KANSAS GAS AND ELECTRIC COMPANY

GLENN L KOESTER
VICE PRESIDENT - NUCLEAR

November 30, 1983

DESIGNATED ORIGINAL

Certified By S. Munroe

Mr. J. E. Gagliardo, Acting Chief
U.S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 1000
Arlington, Texas 76011

DEC - 5 1983

KMLNRC 83-158
Re: Docket No. STN 50-482
Ref: 1) Inspection Report STN 50-482/83-20 dated 10/31/83 from JEGagliardo, NRC, to GLKoester, KG&E
2) Letter KMLNRC 82-170 dated 3/5/82 from GLKoester, KG&E, to HRDenton, NRC
Subj: Experience of Health Physics Technicians

Dear Mr. Gagliardo:

This letter is in response to your request for additional information concerning Kansas Gas and Electric Company's (KG&E) plans for providing an adequate number of qualified radiation protection technicians prior to fuel loading. Your request was transmitted to KG&E in Reference 1.

Since the NRC inspection in August, 1983, the Health Physics staff at Wolf Creek has been increased by the hiring of a Technician with three years of commercial nuclear plant experience and the retention of three contract Technicians with three, six and eleven years of commercial nuclear plant experience. These personnel, plus the Technician on our staff with two years of commercial nuclear plant experience at the time of your inspection, bring our Technician level commercial experience to five technicians, with an average of 4.5 years experience. Between now and fuel load we will continue to be interested in obtaining experienced personnel in these positions, when available.

Before the specific plan for achieving the required experience level is discussed, one item needs to be clarified concerning KG&E's experience and training commitments. Reference 1 (Page 11, "Overall Radiation Protection") indicated that KG&E had committed in the FSAR to NRC Regulatory Guide 1.8, ANSI N18.1-1971 and ANSI/ANS 3.1-1978. As discussed with Region IV representatives during meetings before and during the NRC's Management Structure and Technical Resources Review Team visit to Wolf Creek in September, 1981 and January, 1982 and as reaffirmed by Reference 2, KG&E intends to select and train personnel to meet or exceed the minimum requirements of ANSI/ANS 3.1-1978 (FSAR Section 13.2.1.1). This commitment has existed since KG&E submitted the FSAR to the NRC in February, 1980 and is consistent with our FSAR commitment to proposed Revision 2 (February, 1979) of Regulatory Guide 1.8, which endorses ANSI/ANS 3.1-1978.

The Attachment (Figure 1) indicates the training and experience of WCGS Health Physics Technicians projected to an August, 1984 fuel load date. The Figure includes all Health Physics related training and experience received to date, as well as that currently scheduled from the present date to August, 1984.

Based upon the criteria presented by ANSI/ANS 3.1-1978, KG&E judges that thirteen of our current staff are or will be qualified as Health Physics Technicians by August, 1984. The remaining five will be considered "in training" and, in accordance with Section 4.5 of ANSI/ANS 3.1-1978, will only be permitted to perform work for which qualification has been demonstrated.

The primary qualification criteria of ANSI/ANS 3.1-1978, Section 4.5.2 are: "Technicians shall have three years of working experience in their specialty of which one year should be related technical training." The Technicians identified in the Attachment as numbers one through seven have had at least three years of actual working experience in Health Physics, which is their specialty, in addition to Health Physics-related academic and on-the-job training.

The six Technicians identified as numbers eight through thirteen have four-year bachelor's degrees in Health Physics or subjects closely related to Health Physics. In addition, those Technicians will have worked for at least two and one half months at an operating commercial nuclear power plant and will have had at least one year and ten months experience in preoperational and startup testing activities and technical services within the WCGS Health Physics Group. ANSI/ANS 3.1-1978 states that one year of the required experience <u>should</u> be related technical training.

It is KG&E's position that a four-year bachelor's degree in Health Physics or a closely related field, plus approximately 500 hours of Health Physics training, plus two-three months at commercial nuclear plants is equivalent to three years of actual Health Physics experience. By this accounting, the six Technicians identified as numbers eight through thirteen will more than satisfy the requirements of Section 4.5.2 of ANSI/ANS 3.1-1978, by the projected fuel load date of August, 1984.

The five Technicians-in-Training will not have the required training and experience to be considered qualified by August, 1984. These Technicians-in-Training will only be permitted to perform work for which qualification has been demonstrated in accordance with Section 4.5 of ANSI/ANS 3.1-1978.

Figure 2 of the Attachment indicates those Technicians who are qualified per INPO 82-006 (The INPO Guideline for Health Physics Technician Qualification).

If you have any further questions concerning this matter, please contact me or Mr. Otto Maynard of my staff.

