the buildings and could contain signficant archeological materials.

Consultation with the Missouri State Historic Preservation Officer is recommended either for (1) the filing of (and acquiring written concurrence with) a negative declaration of preservation management needs, or for (2) completion of a Historic Preservation Plan. Such a plan should be in compliance with Army Regulation 420-40 and be based on information available from this report and from the historic architectural study presently being conducted by the Historic American Buildings Survey, to provide the basis for an affirmative cultural resource management program appropriate to a land-managing agency whose fundamental mission is support for America's military.

8.0 BIBLIOGRAPHY

8.1 REFERENCES CITED

Bareis, Charles J., and James W. Porter, (editors). 1984. American Bottom Archaeology: A Summary of the FAI-270 Project Contribution to the Culture History of the Mississippi River Valley. Urbana and Chicago: University of Illinois Press.

Bauxar, J. Joseph. 1978. History of the Illinois Area. In Handbook of North American Indians 15: Northeast, edited by Bruce G. Trigger, pp. 594-601. Washington, DC: Smithsonian Institution.

Beavers, Margaret S. 1984. Personal communication. Documents Examiner, Real Estate Division, Army Corps of Engineers, Kansas City, Missouri.

Benchley, Elizabeth. 1976. An Overview of the Archaeological Resources of the Metropolitan St. Louis Area. Report submitted to the National Park Service, Washington, DC. Springfield: Illinois State Museum Society.

Benham, Ken E. 1982. Soil Survey of St. Louis County and St. Louis City, Missouri. Washington, DC: U. S. Department of Agriculture, Soil Conservation Service.

Brenner, William. 1984. Personal Communication. Principal Investigator, DARCOM HABS Survey; Building Technology, Inc., Silver Springs, MD.

Browman, David L. 1980. Cultural Resource Survey of Stupp Memorial Gardens, Tower Grove Park, St. Louis City, Missouri. Preliminary Survey. Ms. on file, Missouri State Historic Preservation Office, Jefferson City, MO.

Browman, David L., Darwin D. Horn, and Niki R. Clark. 1977. Interim Report on the Archaeological Survey of Construction Areas in Carondolet, O'Fallon, and Shermap Park, City of St. Louis, Missouri. Ms, Department of Anthropology, Washington University, St. Louis.

Bushnell, D. I., Jr. 1904. The Cahokia and Surrounding Mound Groups. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University 3(1).

Callender, Charles. 1978. Illinois. In Handbook of North American Indians 15: Northeast, edited by Bruce G. Trigger, pp. 673-680. Washington, DC: Smithsonian Institution.

Emerson, Thomas E., and Dale L. McElrath. 1983. A Settlement-Subsistence Model of the Terminal Late Archaic Adaptation in the American Bottom Illinois. In Archaic Hunters and Gatherers in the American Midwest, edited by J. Phillips and J. Brown, pp. 219-242. New York: Academic Press.

Environmental Systems Analysis, Inc.; The Historic Kansas City Foundation; and The Missouri Heritage Trust. 1983. Preliminary Master Plan for Archaeological Resource Protection in Missouri. Jefferson City: Missouri Department of Natural Resources.

Faherty, William B. 1978. The Saint Louis Portrait. St. Louis: Continental Heritage, Inc.

Fenneman, Nevin M. 1938. Physiography of Eastern United States. New York: McGraw-Hill.

Fortier, A. 1981. The Carbon Monoxide Site: An Early and Middle Woodland Occupation in the American Bottom. FAI-270 Archaeological Mitigation Project Report 27. Urbana-Champaign: Department of Anthropology, University of Illinois.

Fowler, Melvin L. 1969. The Cahokia Site. In "Exploration into Cahokia Archaeology," edited by M. L. Fowler. Illinois Archaeological Survey Bulletin No. 7, pp. 1-30. Urbana: University of Illinois.

Fowler, Melvin L. and Robert L. Hall. 1975. Archaeological Phases at Cahokia. In "Perspectives in Cahokia Archaeology." Illinois Archaeological Survey Bulletin No. 10, pp. 1-14. Urbana: University of Illinois.

Gerlach, Russell. 1976. Immigrants in the Ozarks: A Study in Ethnic Geography. Columbia: University of Missouri Press.

Gill, McCune. 1952a. Pine Lawn. In The St. Louis Story, Library of American Lives, pp. 294-295. Hopkinsville, KY, and St. Louis: Historical Record Association.

_____. 1952b. The Mound City. In The St. Louis Story, Library of American Lives, pp. 35-38. Hopkinsville, KY, and St. Louis: Historical Record Association.

_____. 1952c. Lewis and Clark. In The St. Louis Story, Library of American Lives, pp. 51-54. Hopkinsville, KY, and St. Louis: Historical Record Association.

Hamilton, M. Colleen, and Joseph M. Nixon. 1984. Report of Phase I Level Cultural Resource Survey of Five Proposed Bridge Modification Sites in Forest Park, City of St. Louis, St. Louis County, Missouri. Report on file, Missouri State Historic Preservation Office, Jefferson City, MO.

Harris, Stanley E., Jr. 1983. Landforms of the Natural Divisions of Southern Illinois. Erigenia 2:41-45. Carbondale, IL.

Humphreys, Meryl. 1984. Personal communication. Commander's Representative, St. Louis Army Ammunition Plant, St. Louis, Missouri.

Kelley, John E., Jean R. Linder, Theresa J. Cartmell. 1979. The Archaeological Intensive Survey of the Proposed FAI-270 Alignment in the American Bottom Region of Southern Illinois. Illinois Transportation Archaeology Scientific Reports 1.

Kent, Jonathan D., Ben A. Nelson, and Joseph L. Harl. 1980. Phase I Survey of Archaeological and Historic Resources, Bonfils Interception System, St. Louis County, Missouri. University of Missouri - St. Louis Archaeological Survey Report No. 1.

King, James E. 1975. Late Pleistocene Paleoecology of the Western Ozarks. In Quaternary Paleoenvironmental History of the Western Missouri Ozarks, 23rd Annual Meeting, Midwest Friends of the Pleistocene, Western Missouri Ozarks Field Conference, August 8-10, 1975.

_____. 1981. Late Quaternary Vegetational History of Illinois. Ecological Monographs 51(1):43-62.

King, James E., and A. H. Allen, Jr. 1977. A Holocene Vegetation Record from the Mississippi River Valley, Southeastern Missouri. Quaternary Research 8:307-323.

Knudson, Ruthann, David J. Fee, and Steven E. James. 1983. A Work Plan for the Development of Archeological Overviews and Management Plans for Selected U.S. Department of the Army DARCOM Facilities. Walnut Creek, CA: Woodward-Clyde Consultants.

Munson, Patrick J. 1982. Marion, Black Sand, Morton, and Havana Relationships: An Illinois Valley Perspective. The Wisconsin Archeologist 63(1):1-17.

Nixon, Joseph M., David Browman, and M. Colleen Hamilton. 1984. Report of Phase I Level Cultural Resource Survey of Proposed Development Tract, the Ellsardsville Area, in Mid-town, City of St. Louis, St. Louis County, Missouri. Ms. on file, Missouri State Historic Preservation Office, Jefferson City.

Nixon, Joseph M, Colleen Hamilton, and Laura E. Kling. 1982. A Prehistoric, Protohistoric and Historic Overview of the River des Peres Drainage Basin, St. Louis County, Missouri. University of Missouri-St. Louis Archaeological Survey Research Report No. 4.

Peterson, Charles Emile. 1949. Colonial St. Louis: Building a Creole Capital. St. Louis: Missouri Historical Society.

Pfeiffer, John E. 1977. The Emergence of Society. New York: McGraw-Hill Book Co.

