ED75-2

INSTRUCTOR MANUAL
INDUSTRIAL HYGIENE CHEMISTRY COURSE

LESSON NUMBER 2

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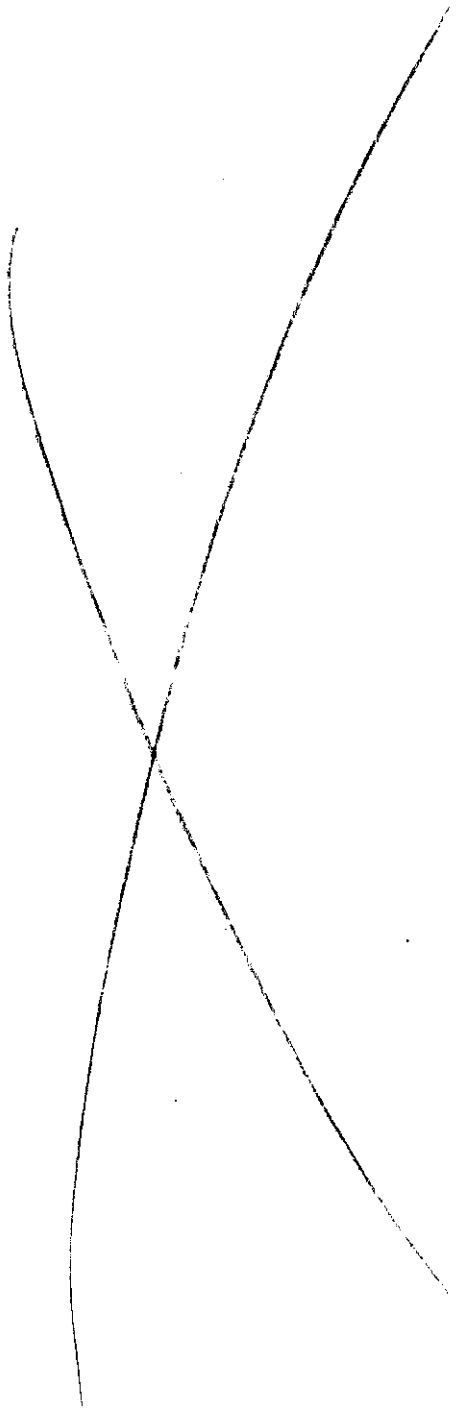


INTRODUCTION

This Instructor Manual has been prepared for industrial hygienists and analytical chemists participating in the National Institute for Occupational Safety and Health's Regional Training Program. The purpose of this Manual is to assist these professionally qualified, but possibly inexperienced, instructors in the preparation and conduct of a one-week "Industrial Hygiene Chemistry" course. This Manual will guide instructors through both lecture and laboratory lessons. It is complemented by a matching Student Manual. The course is recommended for students having, as a minimum, an undergraduate degree in chemistry (or its equivalent) along with at least one year's experience in instrumental analysis.

It is not necessary for instructors to have had prior teaching experience although such experience would be desirable. All instructors should be thoroughly familiar with industrial hygiene chemistry procedures, instruments and equipment relevant to the subject areas they will teach. In addition, each instructor should attend the course director's orientation seminar presented before the start of each one-week "Industrial Hygiene Chemistry" course.

The remainder of this introduction describes the course objectives, lessons, and the organization and format of the documentation in each lesson, including lecture and laboratory lesson plans.

Course Objectives

The following course objectives will be attained by graduates of this program:

- Given a particular chemical health hazard commonly found in the occupational environment, the trainee will be able to select an appropriate sampling strategy using available sampling techniques and to select a corresponding appropriate analytical method for quantitative characterization of the sample by using his knowledge gained from the course and technical information referenced in the course.

- Trainee will be able to apply his knowledge of wet chemical and/or instrumental analysis in employment of current methodologies for evaluating the typical work environment.

- Trainee will be able to perform and evaluate quantitative analytical determinations for four classes (types) of hazardous substances using a correspondingly different method for each class or type.

- Given the analytical results obtained through proper measurement procedures, the trainee will be able to define the data in terms of actual environmental concentration levels and to interpret the results in light of existing exposure standards.

Lessons

18 lessons are presented in this course:

- Introduction to Course
- Introductory Topics
- Direct Reading Instruments
- Air Flow Calibration and Sampling
- Ion Selective Electrode Laboratory
- Introduction to Spectrophotometry
- Instrumentation and Application of Spectrophotometry
- Colorimetric Determination of Free Silica (Quartz) Laboratory
- Introduction to Spectroscopy
- Atomic Absorption Spectrometry
- Atomic Absorption Spectrometry Laboratory
- Introduction to Chromatography
- Insturmentation and Application of Chromatography
- Gas Chromatography of Organic Solvents Laboratory
- Titrametric Determination of SO_2 Laboratory
- Colorimetric Determination of SO_2 Laboratory
- Biological Monitoring
- Related Topics

Lectures

Each lesson that is to be presented as a lecture is documented in a standardized format.

A. Lecture Cover Sheet

A cover sheet for each lecture presents the following information:

- Lesson title
- Lesson number and length
- Behavioral objective
- Scope of the lesson
- List of visuals
- List of exhibits
- List of equipment needed for the lesson

B. References

After the cover sheet, there is a list of references. These references are keyed to the paragraphs within each lesson. The number in parenthesis following each paragraph is the reference number. These references are included so that the instructor, if he wishes, may further research specific instructional subject matter.

C. Additional Readings

Following the reference list, in most lessons, is another listing called "Additional Reading." This bibliography contains books and articles which are generally pertinent to the subject area covered in this lesson. These are considered as important secondary reference sources.

D. Expanded Outline (left-hand page)

On the left-hand page, beginning after the Additional Readings section, is an expanded outline. This outline indicates the information that should be emphasized and covered during the lecture. The sequence of the outline should be followed during

teaching. The expanded outline gives sufficient information to explain the brief outline which is on the right-hand page. All test questions (both self tests and course evaluator) come from the expanded outline. Additionally, there are descriptions of the visuals within the outline.

E. Brief Outline (right-hand page)

This page consists of a notes column and the outline.

1. Notes Column - times (both elapsed and projected) are indicated in this column. The elapsed time designates the time it should take the instructor to reach this point in the lecture starting from 0 at the beginning of each lecture. The elapsed time is in parentheses. The projected time designates the time it should take the instructor to reach the next major portion of the outline. A major portion of an outline is designated by a capital letter in the outline. In addition, transitional phrases connecting the major outline portions are included in the notes column. These phrases are to assist the instructor in bridging from one section of the outline to the next. Notations of what visual, exercise, table, etc., should be introduced at a given point in a lesson and miscellaneous notes to the instructor are contained also in this column.

2. Outline - this is a brief outline corresponding to the expanded outline on the facing page. Words and phrases in the brief outline key the instructor to the lesson's subject content and to the expanded outline on the left-hand page. There is sufficient space between the key words in the brief outline for the instructor to write his own additional notes when he is preparing his lecture.

F. Exercises and Problems

In some lessons, exercises and problems are included. These are given during class time. The answers to the problems are worked out with students after they have had an initial try at completing them on their own. Answers are provided in the Instructor Manual.

G. Self Tests

Self tests are included after most lessons. The Instructor Manual contains the correct answers, whereas the Student Manual does not. The students should first answer the questions, and then the instructor should review the answers, explaining fully the reasons for the correct answers. The self tests are not scored by the instructor and no records are kept of the individual student's performance. The instructor should use the information from the discussion of self tests to remove student misunderstandings or lack of understanding.