Very truly yours,

Kent R Brown

for Glenn L. Koester
Vice President - Nuclear

GLK:cks
Attach
cc: RCDeYoung

Response to Inspection Report

STN 50-482/83-20

Kansas Gas and Electric Company

November 30, 1983

FIGURE 1

H.P. Technician Training Experience Projected to August, 1984

Technician Number	Formal Education	Specialized H.P. Related Training (Contact Hours) in addition to Column 1	H.P. Related Experience	Commercial Nuclear Power at Fuel Load	WCGS Time at Fuel Load	Meets ANSI 3.1 Requirements at Fuel Load
1 (Contractor	30 hrs. toward Eng. Degree	200 hrs plus ELT Trng	7.0 yrs Nav ELT	3 yrs	10 mo.	Yes
2 (Contractor)	40 hrs	200 hrs plus NRRPT Qualified	5.0 yrs RadSafety at a Hospital	3.6 yrs	10 mo.	Yes
3	60 hrs toward Elec. Degree	ELT Trng plus 317 hrs	3 yrs Navy ELT	2 yrs	1 yr. 9 mo.	Yes
4	60 hrs toward Physics Degree	317 hr		3 yrs	10 mo.	Yes
5	B.S. Health Physics	317 hr	2.5 yrs at I.I. Dept. of Nuc Saf. 1yr xray dif tech	2 mo. 2 wks	2 yr. 8 mo.	Yes
6	40 hrs toward Elec. Eng Degree	ELT Trng plus 517 hr	6.0 yrs Navy ELT	2 mo. 3 wks	2 yr. 2 mo.	Yes
7 (Contractor)	B.S. H.P.	19 mo. Nuc Pwr School, Army Corp. Eng.	4 yrs Nuc Eng Test Facility 6 mo. NRC	11 yrs 5 mo.	10 months	Yes
8	B.S. Health Physics;	551 hrs		3 mo. 2 wks	3 years 10 mo.	Yes
9	B.S. Health Physics	501 hrs		3 mo. 2 wks	4 years 4 mo.	Yes
10	B.S. Env. Eng. Technology	501 hrs	6.0 yrs Navy Reac. Operator & Elec. Tech.	3 mo.	2 yr. 2 mo.	Yes
11	B.S. H.P. M.A. Mgmt. & Human Relations	1950 hrs		2 mo. 2 wks	5 yr. 8 mo.	Yes
12	B.S. Physics	501 hrs	ARIX Rad. Assessment 1 year 1 mo.	3 mo. 2 wks	10 mo.	Yes
13	B.S. Biological Health	501 hrs		2 mo. 2 wks	3 yrs.	Yes

FIGURE 1

· H.P. Technician Training Experience Projected to August, 1984

Technician Number	Formal Education	Specialized H.P. Related Training (Contact Hours) in addition to Column 1	H.P. Related Experience	Commercial Nuclear Power at Fuel Load	WCGS Time at Fuel Load	Meets ANSI 3.1 Requirements at Fuel Load
14		501 hrs.		3 mo.	2 yrs. 4 mo.	No
15	15 hrs	517 hrs.		3 mo.	3 yrs. 4 mo.	No
16		501 hrs.	Exxon Fuel Fab. Plant 10 wks	2 mo. 3 wks	3 yrs.	No
17	80 hrs toward non-Science degr	2 hrs.			10 mo.	No
18		444 hrs.		6 wks	1 yr. 8 mo.	No

TECHNICIAN NUMBER

(C)-Contract H.P.

Qualification Topic	INFO Req'd Hours	(C) 1	(C) 2	3	4	5	6	(C) 7	8	9	10	11	12	13	14	15	16	17	18	19
Basic Mathematics	24	1,2	1,3	1,2	1	4	2	1,4	4	4	5,9	4	6	*	8	*	*	*	*	
Algebra	40	1,2	1,3	1,2	1	4	2	1,4	4	4	5,9	4	6	*	*	*	*	*	*	
Mechanics	12	1,2	1,3	1,2	1	4	2	1,4	4	4	5,9	4	6	*	*	*	*	*	*	
Chemistry	24	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	5,9,8	4,8	6,8	7,8	8	8	8	*	8	
Nuclear Physics	8	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	5,9,8	4,8	8	8	8	8	8	*	8	
Reactor Technology	8	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	5,9,8	4,8	8	8	8	8	8	*	8	
Basic Electricity	8	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	5,8,9	4,8	6,8	8	8	8	8	*	8	
Communication	24	1,2	1,3	1,2	1	4	2	1,4	4	4	5,9	4	6	7	*	*	*	*	*	
Radioactivity and Radio-active Decay	24	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	5,8,9	4,8	8	*	*	*	*	*	*	
Sources of Radiation	16	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	5,8,9	4,8	8	*	*	*	*	*	*	
Interaction of Radiation with Matter	16	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	5,8,9	4,8	8	*	*	*	*	*	*	
Radiological Quantities and Units	8	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	5,8,9	4,8	8	*	*	*	*	*	*	
Biological Effects and Risks Associated with Ionizing Radiation	24	1,2	1,3	1,2	1	4	2	1,4	4	4	5,9	4	*	*	*	*	*	*	*	
Radiation Detection and Measurement Principles	24	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	5,8,9	4,8	8,10	8	8	8	8	*	8	

FIGURE 2 #
TECHNICIAN NUMBERS

(C)-Contract H.P.