Primm, James. 1981. Lion of the Valley. Boulder, Colorado: Pruett Publishing.

Stafford, Barbara, Harold Hassen, Edward Jelks, Keith L. Barr, and Marjorie Schroeder. 1985. An Archeological Overview and Management Plan for the St. Louis Support Center, Madison County, Illinois. Report on file with the National Park Service, Atlanta, GA.

Weigers, Robert P. 1984. Archaeological Photograph Collections: The Sugar Loaf Mound Example. Missouri Archaeological Society Quarterly 1(1):16-17.

8.2 OTHER PERTINENT LITERATURE

Bareis, Charles J., anc Patrick J. Munson. 1973. The Lindeman Site (Ms-108), Madison County, Illinois. In "Late Woodland Site Archaeology in Illinois, I." Illinois Archaeological Survey Bulletin 9:23-33.

Bareis, Charles J., and James W. Porter, editor. 1981. Archaeology in the American Bottom. Research Report 6. Urbana-Champaign: Department of Anthropology, University of Illinois.

Billon, Fredrick. 1971. Annals of St. Louis in Its Early Days Under French and Spanish Domiation, 1764-1804. New York: Arno Press.

Benchley, Elizabeth. 1980. 1980 Archaeological Investigations at the Cahokia Mounds Historic Site Interpretive Center Tract. Interim Report. Springfield: Illinois Department of Conservation.

Chapman, Carl H. 1975. The Archaeology of Missouri I. Columbia: The University of Missouri Press.

_____. 1980. The Archaeology of Missouri II. Columbia: The University of Missouri Press.

Cole, Denneth W. 1981. An Intensive Cultural Resource Survey of the Proposed Picnic Shelter Construction Site, Dr. Edmund A. Babley Memorial State Park, St. Louis County, Missouri. Missouri Division of Parks and Historic Preservation, Cultural Resource Survey Report No. 80-49.

Collins, Earl A. 1940. Missouri, Its People and Progress. St. Louis: Webster Publishing.

Conant, A. J. 1877. The Mounds and Their Builders, or Traces of Prehistoric Man in Missouri. In The Commonwealth of Missouri, edited by C. R. Barnes, pp. 1-122. St Louis: Grand.

Conard, Howard L. 1901. Encyclopedia of the History of Missouri: A Compendium of History and Biography for Ready Reference. Louisville: Southern History Company.

Cottier, Randy L., Susan B. Traub, and Don C. Traub. 1973. A Selected Bibliography of Missouri Archeology. Missouri Archaeological Society Research Series No. 10.

Coyle, E. 1964. Old St. Louis Homes, 1790-1865. St. Louis: Folkestone Press.

_____. 1966. St. Louis: Portrait of a River City. St. Louis: Folkestone Press.

Emerson, Thomas E. 1980. The Dyroff and Levin Sites: A Late Archaic Occupation in the American Bottom. FAI-270 Archaeological Mitigation Report 24. Urbana-Champaign: Department of Anthropology, University of Illinois.

Emerson, Thomas E., and Dale McElrath. 1981. An Overview of the Terminal Archaic Prairie Lake Complex. Paper presented at the Midwest Archaeological Conference, Madison, Wisconsin.

Fowler, Melvin L. 1963. Second Annual Report: American Bottoms Archaeology, July 1, 1962-June 30, 1963. Urbana: Illinois Archaeological Survey, University of Illinois.

Gould Directory Company (author unknown). 1900. Gould's Official Street and Avenue Guide of the City of St. Louis. St. Louis: Gould Directory.

Graham, Russel W. 1980. Final Report on Paleontological and Archaeological Excavations and Surface Surveys at Mastodon State Park. Springfield: Illinois State Museum.

Hair, James T. 1896. Gazetteer of Madison County. Alton: J. H. Hair.

Hall, Robert L. 1975. Chronology and Phases at Cahokia. In Perspectives in Cahokia Archaeology. Illinois Archaeological Survey Bulletin 10.

Harn, Alan D. 1971a. An Archaeological Survey of the American Bottoms in Madison and St. Clair Counties, Illinois. In Archaeological Surveys of the American Bottoms and Adjacent Bluffs, Illinois. Illinois State Museum Reports of Investigations 21.

_____. 1971b. An Archaeological Survey of the American Bottoms and Wood River Terrace. Illinois State Museum Report of Investigations 21(2).

Harper, Robert Alexander. 1965. Metro East: Heavy Industry in the St. Louis Metropolitan Area. Carbondale: Department of Geography, Southern Illinois University.

Iseminger, W. R. 1973. Archaeological Investigations at the Argo Site 21C1-25. Archaeological Salvage Report 36:82-102. University Museum, Southern Illinois University at Carbondale.

Kennerly, William. 1948. Persimmon Hill: A Narrative of Old St. Louis and the Far West. Norman: University of Oklahoma.

Linder, Jean R. 1974. The Jean Rita Site: An Early Woodland Occupation in Monroe County, Illinois. The Wisconsin Archaeologist 55(2):99-612.

Linder, Jean R., John E. Kelly, G. R. Milner, and James W. Porter. 1975. An Archaeological Survey of the Mississippi Valley in St. Clair, Monroe, and Randolph Counties. Preliminary Report of 1974 Historic Sites Survey Archaeological Reconnaissance of Selected Areas in the State of Illinois: Part I, Section A, pp. 28-41. Urbana: Illinois Archaeological Survey.

Linder, Jean R., Theresa Cartmell, and John E. Kelly. 1978. Preliminary Archaeological Reconnaissance of the Segments under Study for FAP-413 in Madison County, Illinois. Illinois Department of Transportation, District 8.

Lionberger, I. H. 1928. The Annals of St. Louis, and A Brief Account of Its Foundation and Progress, 1764-1927. St. Louis: Mound City Press.

Maxwell, Moreau S. 1951. The Woodland Cultures in Southern Illinois: Archaeological Excavations in the Carbondale Area. Logan Museum Publications in Anthropology, Bulletin 7.

McDermott, John Francis. 1952. The Early Histories of St. Louis. St. Louis: St. Louis Historical Documents Foundation.

McElrath, Dale, and A. Fortier. 1981. The Missouri Pacific #2 Site: A Late Archaic Occupation in the American Bottom. FAI-270 Archaeological Mitigation Project Report 34. Urbana-Champaign: Department of Anthropology, University of Illinois.

McGrath, Kerry C., Michael J. Fuller, and John Northrip. 1979. A Cultural Resources Survey of the Proposed Park Site on the Mincke Tract, St. Louis County, Missouri: 1979. Project: CAR-220. Ms, on file, Office of the Missouri State Historic Preservation Officer, Jefferson City.

Munson, Patrick J. 1971. An Archaeological Survey of the American Bottoms and Wood River Terrace. Illinois State Museum Report of Investigations 21(1).

_____. 1973. Excavation of the Hill Prairie Mound Group (Ms°252), Madison County, Illinois. In "Late Woodland SIte Archaeology in Illinois I: Investigations in South-Central Illinois. Illinois Archaeological Survey Bulletin 9:1-11.

Munson, Patrick J., and James P. Anderson. 1973. A Preliminary Report on Kane Village: A Late Woodland Site in Madison County, Illinois. In "Late Woodland Site Archaeology in Illinois I: Investigations in South-Central Illinois. Illinois Archaeological Survey Bulletin 9:34-57.

Nixon, Joseph M., Laura E. Kling, and M. Colleen Hamilton. 1982. [Addendum, 1983.] An Intensive Cultural Resource Survey and Assessment of Potential Impact Areas Associated with Pollution Abatement Programs along the Meramec River in Southern St. Louis County, Missouri. University of Missouri, St. Louis, Research Report No. 3.