H. Copies of Visuals

Copies of visuals that are to be shown in a lecture are included at the end of that lesson documentation. These can be useful in preparing for the lecture presentation.

I. Homework

No specific homework assignments are included within the lesson documentation. However, there is a great quantity of information for the students to absorb during this one-week course. Therefore, students should be urged to review nightly all lessons covered during the day and all lessons to be presented on the following day. In particular, they should become familiar with the laboratory procedures for the following day. There is much to be accomplished in every laboratory and little time to do it. If the students are familiar with the procedure, the laboratory experiments will progress much more smoothly.

Laboratories

Each lesson that is to be presented as a laboratory is documented in standardized format consisting of four elements.

A. Laboratory Cover Sheet

A cover sheet for each laboratory presents the following information:

- Lesson title
- Lesson number and length
- Behavioral objective
- Scope of the lesson
- List of equipment, apparatus and forms

B. Special Preparation Section

This section will follow the laboratory cover sheet, and includes specific directions that must be followed prior to actual class time. These instructions are concerned with the preparation of apparatus, facilities, chemicals and materials that are necessary for the laboratory session.

C. Laboratory Procedures

The procedures for performing each laboratory are fully documented on the left-hand page. The elapsed and projected times are indicated for some lessons with the elapsed times appearing in parentheses. The right-hand page is a blank page for notes on specifics of the laboratory to aid the individual instructor in giving an efficient lesson.

D. Figures and Forms

Equipment figures and student forms are included after the procedures. The figures are presented to aid the instructor in setting up the experimental equipment. The forms are to be used by the students during the laboratory to assist them in recording, calculating and analyzing data.

LESSON TITLE	LESSON NUMBER	LESSON LENGTH
Introductory Topics	2	0:50

BEHAVIORAL OBJECTIVE

The student will be able to describe Threshold Limit Values, laboratory quality control and accreditation.

SCOPE

The TLV concept
Quality control
Laboratory accreditation

VISUALS	EXHIBITS
2-1 through 2-10	None

EQUIPMENT

Overhead projector
Screen
Blackboard
Chalk

REFERENCES

LESSON TITLE

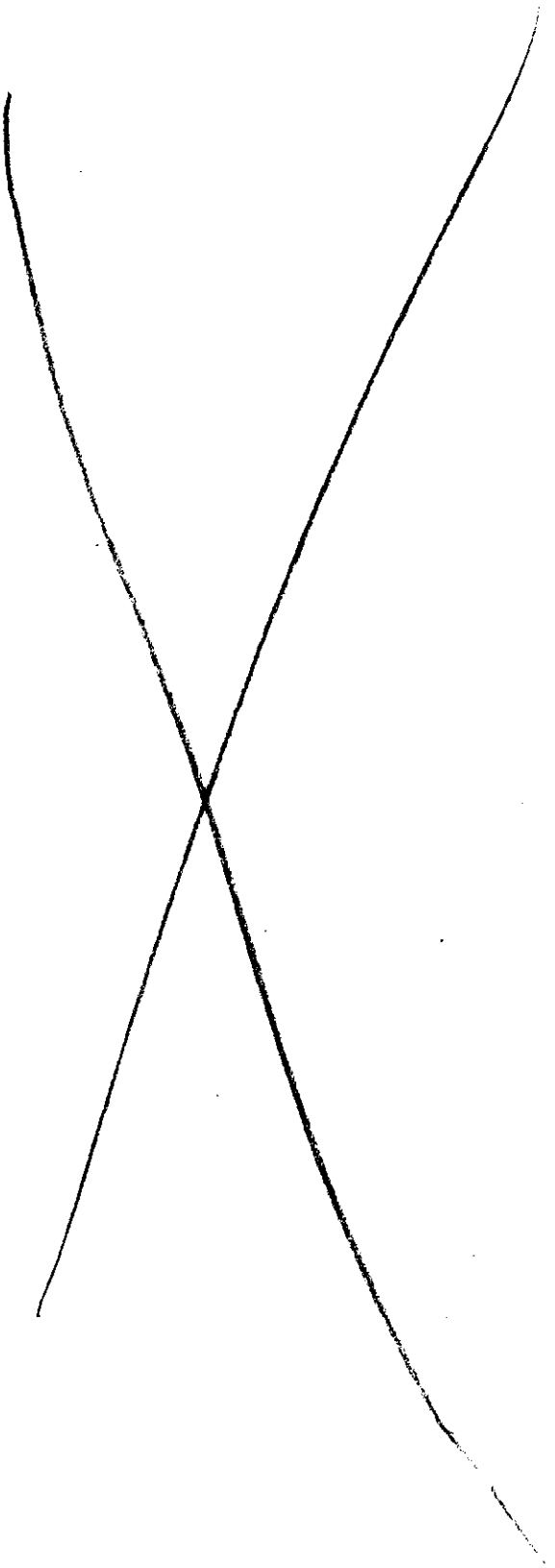
Introductory Topics

1. American Conference of Governmental Industrial Hygienists. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Changes for 1974, Cincinnati, Ohio (1974).

2. American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values for Substances in Workroom Air, 3rd ed., Cincinnati, Ohio (1971).

3. U. S. Department of Health, Education and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health. The Industrial Environment--Its Evaluation and Control, U. S. Government Printing Office, Washington, D. C. (1973).

4. Cralley, Lewis J. Guideline for Accreditation of Industrial Hygiene Analytical Laboratories, American Industrial Hygiene Association Journal, 31, (May-June, 1970).



TITLE	LESSON NUMBER
Introductory Topics	2

A. The TLV Concept

1. Threshold Limit Values (TLV's) represent conditions under which it is believed nearly all workers may be repeatedly exposed 8 hours per day day after day, without adverse effect. This is based on a 40-hour work-week. TLV's are to be used as guides to control health hazards. However, individual susceptibility needs to be considered. Due to the wide variation in susceptibility, a small number of individuals experience discomfort or harm below the TLV levels. The individuals who are hypersensitive should be identified, and their contact with these substances should be minimized or completely eliminated. (1)

2. The basic premise of the of the TLV's is that most chemical substances are toxic at some concentration experienced for some period of time, a concentration usually exists for substances which produce no detectable biological damage. Toxicity sometimes is measured as a response to dosage. Dosage is the amount of energy or substance in a unit volume, individual or organ. Threshold limits are based on the best available information from industrial experience, experimental studies with humans, and animal studies. They are developed and published by the American Conference of Governmental Industrial Hygienists (ACGIH). The bases for individual threshold limit values should be consulted in the companion document to the TLV's entitled, Documentation of the Threshold Limit Values for Substances in Workroom Air. (1, 2)

3. TLV roots originated in the 1920's when NIOSH predecessor organizations began developing such standards based on epidemiologic investigations and animal studies. In 1938, ACGIH was founded and, shortly after, this organization began establishing Maximum Allowable Concentrations (MAC's). Although other organizations were also developing MAC values, the ACGIH became the recognized authority for threshold limits. TLV's are now officially federal standards and have been published in the Federal Register.