Qualification Topic	INPO Req'd Hours	(C) 1	(C) 2	3	4	5	6	(C) 7	8	9	10	11	12	13	14	15	16	17	18	19
Counting Statistics	16	1,2	1,3	1,2,8	1	4	2,8	1,4	8,4	4,8	5,8,9	4,8	*	*	*	*	*	*	*	
Radiation Protection Standards	16	1,2	1,3	1,2,8	1	4	2,8	1,4	4,8	4,8	8,9	4,8	*	*	*	*	*	*	*	
External Radiation Exposure Control	24	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	8,9 10	4,8 10	8,10	8,10	*	*	*	*	*	
Radioactive Contamination Control	24	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	5,8,9 10	4,8 10	8,10	8,10	*	*	*	*	*	
Decontamination	8	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	8,9 10	4,8 10	8,10	8,10	8	8	8	*	8	
Airborne Radioactivity Control	16	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	8,9 10	4,8 10	8,10	8,10	*	*	*	*	*	
Respiratory Protection	16	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	8,9 10	4,8 10	8,10	8,10	*	*	*	*	*	
Radiological Surveys	32	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	8,9 10	4,8 10	8,10	8,10	8	8	8	*	8	
Access Control and Work Monitoring	16	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	8,9 10	4,8 10	8,10	8,10	*	*	*	*	*	
Dosimetry	24	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	8,9 10	4,8 10	8,10	8,10	*	*	*	*	*	
Radioactive Materials Control	32	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	5,8 10	4,8 10	8,10	8,10	*	*	*	*	*	
Environmental Monitoring	8	1,2 10	1,3 10	1,2 10	1,10	4,10	2,10	1,4	4,10	4,10	10	4,10	10	10	*	*	*	*	*	
Radiological Survey and Monitoring Instruments	64	1,2 10	1,3 10	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	5,8,9 19	4,8 10	8,10	8,10	*	*	*	*	*	
Calibration Sources, Equipment and Procedures	20	1,2 10	1,3 10	1,2 10	1,10	4,10	2,10	1,4	4,10	4,10	10	4,10	10	10	*	*	*	*	*	

(C) -Contract H.P.

FIGURE 2#
TECHNICIAN NUMBER

Qualification Topics	Inpo Req'd Hours	(C) 1	(C) 2	3	4	5	6	(C) 7	8	9	10	11	12	13	14	15	16	17	18	19
Radiation Monitoring System	8	1,2 10	1,3 10	1,2, 8,10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	8,10	4,8 10	8,10	8,10	*	*	*	*	*	
Plant Systems	80	1,2	1,3	1,2,8 10	1,10	4,10	2,8 10	1,4	4,8 10	4,8 10	8,9 10	4,8 10	8,10	8,10	*	*	*	*	*	
Plant Operations and Maintenance	16	1,2	1,3	1,2 10	1,10	4,10	2,10	1,4	4,10	4,10	9,10	4,10	10	10	*	*	*	*	*	
Plant Procedures	32	10	10	1,2 10	10	10	10	10	10	10	10	10	10	10	*	*	*	*	*	
Radiological Accident and Incident Evaluation and Control	24	1,2 10	1,3 10	1,2 10	1,10	4,10	2,10	1,4 10	4,10	4,10	9,10	4,10	10	10	*	*	*	*	*	

#See Notes

Notes to Figure 2

1. Qualified per: Commercial Nuclear Power Plant Experience (ANSI 3.1)

2. Qualified per: US Navy ELT Training and Experience (ANSI 3.1)

3. Qualified per: NRRPT Qualification

4. Qualified per: BS Degree Health Physics**

5. Qualified per: BS Degree Environmental Engineering Technology**

6. Qualified per: BS Degree Physics**

7. Qualified per: BS Degree Biological Health**

8. Qualified per: HP/RadChem Course
   A) Prior to July 1983 this course was taught by Texas A & M University (See Enclosure I)
   B) Following July 1983 this course is taught by University of Kansas/Kansas State University on site (See Enclosure II)

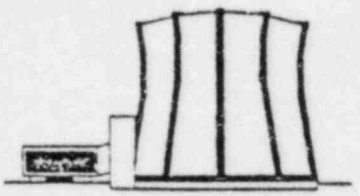
9. Qualified per: US Navy R.O./ET Training and Experience

10. Qualified per: WCGS HP Technician Qualification Program

* Presently Have Completed Basic HP Training and are Qualified to Perform Limited Duties under Section 4.5 of ANSI 3.1.