Nixon, Joseph M., Laura E. Kling, and Joseph L. Harl. 1982. Phase I Cultural Resource Survey of Gravois Creek Drainage Basin, St. Louis County, Missouri. University of Missouri-St. Louis Archaeological Survey Research Report No. 9.

Norton, Wilbur Theodore. 1912. Centennial History of Madison County, Illinois, and its People, 1812-1912, Vol. I. Chicago: Lewis Publishing Company.

Parrish, William. 1973. Turbulent Partnership: Missouri and the Union. Columbia: University of Missouri Press.

_____. 1980. Missouri: The Heart of the Nation. St. Louis: Forum Press.

Peck, John. 1864. Forty Years of Pioneer Life. Philadelphia: American Baptist Publication Society.

Peale, T. R. 1862. Ancient Mounds in St. Louis, 1819. Annual Report of Smithsonian Institution for the Year 1861, pp. 386-391.

Porter, James W. 1971. An Archaeological Survey of the Mississippi Valley in St. Clair, Monroe, and Randolph Counties. Preliminary Report of 1971 Historic Sites Survey Archaeological Reconnaissance of Selected Areas in the State of Ilinois: Part I, Summary, pp. 23-34. Urbana: Illinois Archaeological Survey.

_____. 1972. An Archaeological Survey of the Mississippi Valley in St. Clair, Monroe and Randolph Counties. Preliminary Report of 1972 Historic Sites Survey Archaeological Reconnaissance of Selected Areas in the State of Illinois: Part I Summary, Section A, pp. 25-33. Urbana: Illinois Archaeological Survey.

Porter, James W., and Jean Linder. 1974. An Archaeological Survey of the Mississippi Valley in St. Clair, Monroe and Randolph Counties. Preliminary Report of 1973 Historic Sites Survey Archaeological Reconnaissance of Selected Areas in the State of Illinois: Part I, Summary, Section A, pp. 25-33. Urbana: Illinois Archaeological Survey.

Rafferty, Milton. 1981. Historical Atlas of Missouri. Norman: University of Oklahoma Press.

Scharf, John Thomas. 1883. History of St. Louis and County, Vols. I and II. Philadelphia: Lewis H. Everts.

Selby, Paul. 1966. A Bibliography of Missouri County Histories and Atlases. Kirksville: Northeast Missouri State Teachers College.

Skillman, W. D. 1846. The Western Metropolis: St. Louis in 1846. St. Louis: W. D. Skillman.

Stevens, Walter. 1921. Centennial History of Missouri (The Center State): One Hundred Years in the Union, 1820-1921. St. Louis: S. J. Clarke.

Troen, Selwyn K., and Glen E. Holt. 1977. St. Louis. New York: New Viewpoints.

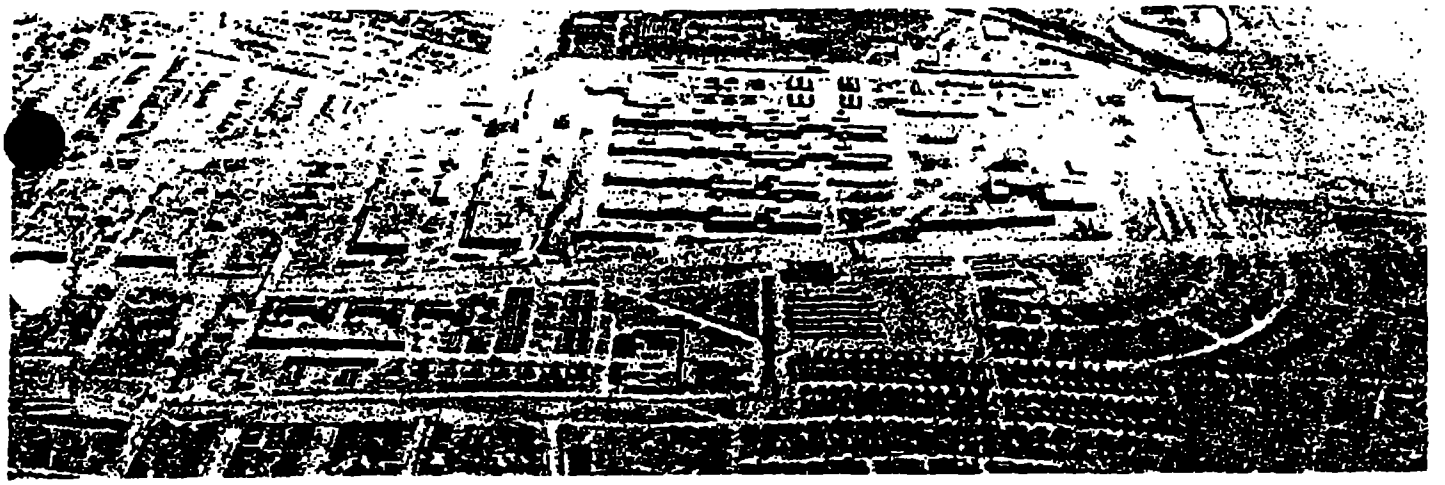
University of Missouri Press (author unknown). 1971. A History of Missouri. Columbia: University of Missouri Press.

Vexler, Robert I. 1974. St. Louis: A Chronological and Documentary History, 1762-1970. Dobbs Ferry, NY: Oceana Publications.

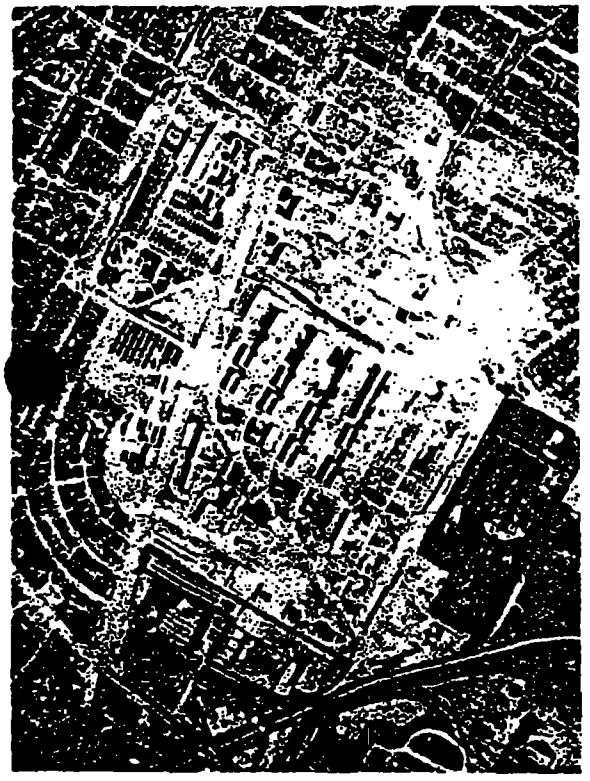
_____. 1978. Chronology and Documentary Handbook of the State of Missouri. Dobbs Ferry, NY: Oceana Publications.

Vidette, Eugene. 1918. A History of Missouri. Boston: D. C. Heath.

Westmore, Alphonso. 1975. Gazeteer of the State of Missouri. New York: Arno Press.