NOTES	Times (elapsed) projected	LESSON OUTLINE
	(---) 0:15	A. The TLV Concept 1. Individual susceptibilities to hazardous substances vs. TLV's 2. Premise, basis, developer of TLV's 3. TLV history--MAC, ACGIH, official standards

4. Visual 2-1 is the formula for calculating a time-weighted average for an eight-hour period.

5. Time-weighted averages permit excursions above the limit, provided they are compensated by equivalent excursions below the limit during the work day. Degree of the permissible excursion is related to the magnitude of the threshold limit and other factors. (Visual 2-2). Time-weighted averages are inappropriate for some substances (e.g., fast acting). Substances of this type are best controlled by a ceiling "C" limit that should not be exceeded. (Visual 2-3). (1)

6. Substances listed with the designation "Skin" preceding TLV are those which may contribute to overall exposure by the cutaneous route including mucous membranes and eye, either by airborne or direct contact. The purpose of this "skin" designation is to prevent absorption through this route and, thereby, possibly invalidating the TLV. (1)

7. TLV's for most mineral dust are expressed in "m.p.p.c.f." which indicates millions of particles per cubic foot of air. For some substances TLV can be expressed as mg./m.^{3}. Nuisance particulates have little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. (Visual 2-4). A nuisance particle is one which allows the following:

   - Architecture of the air spaces in the lung remains intact.
   - Collagen (scar tissue) is not formed to a significant extent.
   - Tissue reaction is potentially reversible. (1)

NOTES	Times (elapsed) projected	LESSON OUTLINE
Visual 2-1		4. TLV formula
Visual 2-2, Visual 2-3		5. Excursions and ceiling limits
		6. "skin"--meaning, purpose
Visual 2-4		7. TLV's for particulates; nuisance particles:
		. Air space--intact
		. Collagen not formed
		. Tissue reaction--reversible

8. Carcinogens include substances in industrial use which have induced cancer in man or have induced cancer in animals under experimental conditions. Four categories are currently identified: (Visual 2-5).

   - Human carcinogens which include occupational carcinogens with an assigned TLV (e.g., asbestos)

   - Human carcinogens which include occupational carcinogens without an assigned TLV (e.g., benzidine)

   - Human carcinogens awaiting reassignment of TLV due to new evidence in regard to carcinogenity

   - Experimental carcinogens include industrial substances found to be of high potency in inducing tumors under experimental conditions in animals (e.g., beryllium). (1)

9. The human carcinogens without TLV's should not contact the worker at all. The worker should not be exposed by any route (respiratory or cutaneously). This is determined by the most sensitive detection methods currently available. Workers should not be exposed to the experimental carcinogens above the levels consistent with the available experimental evidence except in the cases of substances with TLV's already established. (1)

10. Threshold Limit Values for mixtures of two or more substances should consider a combined effect, as indicated in Visual 2-6. In the absence of information to the contrary, the effects should be considered additive. Some substances may not be additive, but they may be independent as when purely local effects on different organs of the body are produced by the various components of the mixture. Antagonistic action or potentiation may occur with some combinations of atmospheric or physical conditions. (1)

NOTES	Times (elapsed) projected	LESSON OUTLINE
Visual 2-5		8. Four categories of carcinogens: . Human with TLV . Human without TLV . Human awaiting TLV . Experimental 9. Amount of exposure permitted with carcinogen
Visual 2-6		10. Combined effect of more than one substance

11. TLV's are to be used as guides in the control of health hazards and do not represent fine lines between safe and dangerous concentrations. Concentrations above TLV's are considered unsafe. Concentration just below TLV's may not be totally safe either, depending upon the circumstances of the exposure, the frequency of the exposure and the people being exposed. The standards assume exposure of the healthy adult worker. Standards cannot be applied to population of all ages and in varying states of health. High variation in individual susceptibility must be borne in mind. Amount and nature of information on which TLV is based varies from substance to substance. However, they are based on the best information available from experience in industry, human and animal experimentation. Latest documentation should be consulted. TLV's are intended for use in practice of industrial hygiene and should be interpreted and applied only by persons properly trained. TLV's cannot be used as a relative index of hazard or toxicity (i.e., they do not represent a common denominator of toxicity). TLV's cannot be used in the evaluation of air pollution nuisances. TLV's cannot be used in estimating the toxic potential of continuous, uninterrupted exposures. (1)

B. Quality Control

1. The measurement of physical entities such as length, volume, weight, electromagnetic radiation and time involves uncertainties which cannot be eliminated entirely, but when recognized can be reduced to tolerable limits by meticulous attention to detail and close control of the significant variables. In addition, errors, often unrecognized, are introduced by undesirable physical or chemical effects and by interferences in chemical reaction systems. In many cases, absolute values are not directly obtainable; therefore, standards from which the desired result can be obtained by comparison must be established. Errors are inherent in the measurement system. Although the uncertainties cannot be reduced to zero, methods are available by which reliable estimates of the probable true value and the range of measurement error can be made. (3)

NOTES	Times (elapsed) projected	LESSON OUTLINE
		11. Caution with TLV's: guides, below not totally safe, healthy worker, individuality, used by those trained, no hazard index, not for pollution, not for continuous exposure
(Transition A.-B.) From TLV's to quality control.	(0:15)	B. Quality Control
	0:15	1. Reduction of errors to tolerable levels

2. A quality control program concerned with sampling and laboratory analysis is a systematic attempt to assure the precision and accuracy of future analysis by detecting determinate errors in analysis and preventing their recurrence. Confidence in the accuracy of analytical results and improvements in analysis precision are established by identification of the determinate sources of error. The precision will be governed by the indeterminate error inherent in the procedure and can be estimated by statistical techniques. For a result to be accurate, the procedure must not only be precise, but must also be without bias, i.e., deliver the correct result. Quality control programs should cover instrumental control as well as total analysis control. The use of replicates provides assurance that the procedure will remain in statistical control. (3)

3. A numerical value of an analysis for which the range of uncertainty inherent in the method has not been established, cannot be reliably considered a reasonable estimate of the true or actual value. The basic quality control program incorporates the concepts of:

   - Calibration to attain accuracy

   - Replication to establish precision limits and range

   - Correlation of quantitatively related tests to confirm accuracy, where appropriate. This test implies analysis of a sample by two or more basically different procedures to confirm the true result as the determination of free silica in dust by x-ray diffraction, infrared absorption and the colorimetric wet chemical method. (3)

NOTES	Times (elapsed) projected	LESSON OUTLINE
		2. Quality control program--description, errors, statistics
		3. Quality control program contains:
		. Calibration
		. Replication
		. Correlation of quantitative methods

4. Evaluation of overall effectiveness of the quality control program encompasses a number of parameters:

   - Equipment and instruments
   - The current state of the art
   - Expected ranges of analytical results
   - Precision of the analytical method itself
   - Control charts to determine trends as well as gross errors
   - Data sheets and procedures adapted for control of sample integrity in the laboratory
   - Quality control results on a short term as well as an accumulated basis (3)

5. The manipulative operations which are directly influenced by quality control include:

   - Sampling techniques
   - Preservation of sample integrity (identification, shipping and storage conditions, contamination, desired component losses, etc.)
   - Aliquoting procedures
   - Dilution procedures

NOTES	Times (elapsed) projected	LESSON OUTLINE
		4. Evaluation of effectiveness: . Equipment . State of the art . Range of results . Precision . Control charts . Procedures for sample integrity . Short term 5. Manipulative operations affecting quality control: . Sampling . Sample integrity . Aliquoting . Dilution

- Chemical and physical concentration, separation and purification

- Instrument operation (3)