** Transcript Available for NRC Review.

TEXAS ENGINEERING EXPERIMENT STATION
THE TEXAS A&M UNIVERSITY SYSTEM
COLLEGE STATION, TEXAS 77843



NUCLEAR SCIENCE CENTER
713/845-7551

12 March 1982

Mr. Richard Coulthard
Kansas Gas & Electric
Wichita, KS

Dear Mr. Coulthard:

Enclosed are your copies of the outlines we have developed for the KG&E courses. If you have any questions or comments please contact me.

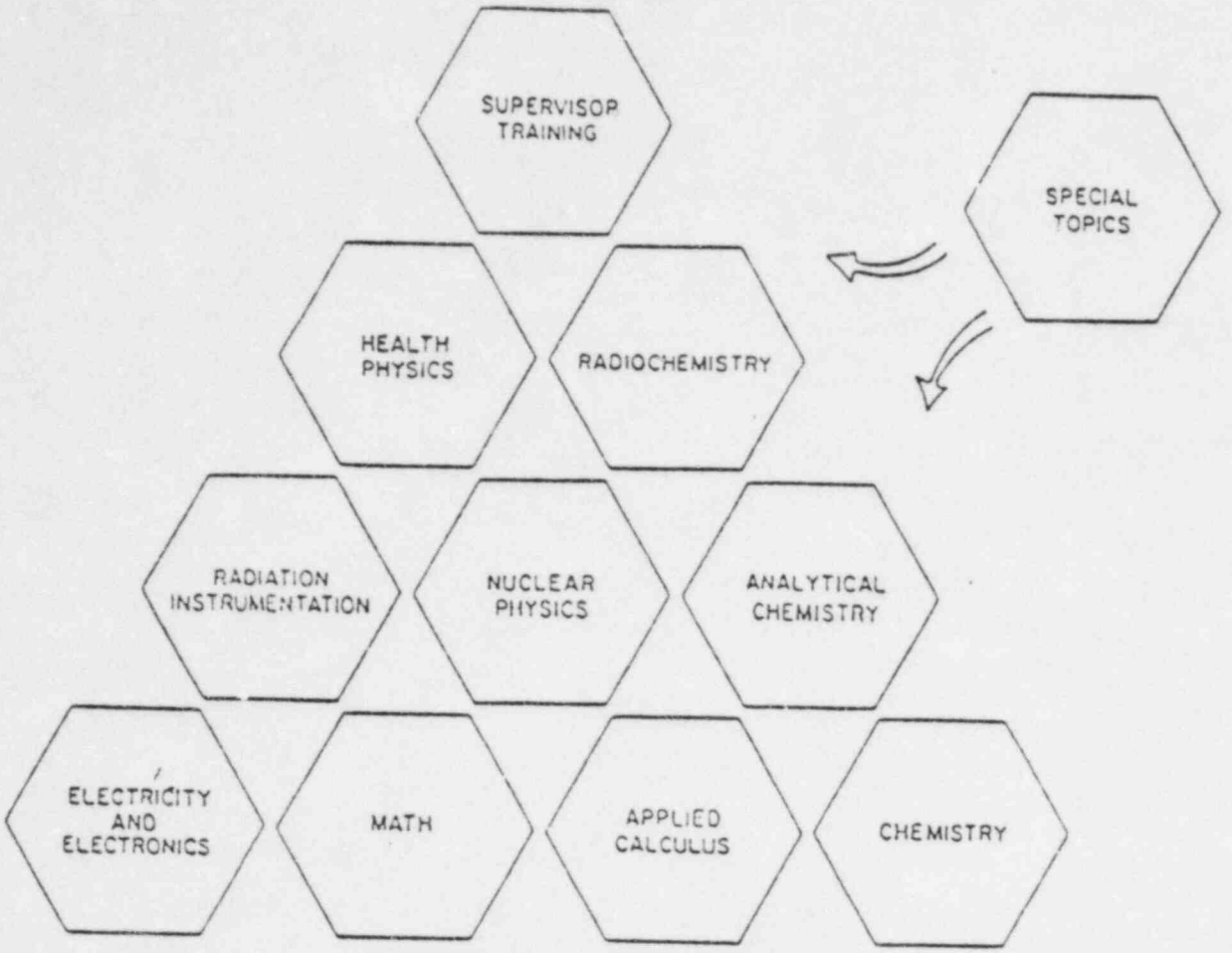
Sincerely,

Ronnie J. Buchanan, Manager
of Training Program
Nuclear Science Center
F. E. Box 89
Texas A&M University System
College Staion, Texas 77843
Phone: 713/845-5998

RJB/chh

Attachment

HEALTH PHYSICS / RADIOCHEMISTRY TRAINING



Programs in Health Physics/Radiochemistry That Have Been Conducted by TEEX Training

Course	Client	Length	Date
HP/RC	KG&E of Wichita	12 Weeks	1/82

HEALTH PHYSICS

PURPOSE - To provide the student with a knowledge of basic nuclear physics, particle interactions, internal and external dosimetry, federal regulations, and health physics operations.

STRUCTURE - Seventy-two hours of lecture, 36 hours of practice, homework, four exams.