AERIAL VIEW—LOOKING EAST (CORE PLANT ON EXTREME RIGHT)



VERTICAL VIEW

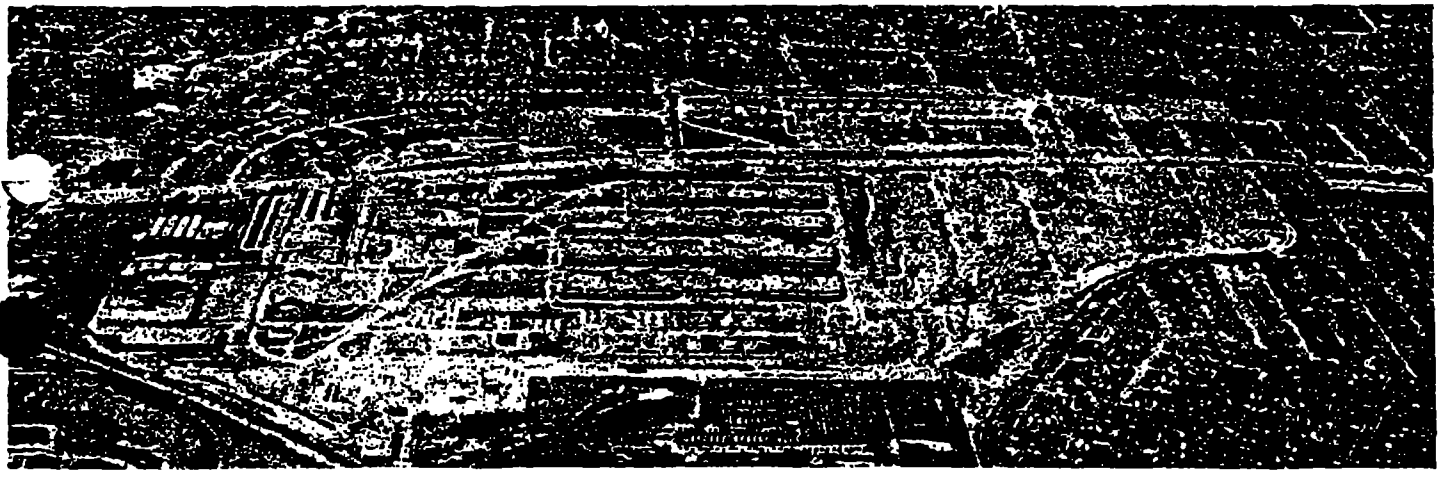
ARMOR PIERCING CORE PLANT

ST. LOUIS, MISSOURI

KNOWN AS
ST. LOUIS ORDNANCE PLANT AND
ARMOR PIERCING CORE PLANT

AVAILABILITY AND DISPOSAL
INFORMATION THROUGH

RECONSTRUCTION FINANCE CORPORATION



AERIAL VIEW—LOOKING WEST (CORE PLANT ON EXTREME LEFT)

AP-110A

AVAILABILITY AND DISPOSAL INFORMATION

through

RECONSTRUCTION FINANCE CORPORATION

811 Vermont Avenue, N. W.

Washington 25, D. C.

LOCATION: 4014 Siemers Lane, St. Louis, Missouri.

PLANT: Land, buildings, machinery and equipment. Project designed for production of .30 cal. and .50 cal. armor piercing cores.

The Core Plant is equipped for manufacturing of screw machine products and includes heat-treating facilities. The project is adaptable to other manufacturing of a light, medium, or heavy nature.

See Brochure AP-110 for adjoining Small Arms Plant.

LAND: About 12 acres.

BUILDINGS: Total area about 304,000 sq. ft.

Core Plant—Total area 190,300 sq. ft.

Basement—29,500 sq. ft. Clearance 10'6" and 34'9".

First Floor—142,300 sq. ft. Clearance 22'9" and 10'6".

Second Floor—12,500 sq. ft. Clearance 11'9".

Third Floor—6,000 sq. ft. Clearance 10'.

Concrete basement floor. Concrete first floor (beam and slab design over basement). Second and third floor reinforced concrete. Finish on first floor about 70% wood block, 20% cement balance grating or asphalt tile. Structural steel framing and trusses. Brick exterior walls. Precast concrete slack deck, built-up roofing Fluorescent lighting. Steam unit heaters, and radiators. Sanitary and locker facilities. Cafeteria seating about 270.

Warehouse—One story and mezzanine. First floor 50,000 sq. ft., mezzanine 4,300 sq. ft. Total area 54,300 sq. ft. Clearance first floor 18' to 26'. Under mezzanine 10'3", in mezzanine 14'9". First floor concrete slab on ground. Mezzanine floor wood. Structural steel framing and trusses. Walls of wood studs with sheathing and siding. Wood deck on steel purlins. Built-up roofing. Fluorescent lighting. Sanitary and locker facilities. Steam unit heaters and radiators. Cafeteria for 72 people.

Furnace Building—Total area 49,800 sq. ft.

Basement—14,800 sq. ft. Clearance 12'.

First Floor—31,000 sq. ft. Clearance 18'9".

Second Floor—4,000 sq. ft. Clearance 9'.

First floor concrete. Second floor wood. First floor mostly wood block finish. Structural steel columns and trusses. Walls wood studs with sheathing and siding. Wood deck on steel purlins. Built-up roofing. Fluorescent lighting. Steam unit heaters, blast coils, radiators. Sanitary and locker facilities. Cafeteria for 60 people.

Laboratory—Total area about 4,700 sq. ft. Clearance 14'. Concrete floor, asphalt tile finish. Brick walls. Concrete deck, built-up roofing. Fluorescent lighting.

Storage Shed—Area about 3,400 sq. ft. Earth floor. Wood construction.

MACHINERY AND EQUIPMENT: *Production Equipment*—Includes 46 centerless grinders, 32 gauging machines, approximately 400 automatic screw machines, 29 Hydryzing furnaces, 2 washer machines, 4 wash, rinse, and dry machines; Chip conveyor system, Oil Coolers, air compressors, etc.

Machine Tools—About 100 items, including hydraulic surface grinders, lathes, millers, shapers, drill presses, etc.

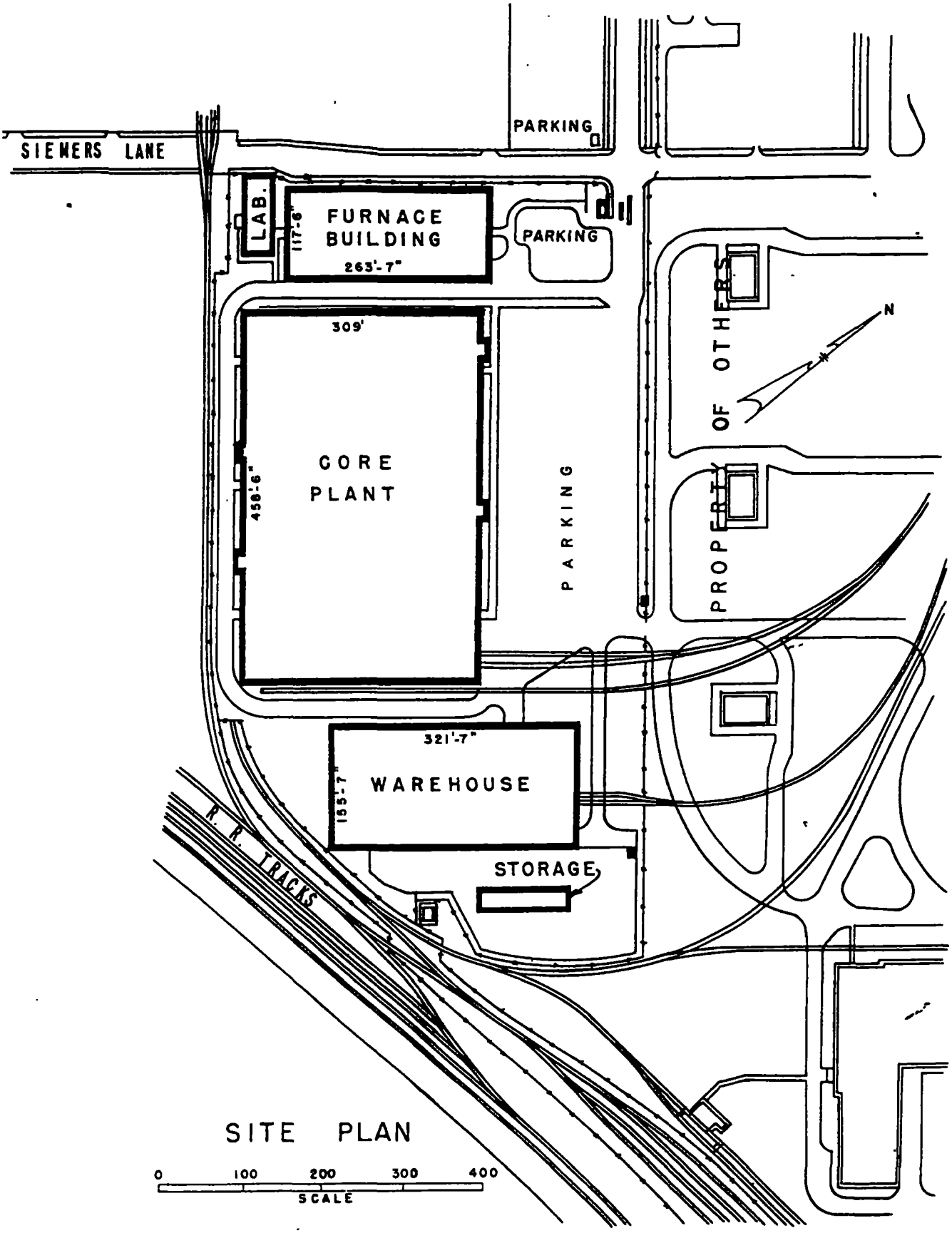
Furniture and Fixtures—Office furniture and equipment, factory furniture, hospital equipment, cafeteria equipment, etc.