6. Precision is evaluated by repetitive analysis of the same sample and is based on the deviation of the results from the average of all results, and on the range--the difference between the highest and lowest results. In all cases, where the analyzed substance and its matrix are stable for an extended period, a reference sample should be set aside and analyzed repeatedly along with samples collected in the field. After a number of replicate results--usually 8 to 10--have been obtained, a tentative mean, standard deviation and range can be calculated and plotted on a quality control chart. (3)

7. The analysis of lead in blood can serve as an example. A pint bag of outdated blood obtained from a blood bank was thoroughly mixed and 10 gm. aliquots transferred to "vacutainer" tubes. One of the tubes was included in each batch of 20 blood samples analyzed by the dithizone procedure. The results were averaged and standard deviation (sigma or σ) calculated from the equation:

$$\sigma = (\Sigma (x - \bar{x})^2 / (n-1))^{1/2}$$

where: x = observed result

$\bar{x}$ = mean of all results

n = number of determinations

Σ = sum of $(x-\bar{x})^2$

The Gaussian curve of frequencies of normal distribution (Visual 2-7) of results indicates that 68.3% of the results will fall within $\pm 1\sigma$, 95.5% within $\pm 2\sigma$, and 99.7% within $\pm 3\sigma$. The usual control limit is $\pm 2\sigma$ or 95% confidence limits. Visual 2-8 illustrates the data obtained from such a study. In this case, the results are expressed

NOTES	Times (elapsed) projected	LESSON OUTLINE
		. Concentration, separation, purification
		. Instrument operation
		6. Precision--description, use
Visual 2-7, Visual 2-8		7. Lead in blood example, standard deviation

in total micrograms lead/10 gm. sample and plotted versus consecutive results (in days). The control limits were set at $\pm 2\ \sigma$, and the analyst submitting the results indicated it to disclose possible determinate error. Two results in a "set" of 19 were out of control, and a trend from the eighth to fifteenth day was corrected by review of reagent quality. (3)

8. A range chart also provides useful information relative to precision. The use of range (R) in place of standard deviation (σ) is justified for limited sets of data (n less than 10) since R is approximately as efficient and is easier to calculate. (3)

9. The control chart is actually a graphical presentation of quality control efficiency. If the procedure is in control, the results will fall within the established control limits. Further, the chart will disclose trends and cycles from assignable causes which can be corrected promptly. The spiking technique probably is the most expedient and direct approach to accuracy control. As an example, the determination of lead in blood will be referred to again. In addition to analyzing an aliquot of the reference sample for precision control, a second aliquot is spiked with a known quantity of lead nitrate standard and the recovery posted on a control chart as % recovery. (Visual 2-9).

$$\% \text{ recovery} = \frac{(\text{Total Weight of Pb found} - \text{Wt. Pb in the original blood}) \times 100}{\text{Weight Pb in standard added}}$$

In this case the upper and lower control limits were set arbitrarily to conform with acceptable performance based on the end use of the data collected. Several trends will be noted: downward from day 3 to day 5, thence upward to day 9, then downward again to day 14. Corrective action was indicated in each case. Further examination will disclose the significant effect of the variations in the background lead analysis (precision chart) on the 5% recovery performance. (3)

NOTES	Times (elapsed) projected	LESSON OUTLINE
		8. Range--description, use
Visual 2-9		9. Control chart--description, use, example

10. In all cases where the material from which the offending substances was derived can be obtained, bulk samples should be analyzed before airborne samples are analyzed to determine matrix effects and identify interferences. This precaution is especially important for the analysis of dusts for free silica where coexisting materials (matrix) may determine the results of analysis. This technique is equally important in gas chromatographic analysis of solvent vapor samples collected from the industrial atmosphere. (3)

11. The application of analytical results to the evaluation of exposure control efficiency also can be displayed in the form of a quality control chart as illustrated in Visual 2-10. In this case the 20% control limit was based upon biological monitoring, and a result was considered to be "abnormal" if the urinary level exceeded 0.1 mg./l. Trend lines drawn in by inspection disclosed a relationship with the production schedules. (3)

C. Laboratory Accreditation

1. The industrial hygiene laboratory has as its main function the analysis of materials in the work environment to define the extent to which health hazards may be present. The materials for analysis usually consist of raw and intermediate products, settled dusts and air samples. However, at times the worker is used as a sampler; and biological fluids, such as urine and blood, are analyzed for specific chemicals to assure that environmental exposure concentrations are within safe levels. There was a demonstrated need for upgrading, maintaining surveillance, and providing a standard of performance for the industrial hygiene analytical laboratory. This need was made more urgent by the Clinical Laboratories Improvement Act of 1967 which requires the licensing or accreditation by an approved body of laboratories that analyze biological materials for the assessment of health. In 1970 the American Industrial Hygiene Association (AIHA) drew up guidelines for accreditation of industrial hygiene laboratories, and in December, 1970 additional impetus was added with the passage of the Occupational Safety and Health Act. The National Institute for Occupational Safety and Health (NIOSH) was given the responsibility of assuring the quality of the analytical data needed for the implementation of the OSHA program. In May 1972, NIOSH signed a contract with AIHA to administer a laboratory accreditation program. AIHA has established several criteria for the accreditation. (4)

NOTES	Times (elapsed) projected	LESSON OUTLINE
		10. Matrix effects and interferences
Visual 2-10		11. Control chart--biological monitoring
	(0:30)	C. Laboratory Accreditation
(Transition B.-C.) From quality control to accreditation of laboratories	0:15	1. Accreditation-need, history

2. A qualified laboratory director should be a diplomate of the American Board of Industrial Hygiene or have a degree in one of the basic sciences or a medical degree with at least six years experience in industrial hygiene. (4)

3. The laboratory supervisor is responsible for supervising the laboratory, and should have a doctorate degree or medical degree with two years experience in related procedures, a master's degree with four years additional experience or a baccalaureate degree and six years experience in related procedures. (4)

4. Industrial hygiene technologists are responsible for analysis of materials submitted to that laboratory under the direction of the supervisor, and shall have a baccalaureate degree in the basic science relating to their duties. The industrial hygiene technician is responsible for carrying out designated activities related to the analysis of materials submitted to the laboratory under the direct supervision of the director, supervisor or industrial hygiene technologist. Qualifications include graduation from an accredited high school and at least two years experience as a laboratory technician or two years in an accredited college with at least one course in chemistry. (4)

5. The proficiency testing will be carried out by NIOSH under their PAT (Proficiency Analytical Testing) Program. Data resulting from this program are evaluated by the AIHA Laboratory Accreditation Committee (LAC) for purposes of laboratory accreditation. Judgment is made on the basis of the results from all laboratories and a statistical estimation of whether the results obtained are probably representative of analytical competence. (4)

6. Routine quality control procedures shall be an integral part of the laboratory procedures and functions. These shall include:

   - Routinely introduced samples of known content along with samples submitted for analysis (reference sample system)

NOTES	Times (elapsed) projected	LESSON OUTLINE
		2. Qualifications of lab director 3. Lab supervisor--responsibilities and qualifications 4. Industrial hygiene technologist and technicians--qualifications and responsibilities 5. Proficiency testing 6. Quality control: . Known samples with unknown

- Routine checking, calibrating, and maintaining adequate performance of equipment and instruments

- Routine checking of procedures and reagents

- Good housekeeping, cleanliness and general orderliness of the premises (4)

7. The industrial hygiene laboratory shall have space, facilities, and equipment adequate for the services provided. These shall include as a minimum:

- Ample workbench and instrumentation space in a well lighted facility with proper temperature control