TEXT - Introduction to Health Physics, H. Cember, 3rd Ed., Pergamon Press Inc., 1978, Chapters 1 through 8, 10, 11, and 13.

ADDITIONAL REFERENCE - Radiological Health Handbook, U.S.D.H.E.W., 1970

CONTENTS -

- Review of Physical Principles
  - Mechanics
  - Electricity
  - Energy transfer
  - Quantum theory
- Atomic and Nuclear Structure
- Radioactivity
  - Radioactivity and decay mechanisms
  - Kinetics and units of decay
  - Naturally occurring radioactivity
- Interaction of Radiation with Matter
  - Beta-ray interactions
  - Alpha-ray interactions
  - Gamma-ray interactions
  - Neutron production and interaction
- Radiation Dosimetry
  - Units
  - Exposure and dose measurements
  - Internally deposited radioisotopes
  - Neutron dose
- Biological Effects of Radiation
  - Dose-response characteristics
  - Acute effects
  - Delayed effects
  - RBE and QF
  - Dose equivalent
- Radiation Protection Guides
  - Organizations
  - MPC calculations
  - 10-CFR-20
  - DOT, shipping
- External Radiation Protection
  - Basic principles
  - Techniques of external radiation protection
- Internal Radiation Protection
  - Internal hazard
  - Control practices
  - Surface contamination
  - Waste disposal
- Evaluation of Protective Measures
  - Personnel monitoring
  - Bioassays
  - Radiation contamination surveys
  - Air sampling
  - Environmental monitoring
- Applications at Nuclear Science Center
  - Air monitoring system calibration
  - Shipping and radioactive materials handling
  - Dosimeter and instrument calibrations
  - Use of anti'Cs
  - Radiation field surveys
  - Radioactive contamination surveys
  - Bioassays
  - Environmental sampling
  - Decontamination of equipment and areas
  - Health physics daily procedures

RADIATION INSTRUMENTATION

PURPOSE - To provide the student with a knowledge of the theory of operation of radiation detection instruments. Also provides hands-on experience with a wide variety of instruments.

STRUCTURE - Seventy-two lecture hours, twelve 3-hour laboratory sessions, homework, three exams.

TEXT - Introduction to Health Physics, H. Cember, 1969, Chapter 9.

ADDITIONAL REFERENCES - Nuclear Radiation Detection, W. J. Price, 1964.
Radiation Safety Technician Training Course, H. J. Moe, 1972.
Nuclear Physics, I. Kaplan, 1964.
Table of Isotopes, 7th Ed., Browne, Dairiki and Doebler, 1978.
Gamma Transition Energies of the Major Fission Products, P. Grant, et al., University of California, Irvine, 1971.

CONTENTS -

- Types of Radiation and Interactions
- Counting Statistics
- Electronics of Counting Systems
- Gas-filled Detectors
  - Ionization chambers
  - Proportional counters
  - GM counters
- Detector Efficiency and Calibration
- Scintillation Detectors
  - NaI(Tl) detectors
  - Liquid scintillators
  - α scintillators
- Spectrometry (α, β, γ)
- Semiconductor Detectors
- Multichannel Analyzers
- Activation Analysis
- Average Gamma-ray Energy

CHEMISTRY

PURPOSE - To provide the student with an understanding of the basic principles of chemistry and radiochemistry, general techniques of quantitative analysis, radiochemical separations, and counting statistics.

STRUCTURE - Fifty-four lecture hours, homework, five exams.

TEXTS - (1) Foundations of College Chemistry: The Alternate Edition, M. Hein 1980, Chapters 2-7, 9-17. (2) Qunatitative Analysis, R. Brumblay, 1972, Chapters 8, 10-14. (3) Principles of Radioisotope Methodology, Chase and Rabinowitz, 1968, Chapters 4-6, 10-13.

CONTENTS -

I. GENERAL CHEMISTRY

- Measurements
- Properties of Matter
- Elements and Compounds
- Atomic Theory
- Periodic Table
- Bonding
- Equations - Heat of Reaction
- Stoichiometry
- Gases
- Properties of Water
- Solutions
- Acids and Bases
- Equilibrium - Reaction Rates
- Oxidation - Reduction
- Conductivity of Compounds

II. ANALYTICAL CHEMISTRY

- Redox Electrodes
- Specific Ion Electrodes
- pH Meter
- Electrodeposition
- Separations
  - Precipitation
  - Volatilization
  - Extraction
  - Ion-exchange
  - Electrolytic
  - Chromatography
- Complex Ion Formation - EDTA
- Instrumentation
  - Absorptiometry
  - Turbidity
  - Fluorescence
  - Emission
  - Conductance

III. RADIOCHEMISTRY

- Statistics
- Types of Radiation
- Decay - Growth
- Separations
- Carrier Methods
- Isotopic Dilution Method
- Tracer Concept

MATH AND APPLIED CALCULUS

PURPOSE - To provide the student with the knowledge necessary to understand and work with algebraic, exponential, logarithmic, differential, and integral equations in solving practical problems.