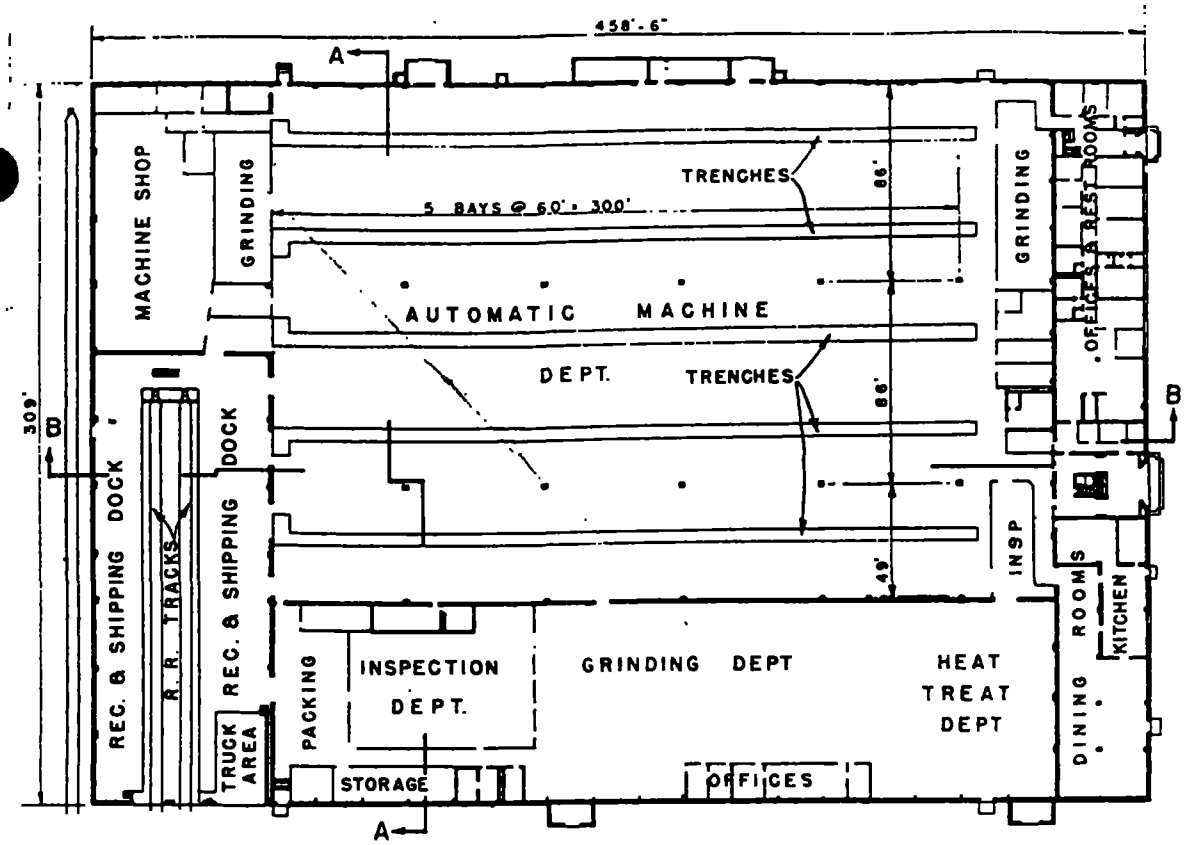
UTILITIES: Utilities from same source as and furnished through the facilities of the Small Arms Ammunition Plant adjoining, except sewers, which discharge into St. Louis System.

TRANSPORTATION: *Highways*—An adequate system of concrete roads connects the various units of the manufacturing plant and provides access to Goodfellow Avenue.

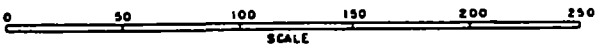
Railroad—Principal buildings of the Core Plant and of the Small Arms Plant are served by a plant railway system, having a total trackage of about five miles and capacity of 249 cars. System connects to the Terminal and Wabash Railroads.

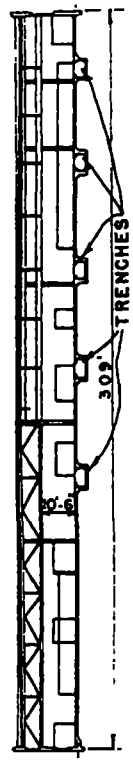
THE INFORMATION CONTAINED HEREIN IS BELIEVED TO BE CORRECT, BUT NO GUARANTEE THEREOF IS MADE.


SIEMERS LANE
PARKING
LAB.
117'-6"
FURNACE BUILDING
263'-7"
PARKING
309'
CORE PLANT
458'-6"
PARKING
PROPERTY OF OTHERS
N
321'-7"
WAREHOUSE
155'-7"
STORAGE
R. R. TRACKS
SITE PLAN
0
100
200
300
400
SCALE