- Proper ventilation of laboratory hoods and instruments

- Adequate services such as electricity, water, compressed air and vacuums in suitable locations

- Safe procedures for chemical storage and for the disposal of containers, chemicals and refuse

- Safety equipment such as goggles, shields, protective clothing, deluge showers and fire extinguishers, suitable and adequate for the needs

- Suitable location of the laboratory in relation to potable drinking water, eating facilities, toilets and showers (4)

NOTES	Times (elapsed) projected	LESSON OUTLINE
		. Checking, calibrating, and monitoring equipment . Checking procedures and reagents . Housekeeping 7. Facilities . Adequate space, light, temperature . Proper ventilation . Adequate services . Safe storage and disposal . Safety equipment . Suitable location

8. The industrial hygiene laboratory shall maintain proper and adequate records and files. These shall include as a minimum:

   - The identification and numbering of incoming samples
   - An adequate and systematic numbering system relating laboratory samples to incoming samples
   - An adequate record system of internal logistics for each sample including incoming sample data, analysis and procedures, and reporting of data
   - A record of the checking system for the calibration and standardization of equipment and of internal control samples (4)

9. Accreditation shall be granted for a period of three years with continued proof of competency through annual site visits and proficiency testing results (PAT program). (4)

10. Application for accreditation of industrial hygiene laboratories shall be made on forms provided by the AIHA and forwarded to the Coordinator of Laboratory Accreditation. (Newton E. Whitman, Coordinator of Laboratory Accreditation, Reading Aviation Service Building, ABE Airport, Allentown, Pennsylvania 18103). Upon receipt of the application and required fee, an application form will be forwarded to the applicant. Upon receipt of the completed application form, and designated fee, arrangement for the following will be made:

    - Enroll the laboratory in the PAT program of NIOSH
    - Review of the application by qualified specialists
    - Carry out a site visit by approved laboratory appraisers at a mutually convenient time (4)

NOTES	Times (elapsed) projected	LESSON OUTLINE
		8. Records: . Identification of incoming samples . Numbering system . Records of internal logistics . Checking system for calibration, standardization, internal control 9. Accreditation--three years 10. Application to AIHA leads to: . Enrollment in PAT . Review of application . Site visit

11. Based upon the opinion of the reviewers, data from the PAT program, and reports from the site visitors (appraisers) and other applicable considerations, the Laboratory Accreditation will recommend, and so notify the applicant that:

    - The laboratory should be accreditated by the AIHA Board of Directors

    - Certain correctional measures are necessary before accreditation can be granted

    - The laboratory is not acceptable. An appeal system has been established for those cases where disagreements are encountered (4)

D. Self Test

1. Test instructions and review of questions are presented.

NOTES	Times (elapsed) projected	LESSON OUTLINE
		11. Results of lab review:
		. Accreditation
		. Corrective measures needed before accreditation
		. Not acceptable
	(0:45)	
Self Test		D. Self Test
	0:05	
		1. Instructions and review
	0:50	

SELF TEST	Page 1 of
LESSON TITLE Introductory Topics	LESSON NUMBER 2

1. Define the following:

   a. Threshold limit value (TLV):

see A. 1

   b. Ceiling limit:

see A. 5

2. Which of the following are correct statements? (Circle true or false)

   T (F) a. The quality control should control only instrumental control.

   (T) F b. Precision is evaluated by repetitive analysis of the same sample and is based on the deviation of the results from the average of all results and on the range

   T (F) c. Annual quality control procedures shall be an integral part of laboratory procedures and functions in an accredited laboratory.

   (T) F d. An accredited laboratory needs an adequate record system of internal logistics for each sample including sample data, analysis and procedures, and reporting of data.

VISUALS, TABLES, FIGURES AND EXHIBITS

CUMULATIVE EXPOSURE FOR 8 HOURS

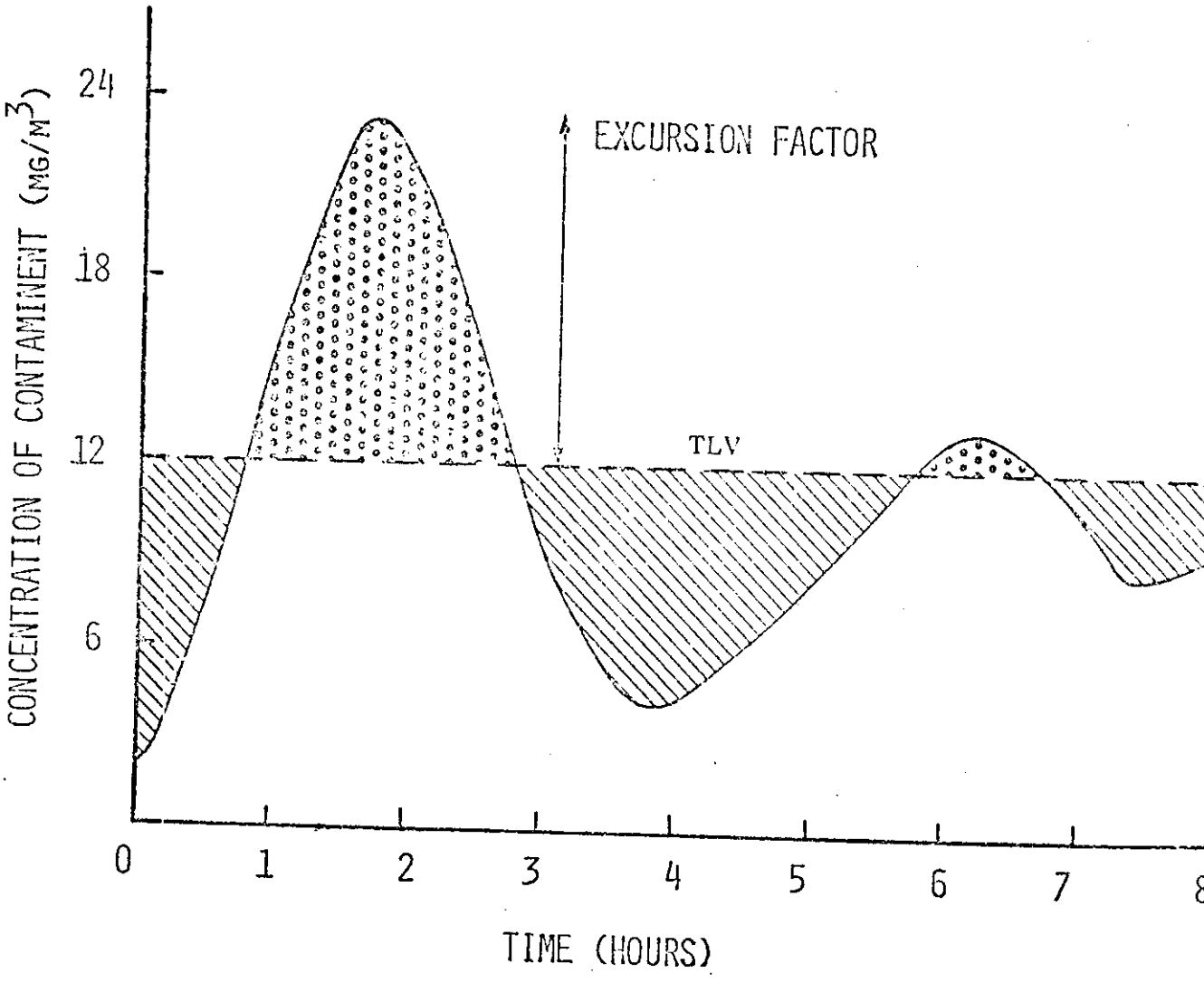
$$E = \frac{C_a T_a + C_b T_b + \cdots C_n T_n}{8}$$