STRUCTURE - Twenty-two lecture hours, homework, two exams.

TEXTS - (1) Basic Mathematics for Calculus, Zill, Dewar, and Wright, 1978, Chapters 1, 2, 3, and 6. (2) Calculus and Its Applications, 2nd Ed., Goldstein, Lay, and Schneider, 1980, Chapters 0, 1, 2, 3, 4, 5, and 7.

CONTENTS -

I. MATH

- Algebraic Concepts
  - Real numbers
  - Inequalities
  - Exponents and radicals
  - Scientific notation
  - The binomial theorem
  - Factorials
  - Polynomial equations
  - Summation notation
  - Dimensional analyses
- Analytical Geometry
  - Cartesian coordinate system
  - Graphing
  - Distance formula
  - Equations of straight lines
- Functions
  - Definitions and basic properties
  - Proportionalities
- Exponential And Logarithmic Functions
  - Exponential functions
  - Logarithms
  - Logarithmic functions
  - Computations with logarithms
  - Logarithms to other bases

II. CALCULUS

- Functions
  - Linear
  - Quadratic
  - Zeroes of functions
- Derivatives
  - The slope of a straight line
  - The slope of a curve at a point
  - Limits and the derivative
  - Rules for differentiation
  - Second derivative
  - The derivative as a rate of change
- Application of Derivatives
  - Describing graphs of functions
  - First and second derivative rule
  - Curve sketching
  - Optimization problems
- Exponential Functions
  - Graphs of exponential functions
  - Differentiation of exponential functions
- Logarithm Functions
  - The natural logarithm function
  - The derivative of Ln x
- Integration
  - Antidifferentiation
  - Definite integrals
  - Theorem of calculus
  - Problems using integration

BASIC ELECTRICITY/ELECTRONICS

PURPOSE - To provide the student with a knowledge of basic electrical/electronic terms and devices used in scientific instruments and power plants.

STRUCTURE - Ten lecture hours, with hands-on experience, homework, one exam.

TEXT - Basic Electricity and an Introduction to Electronics, 3rd Ed., H. W. Sams, 1980, Chapters 1, 2, 3, 4, 5, 6, 7, and 11.

CONTENTS -

Fundamentals
- History of electricity
- Nature of matter
- Electron theory
- Coulomb's law

Direct Current
- Circuits and symbols
- Volts, amperes, ohms
- Ohm's law
- Meters
- Resistance
- Capacitance
- Kirchhoff's laws
- Watt's law

Batteries
- Fundamentals
- Internal resistance

Magnetism
- Nature of magnetism
- Electromagnetism
- Induced currents

Alternating Current
- AC theory
- AC voltages

Electromagnetic Induction
- Generators and alternators
- Motors
- Transformers

Controls
- Switches
- Relays
- Fuses

Electronics
- Electron emission
- Vacuum tubes
- Diodes
- Transistors
- Amplification
- Integrated circuits
- Microprocessors
- Electronic circuits
- Instrumentation electronics

NEUTRON PHYSICS

PURPOSE - To provide the student with a knowledge of neutron interactions, detection methods, and instrumentation used to measure neutron flux and dose equivalent.

STRUCTURE - Ten lecture hours, one 3-hour laboratory session, homework, one exam.

TEXT - Nuclear Radiation Physics, 4th Ed., Lapp and Andrews, 1972, Chapter 16.

CONTENTS -

- Discovery of the Neutron
- Energy Classification
- Interactions with Matter
  - Slow neutrons
    - (n,γ)
    - (n,P)
    - (n,α)
  - Fast neutrons
    - elastic collisions
    - inelastic collisions
    - (n,2n)
    - charged-particle emission
- Absorption cross-section
  - wave length
  - barn
  - 1/v law
  - resonance capture
- Neutron Flux
- Neutron Dose
  - Measurement of dose
  - Flux to dose conversion
- Neutron Instrumentation
  - Nuclear emulsion
  - BF_3 detectors
  - Proton recoil detectors
  - Hurst counters
  - Time of flight
  - Neutron activation
  - Calibration
- Neutron Sources
  - (α,n)
  - (γ,n)
  - D-D and D-T
  - Cf-252

R. J. BUCHANAN, Manager of Training. Ph.D., Radiation Biophysics, Univ. of KS, Lawrence, KS, 1976. Five years experience at Los Alamos National Lab's 800 MeV proton accelerator in neutron and health physics research. Univ. of KS Research Reactor, Health Physicist, 1970-1975. U.S. Army Nuclear Pwr. Program (SM-1 Pwr. Reactor, Oper. and Health Physicist, Ft. Belvoir, VA, 1967-1968; PM-3A Pwr. Reactor, Health Physicist, Antarctica, 1969). Seven years experience as electronic technician.