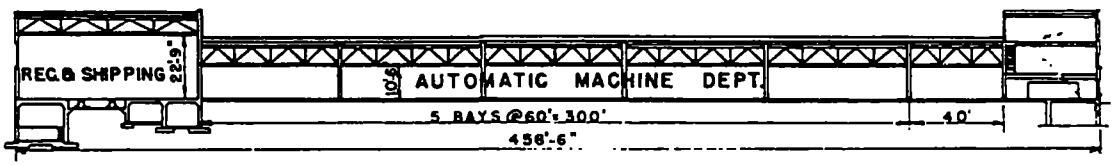


FIRST FLOOR PLAN
CORE PLANT





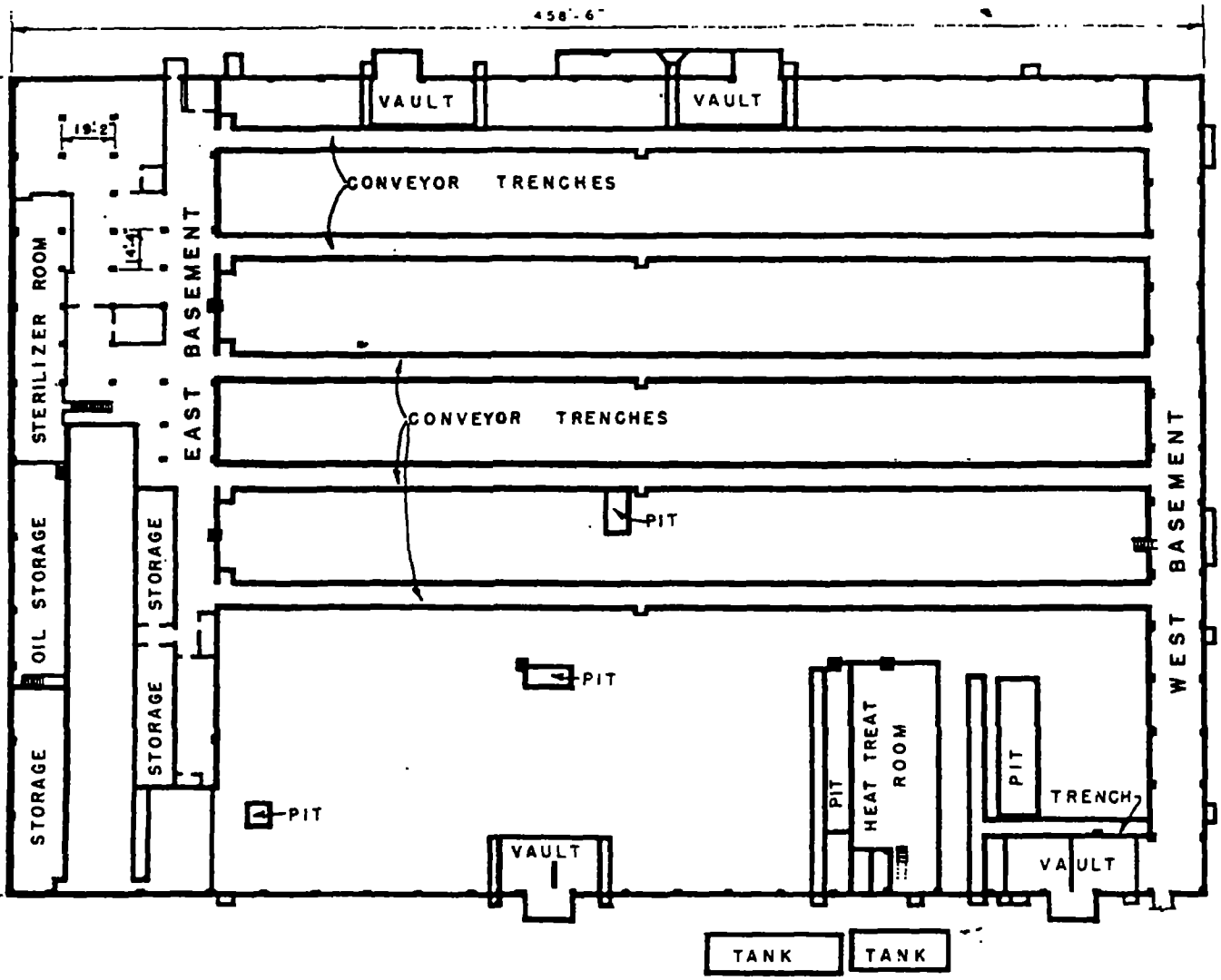
SECTION A-A



SECTION B-B

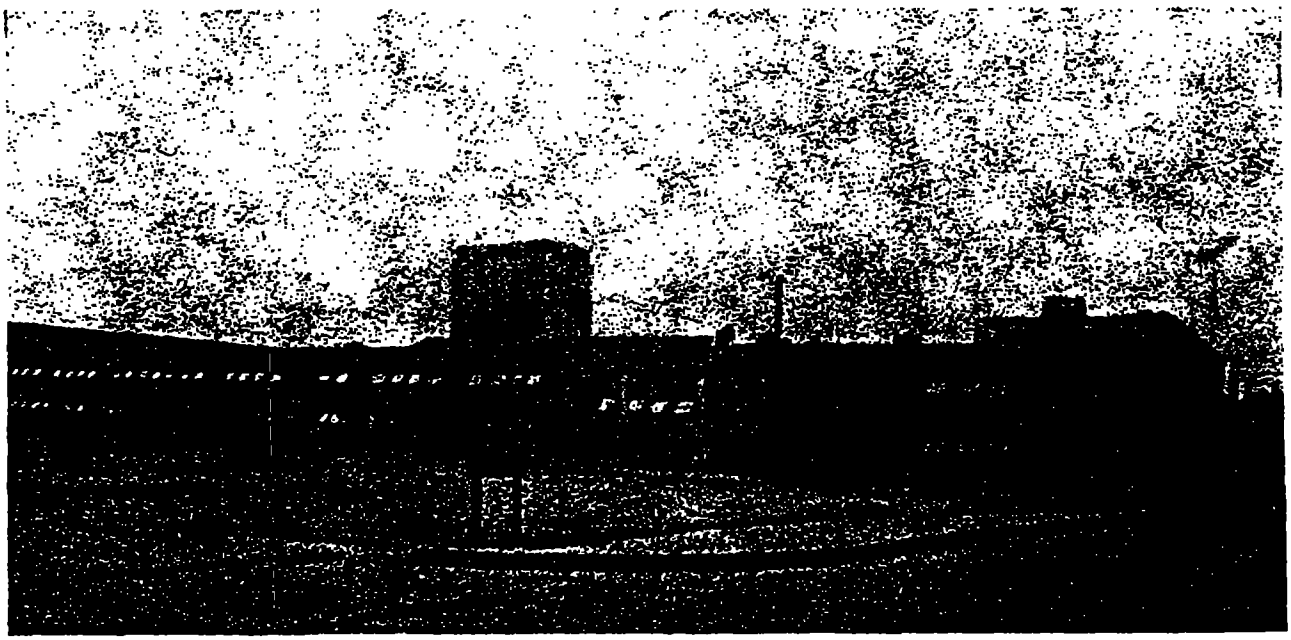
INTERIOR—CORE PLANT INSPECTION ROOM

SECTION A-A

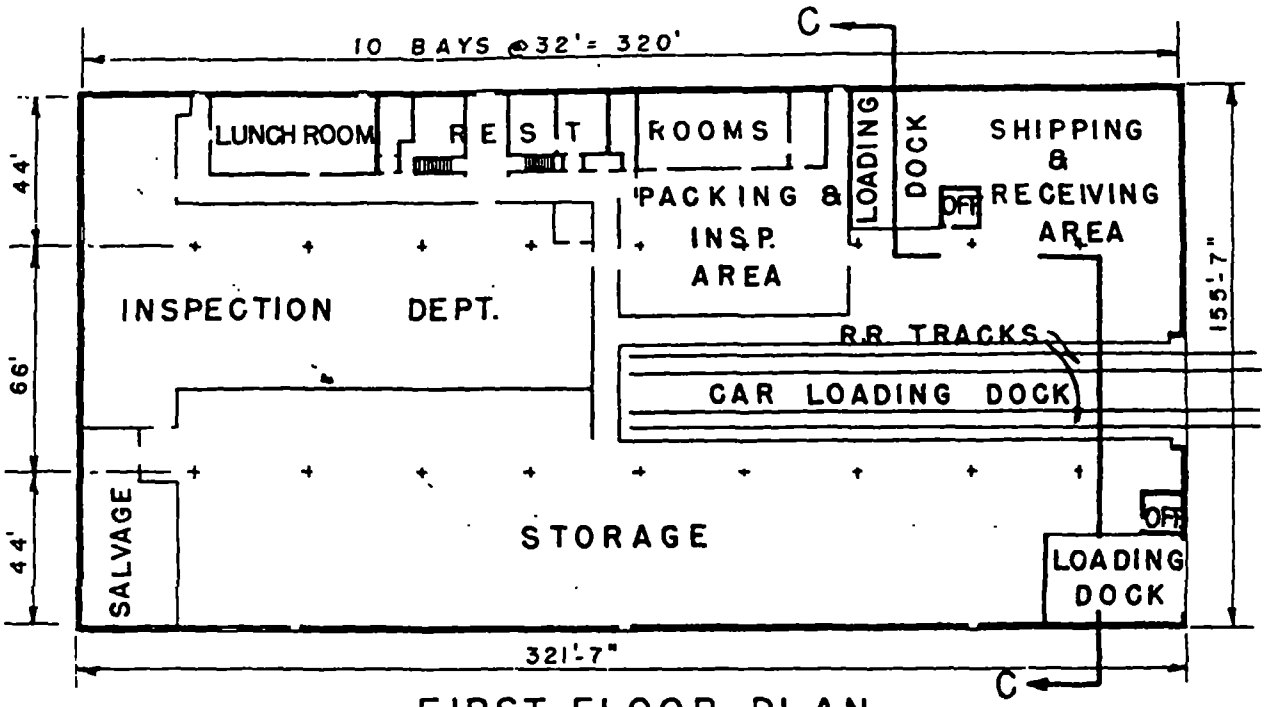


BASEMENT PLAN-CORE PLANT

0 50 100 150 200 250
SCALE

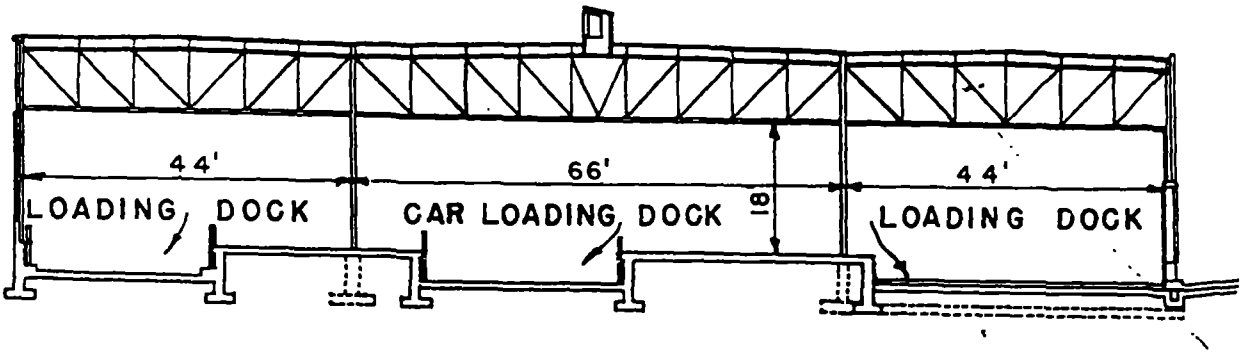


CORE PLANT

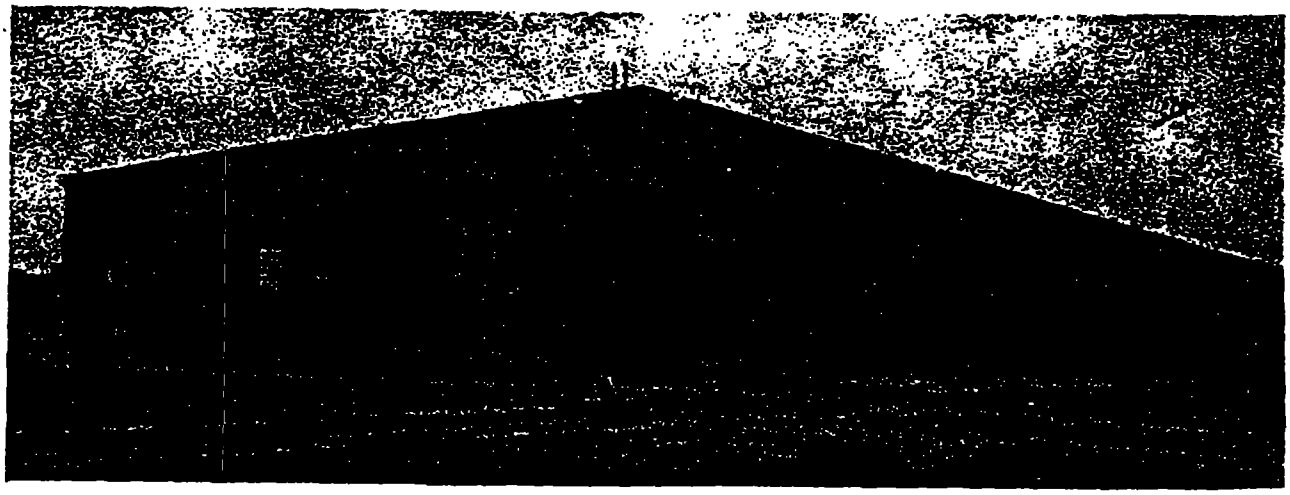


FIRST FLOOR PLAN
WAREHOUSE

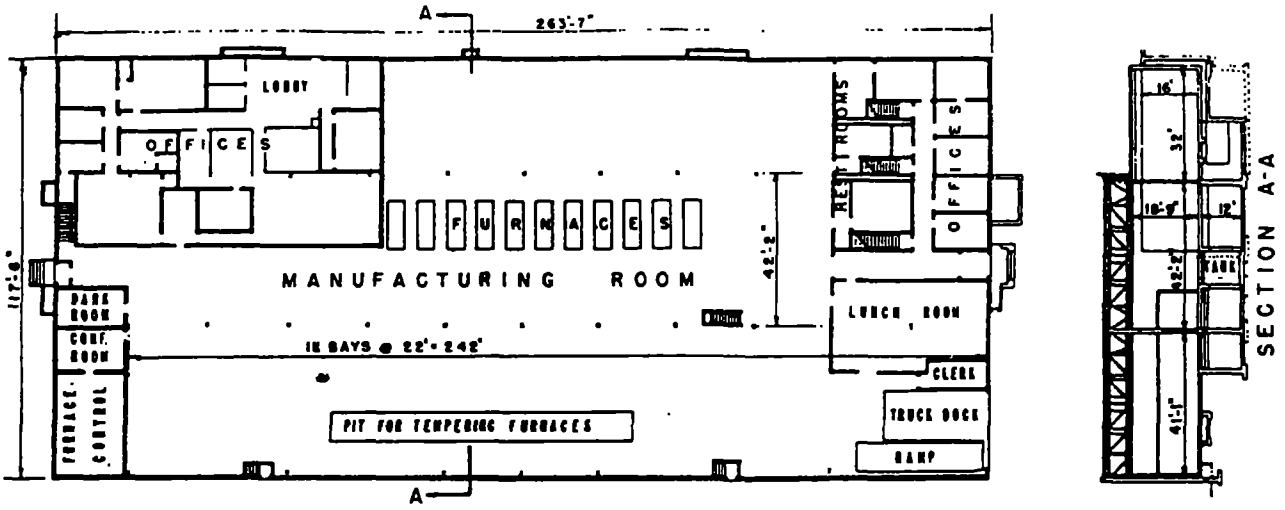
0 50 100 150 200
SCALE



SECTION C-C

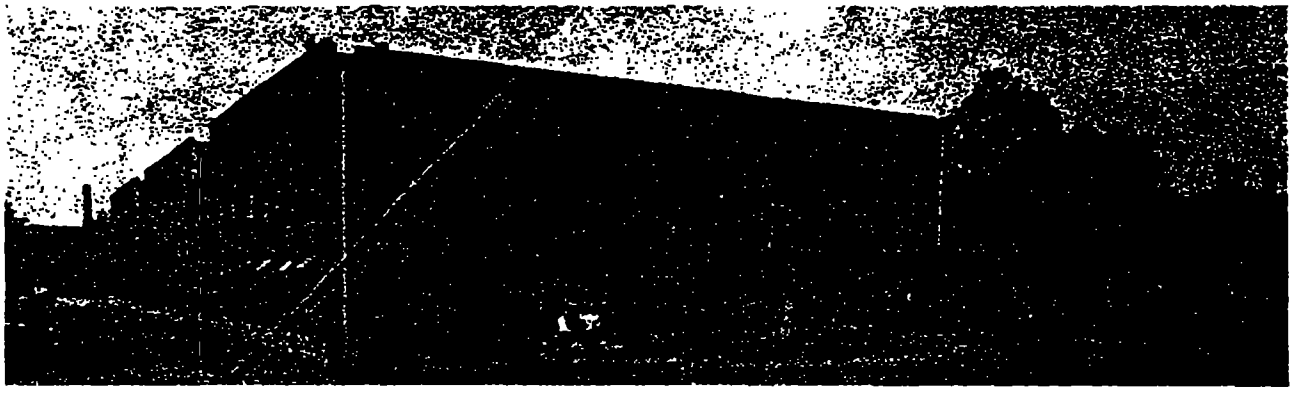


WAREHOUSE



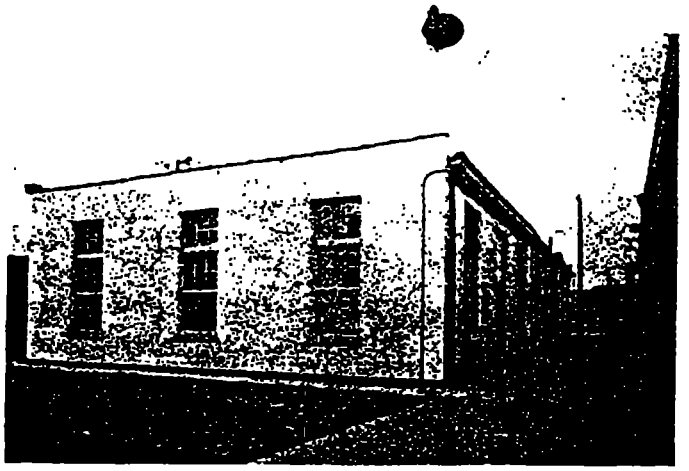
FIRST FLOOR PLAN
FURNACE BUILDING

0 20 40 60 80 100 120 140
SCALE



FURNACE BUILDING

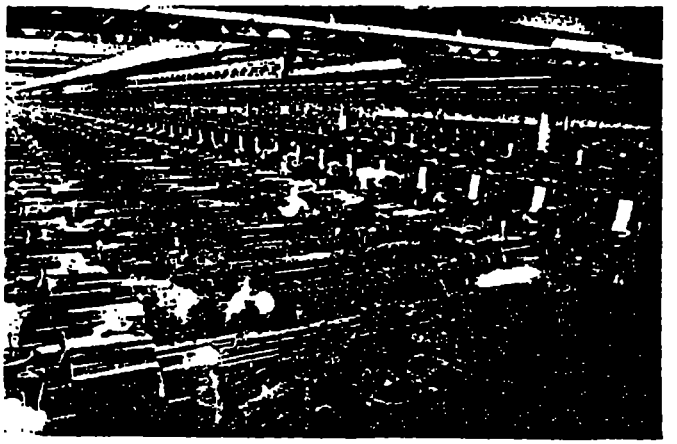
INTERIOR—FURNACE BUILDING



LABORATORY BUILDING

INTERIOR—LABORATORY BUILDING

INTERIOR—CORE PLANT TOOL AND DIE SHOP



INTERIOR—CORE PLANT SCREW MACHINE ROOM

INTERIOR—WAREHOUSE—PACKING INSPECTION ROOM

SMALL ARMS AMMUNITION PLANT
INDUSTRIAL DEVELOPMENT MASTER PLAN

I. INTRODUCTION

A. General

The following pages of this report represent the culmination of a seven month program directed toward preparation of a master plan for the remaining, unused/underused portions of the former Small Arms Ammunition Plant located in the northwest portion of the City of St. Louis. It is the intention of the City of St. Louis under auspices of the Planned Industrial Expansion Authority (PIE) to redevelop and recycle these four tracts of land for industrial purposes thereby creating new job opportunities for City residents.

This report is organized into several general sections which set forth the material about the project area and planning proposals. These sections are:

Introduction
Review of Existing Conditions
Alternative Planning Proposals
Development Plan
Implementation
Summary and Conclusions
Appendices
Plates