WHERE:

$E =$ EQUIVALENT EXPOSURE FOR (WORKING) SHIFT

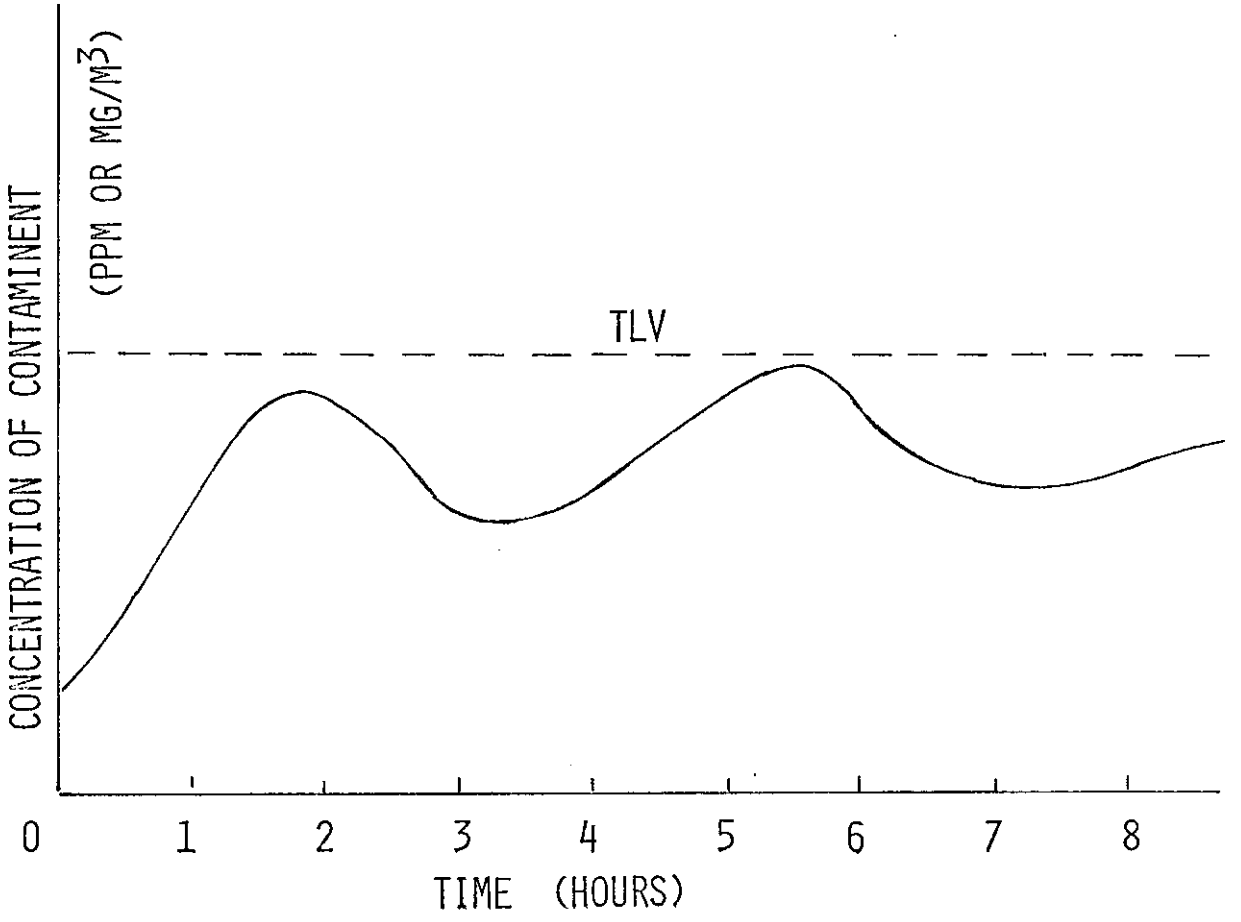
$C =$ CONCENTRATION DURING PERIOD WHERE CONCENTRATION REMAINS CONSTANT

$T =$ DURATION IN HOURS OF EXPOSURE TO CONCENTRATION C



(AREA OF CURVE ABOVE TLV ⁝⁝⁝ MUST BE LESS THAN AREA BELOW TLV ▨ FOR TIME WEIGHTED AVERAGE EXPOSURE TO BE LESS THAN THE TLV.)

TIME-WEIGHTED AVERAGE AND THE EXCURSION FACTOR



(FOR CHEMICAL AGENTS WITH A CEILING VALUE, THE TLV SHOULD NOT BE EXCEEDED.)

RELATIONSHIP OF CEILING VALUE TO TLV

Visual 2 - 3

CALCIUM CARBONATE

CELLULOSE

PORTLAND CEMENT

EMERY

GLYCERIN

LIMESTONE

PLASTER OF PARIS

ROUGE

SILICON CARBIDE

STARCH

SUCROSE

SOME INERT OR NUISANCE PARTICULATES

Visual 2 - 4

C A R C I N O G E N S

HUMAN WITH TLV'S

ASBESTOS

BIS (CHLOROMETHYL) ETHER

CHROMATES (CERTAIN INSOLUABLE FORMS)