R. D. NEFF, Professor of Nuclear Engineering, Radiological Safety Officer. Ph.D., Biophysics and Nuclear Medicine, U.C.L.A. Certified Health Physicist, American Board of Health Physics. Twenty five years experience as a Professional Health Physicist in Reactor Accelerator, and Fuel Fabrication Facilities. Consultant for Battelle and Nuclear Regulatory Commission in the Program for Health Physics Appraisal at Operating Nuclear Power Plants. Consultant for other companies in environmental and operational Health Physics.

J. D. RANDALL, Director of Nuclear Science Center, Professor, Nuclear Engineering, TAMU. Ph.D., P.E. License Examiner for USNRC. Past Chairman, Reactor Operations Division, ANS Fellow and Recipient of Exceptional Service Award, ANS.

C. A. HASSELL, Assistant Professor of Chemistry. Ph.D., Nuclear Chemistry, TAMU, 1975. Six years as Assistant Director of Freshman Chemistry Programs at TAMU.

H. J. DEICL, Senior Health Physicist at Nuclear Science Center. B.S., Radiation Protection Engr., St. Edwards Univ., Austin, Texas, 1978. 1978-80: Medical Physics, King Faisal Specialist Hospital and Research Center, Riyadh, Saudi Arabia. Two years experience as Health Physics Instructor, Texas State Technical Institute, Waco, Texas. Thirteen years as Radiation Safety Officer, Cornell University, Itaha, NY. Four years U.S. Navy Submarine Nuclear Power Program.

C. H. HOLSTE, Instructor of Chemistry Labs. M.S., Zool, Iowa State Univ., Ames, IA, 1972. Four years as Chemistry Lab Instructor at TAMU. Four years as Zoology Instructor, Iowa State Univ.

J. E. SIMEK, Assistant Radiological Safety Officer. M.S., Nuclear Engineering/ Health Physics, TAMU. Certified Health Physicist - American Board of Health Physics, Member of the Texas Governor's Advisory Board on Low Level Radioactive Waste. 22 years Health Physics experience including Research Reactor Health Physics, Cyclotron Health Physics and Radioisotope Laboratory Health Physics. Areas of expertise are Federal, State and Transportation Regulations, Instrumentation, Bioassay Procedures, TLD and Film Dosimetry, and Radioactive Waste Management.

P. S. SANDEL, Senior Health Physicist. M.S., Biophysics/Health Physics, TAMU. 27 years experience including Research and Production Reactor Health Physics, Cyclotron Health Physics, Radioisotope Laboratory Health Physics and Associated Instrument Calibration, Dosimetry, Bioassay and Waste Management and Disposal. Four years experience with the Nuclear Regulatory Program as an inspector.

D. E. FELTZ, Associate Director of Nuclear Science Center. M.S., Nuclear Engineering, TAMU, 1963. 23 years experience at NSC, TAMU (in addition to Associate Director, has served as Assistant Director, Chief of Facility Operations, Reactor Supervisor, Graduate Assistant). One year experience as Engineer in Training, Texas Power and Light. Two years in U.S. Army Artillery.

R. D. ROGERS, Manager of Reactor Operations at Nuclear Science Center. B.S., Nuclear Engr., TAMU, 1981. 1979-1981: Senior Reactor Operator, NSC, TAMU. Three years experience at U.S. Naval Nuclear Power Training Unit, S1W Prototype, Idaho Falls, Idaho (Staff Instructor - Classroom Phase Leading Reactor Operator, Crew Reactor Operator Training Petty Officer, Crew Staff Reactor Operator Instructor). Three years experience as Reactor Operator/Electronics Technician, U.S.S. Nautilus.

C. M. MEYER, Instructor of Health Physics. B.S., Nuclear Engr., TAMU, 1980. Two years experience as lab technician and instructor.

J. G. HEAD, Instructor of Health Physics. B.S., Nuclear Engr., TAMU, 1980. Two years experience as Engineering Research Associate.

Kansas Gas and Electric Company

HP/RadChem Course

Instructors

From

University of Kansas

and

Kansas State University

August 1983

		MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Sept.	5- 9	Vacation	MA	MA	MA	MA
	12-16	MA/EL(2)	MA/EL(2)	MA/EL(2)	MA/EL(2)	MA/EL(2)
	19-23	MA/CH	MA/CH	MA/CH	HP	MA/CH
	26-30	MA/CH	CH	MA/CH	HP	MA/CH
Oct.	3- 7	CH	RI	CH	HP	CH
	10-14	CH	RI	CH	HP	CHL/HPL
	17-21	CHL/RIL	RI	RIL/HPL	HP	CHL/HPL
	24-28	CHL/RIL	RI	RIL/HPL	HP	CHL/HPL
	31- 4	CHL/RIL	RI	RC	HP	HP
Nov.	7-11	CHL/RIL	RI	RC	CHL/HPL	Vacation
	14-18	CHL/RIL	RI	RC	HP	CHL/HPL
	21-25	CHL/RIL	RI	CHL/HPL	Vacation	Vacation
	28- 2	RI	RI	RIL/HPL	HP	RIL/HPL
Dec.	5- 9	RI	RI	RIL/HPL	HP	RIL/HPL
	12-16	NP	NP	RIL	HP	RIL
	19-23	NP				