It should be noted that the data, findings, and/or recommendations contained herein do not represent the total work which has comprised the plan development. Booker project team members spent many hours coordinating various elements of the project with the PIE staff and with other City, State, and Federal agencies. Equally substantial time was devoted to discussions with area property owners/occupants and to interviews with area industries who the project team and PIE staff felt would be prime candidates for locating on the sites which would be available as a result of implementation of the plan.

A major caution regarding the use of this report should be stressed. Ammunition manufacturing processes are by nature somewhat complex. Because of this, the original design of the facilities at the Small Arms Ammunition Plant included not only a diverse variety of building types, but also a maze of utilities and service tunnels which interconnect throughout the overall site. The total area was constructed over a relatively short period of time and therefore, although plans for construction "as-built" exist, there is some question as to their actual validity. Since the major portion of the plant ceased operation after portions were briefly reused

during the Korean War, many of the building and land areas were sold to the various industries and governmental agencies who now occupy them. During these earlier redevelopment efforts, many additional utility and building alterations have been made. For master planning purposes, data were collected regarding these factors to the extent that the information was readily available and apparent. Planning recommendations and cost estimates which were developed for the master plan are therefore relative to the accuracy of these data. Final engineering design for the project will involve actual field investigation of these factors. To the extent that other information is uncovered, the planning recommendations and cost estimates which are contained in this report, may be altered to reflect these findings.

B. Background and History