COAL TAR PITCH VOLATILES

NICKEL CARBONYL

HUMAN WITHOUT TLV's

4 - AMINODIPHENYL

BENZIDINE AND ITS SALTS

BETA - NAPHTHYLAMINE

4 - NITRODIPHENYL

HUMAN AWAITING TLV

VINYL CHLORIDE

EXPERIMENTAL

BERYLLIUM

3,3' - DICHLOROBENZIDINE

DIMETHYL SULFATE

ETHYLENIMINE

4,4' - METHYLENE BIS

N--NITROSODIMETHYLAMINE

BETA - PROPIOLACTONE

EQUIVALENT EXPOSURE

WITH

AIR CONTAMINANT MIXTURE

$$E_m = \frac{C_1}{L_1} + \frac{C_2}{L_2} + \cdots \frac{C_n}{L_n}$$

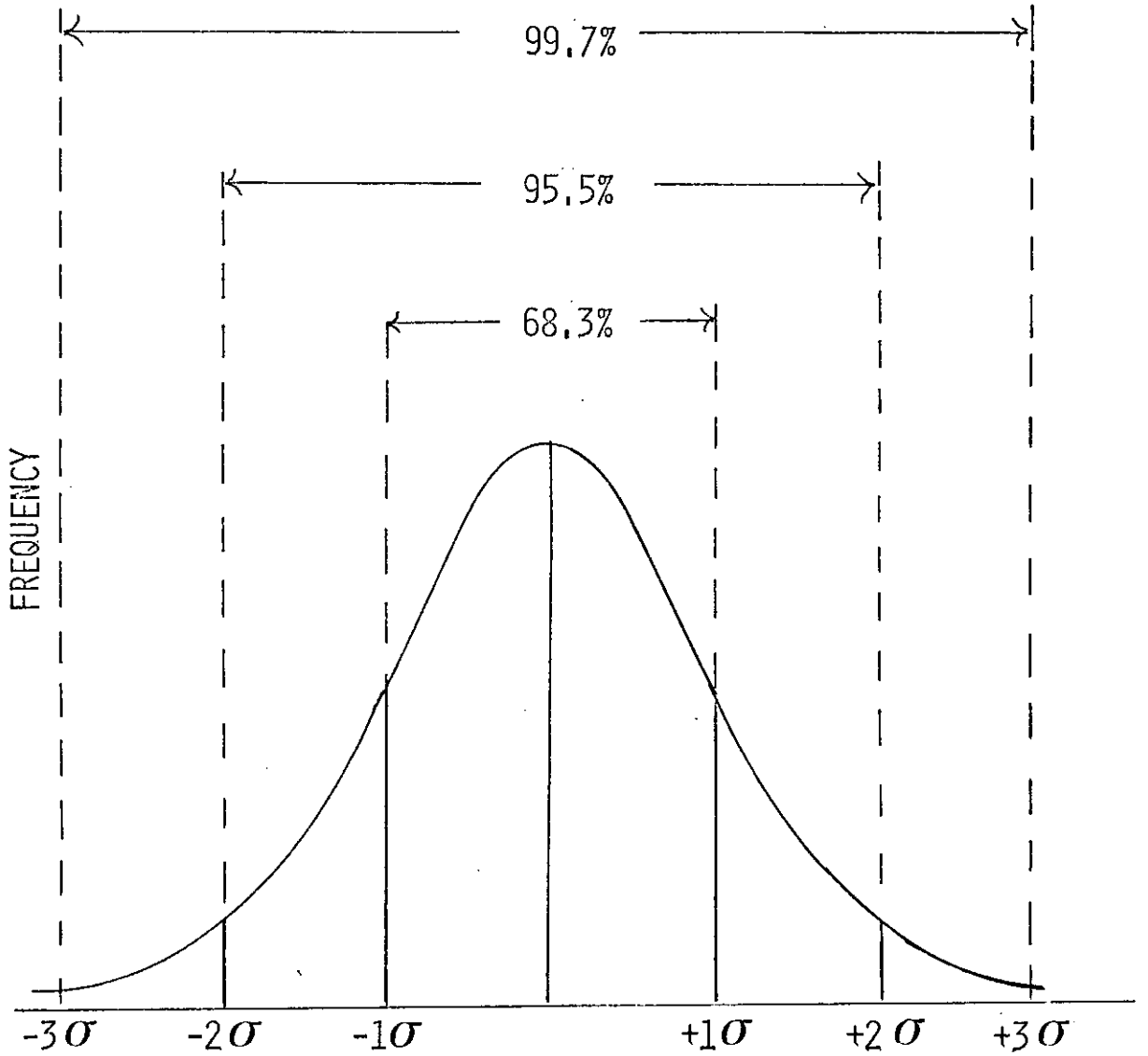
WHERE:

E_m = EQUIVALENT EXPOSURE FOR MIXTURE

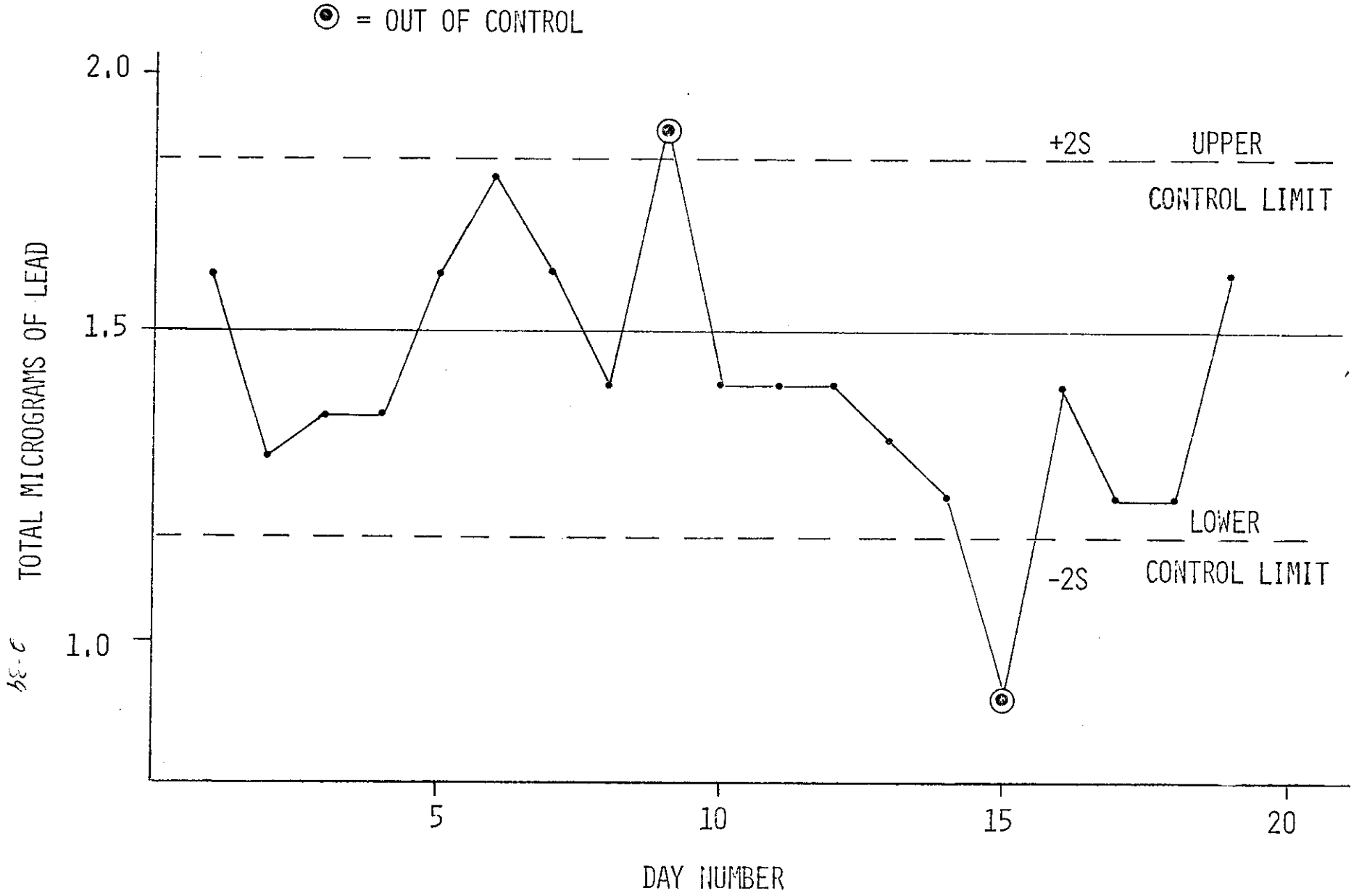
C = CONCENTRATION OF A PARTICULAR CONTAMINANT

L = EXPOSURE LIMIT FOR THAT CONTAMINENT ACCORDING TO FEDERAL OR LOCAL STANDARDS

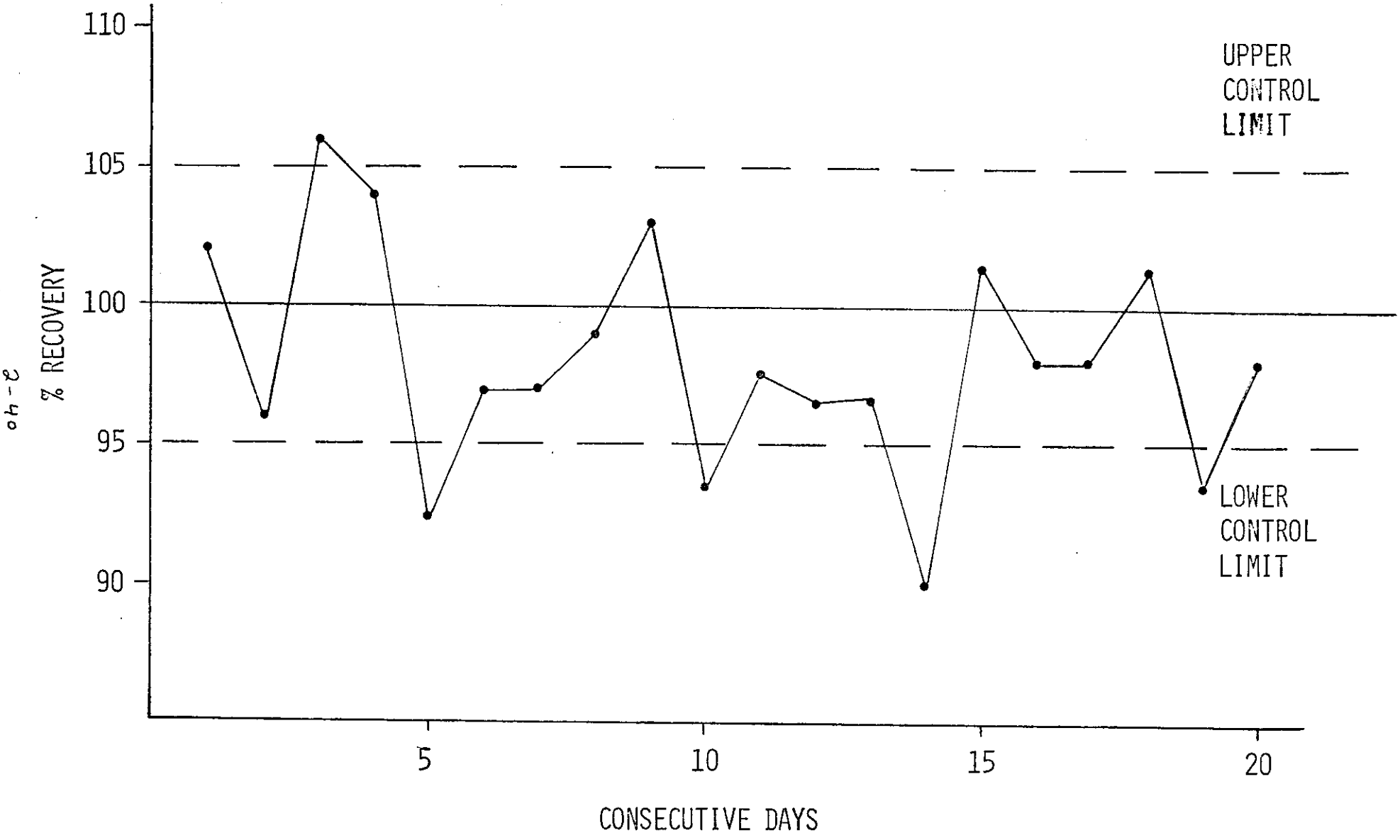
Visual 2 - 6

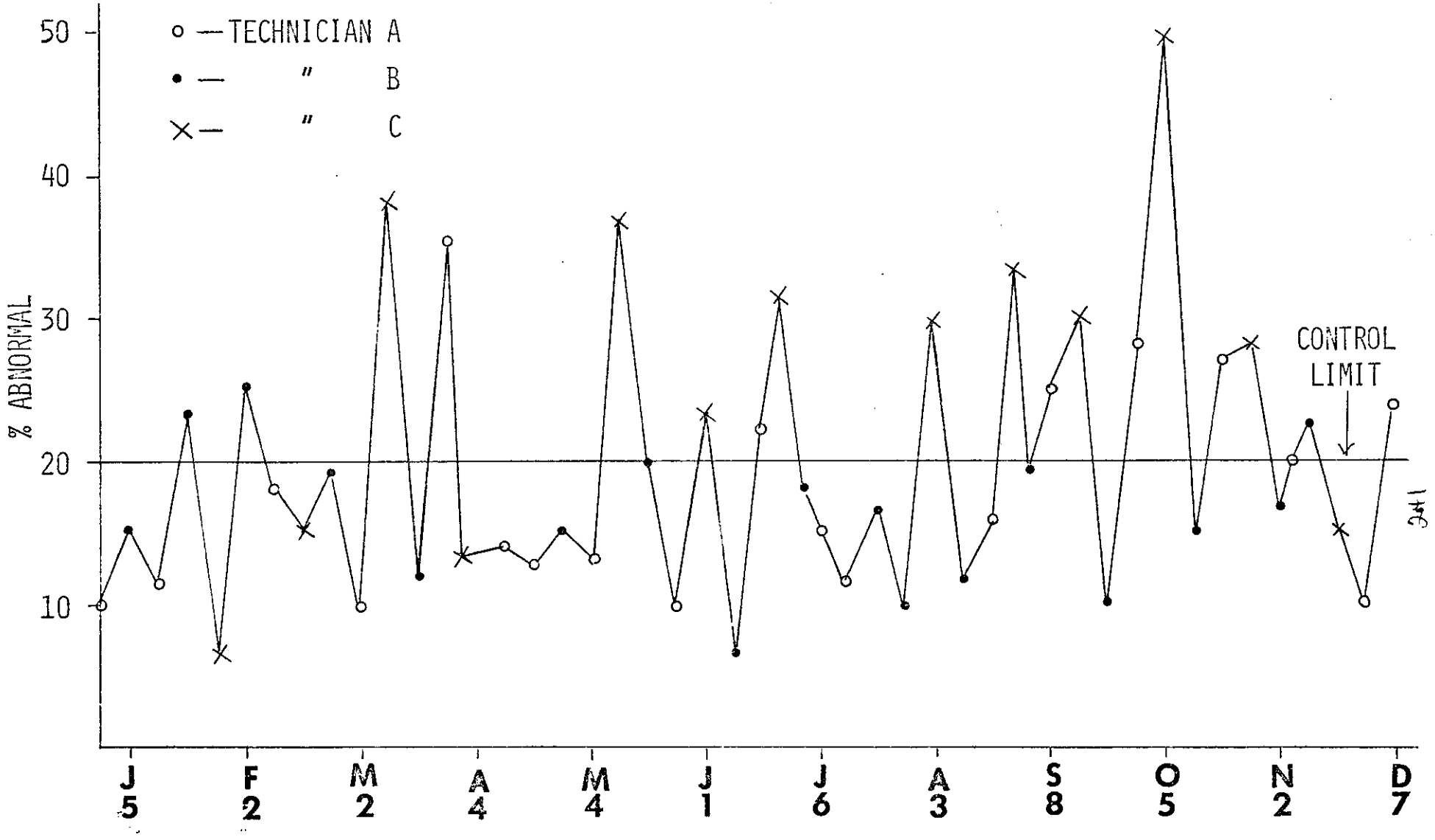


GAUSSIAN OR NORMAL CURVE OF FREQUENCIES



LEAD IN BLOOD CONTROL CHART


110
105
100
95
90
% RECOVERY
UPPER
CONTROL
LIMIT
LOWER
CONTROL
LIMIT
5
10
15
20
CONSECUTIVE DAYS



LEAD IN URINE ANALYSIS - % EXCEEDING THRESHOLD LIMIT

(0.1 MG/LITER) ON WEEKLY BASIS