The St. Louis Army Ammunition Plant was constructed in 1941 in preparation for United States involvement in World War II. Ground was broken on March 28th of that year. On October 20, only seven months later, cartridge component production started. The plant's function was the manufacture of 30 and 50 caliber cartridge components and assembly of the components into finished cartridges. These functions were conducted under contract with the Western Cartridge Company. At its peak of production, from 1941 to 1944, some 40,000 workers were employed at the plant, working around the clock. The majority of these employees were women. At the end of World War II, the plant was deactivated until the beginning of the Korean War in 1951. During this inactive period, much of the plant was modified for the manufacture of 105 mm. shells, the production of which was contracted to Chevrolet Division of General Motors. It was these larger shells that were produced when the plant was reactivated during the Korean War.

The plant was again deactivated in 1954. Much of the property was declared surplus by the Army and came under control of the General Services Administration (GSA). Since that time, the property surrounding the present day plant began to be sold off in a piece-meal fashion. The remaining plant was again reactivated from 1966 to 1969 for the Vietnam War, again for the production of 105 mm. shells by Chevrolet. In 1971, Chevrolet closed its contract with the Army, and by 1972, Donovan Construction was contracted for maintenance and updating of the plant and its equipment so that it can be reactivated at any time.

Today, a variety of new tenants occupy the former Plant site. They vary widely in the nature and scope of their operations. Because they are described in Section II of this report, no discussion of them is provided here. The significant factor to note is that the four tracts within the Plant site which are the subject of this master plan are the key remaining parcels. If PIE is successful in redeveloping these parcels with new industries or expansion of those in the area, then almost total recycling of the Plant site will have been achieved. The only portions of the site which have future potential for redevelopment are those areas which are