			Begin	End	Hours*
MA	-	Math	9- 6	9-30	65
CH	-	Chemistry	9-19	10-12	57
EL	-	Electricity/Electronics	9-12	9-16	10
RC	-	Radiochemistry	11- 2	11-16	18
NP	-	Neutron Physics	12-12	12-19	18
RI	-	Radiation Instrumentation	10- 4	12- 6	72
HP	-	Health Physics	9-22	12-15	72
RIL	-	Radiation Instrumentation Lab	10-17	12-16	48
HPL	-	Health Physics Lab	10-14	12- 9	36
CHL	-	Chemistry Lab	10-14	11-23	36

* Assume 6 hours full day and 3 hours half day.
MA/EL(2) = 4 hours math and 2 hours electricity.

Revised 23 August 1983

SCHEDULE

RADIATION INSTRUMENTATION

and

NEUTRON PHYSICS

	DATE	TOPIC	INSTRUCTOR
RI	October 4	Radiation Sources	Simons
	October 11	Radiation Interactions	Simons
	October 18	General Properties of Radiation Detectors	Simons
	October 25	Counting Statistics and Error Prediction	Eckhoff
	November 1	Gas-Filled Detectors	Simons
	November 8	Scintillation Counters	Eckhoff
	November 15	Semiconductor Detectors	Eckhoff
	November 22	Neutron Detectors	Eckhoff
	November 28	Electronics	Simons
	November 29	Thermoluminescence Dosimetry	Simons
	December 5	Neutron Activation Analysis	Eckhoff
	December 6	Background Radiation	Eckhoff
NP	December 12	Nuclear Energy Fundamentals	Eckhoff
	December 13	Nuclear Reactions and Radiation	Simons
	December 19	Lab on KSU Campus	Eckhoff Simons

SCHEDULE

RADIATION INSTRUMENTATION LABORATORY

DATE	EXPERIMENT
October 17	Ionization chambers
19	Geiger muller counter (Plateau and counting statistics)
24	Geiger mueller counter resolving time (split source)
26	Geiger mueller counter efficiency calibration (various beta energies)
31	Proportional counter plateau (alpha and beta)
November 7	Proportional counter resolving time
14	Proportional counter efficiency calibration (alpha and beta)
21	NaI scintillation detector (energy and efficiency calibration)
30	NaI gamma spectrum using single channel analyzer
December 2	NaI gamma spectrum using multi channel analyzer
7	Intrinsic Ge gamma spectrum (energy and efficiency calibration)
9	Liquid scintillation counting
14	Portable instruments (GM and ionization chamber survey meters)
16	Portable instruments (Neutron proportional counter and alpha scintillation counter)

RADIATION BIOPHYSICS
THE UNIVERSITY OF KANSAS
Lawrence, Kansas 66045

Nuclear Reactor Center
West 15th Street

Phone: (913) 864-3867

SCHEDULE
KG&E HP TECHNICIAN COURSE
FALL 1983

	DATE	TOPIC	INSTRUCTOR
HP	September 22	Mechanics, Electricity and Energy Transfer	Milavickas
	September 29	Quantum Theory, Atomic Structure	Milavickas
	October 6	The Nucleus, Radioactivity and Decay Mechanisms	Milavickas
	October 13	Kinetics of Decay, The Curie (Bq), Naturally Occuring Radioactivity and Serial Decay	Milavickas
	October 20	Interaction of Radiation with Matter	Claycamp
	October 27	Interaction of Radiation with Matter	Claycamp
	November 3	Radiation Dosimetry	Claycamp
	November 4	Biological Effects of Radiation	Shaw
	November 17	Radiation Protection Guides	Claycamp
	December 1	External Radiation Protection	Friesen
	December 8	Internal Radiation Protection	Friesen
	December 15	Evaluation of Protective Measures	Friesen
RC	November 2	Statistics, Types of Radiation	Shaw
	November 9	Decay-Growth, Carrier Methods, Isotopic Dilution Method	Shaw
	November 16	Tracer Concept, Separations	Shaw

Radiochemistry: Text: Chase and Rabinowitz. Principles of Radioisotope Methodology, 1968, Chapters 4-6, 10-13.

Reference: Overman and Clark. Radioisotope Techniques, McGraw-Hill, New York, 1960. (This book is probably out of print. Supplemental material from it will be provided by us. It may be helpful to the students if you could get a hold of copies for reference purposes.)

SCHEDULE

HEALTH PHYSICS LABORATORY

DATE	EXPERIMENT
October 14	Pocket ionization chamber (PIC) use and calibration
19	Survey instrument calibration
21	TLD calibration
26	Radiation field surveys and contamination surveys
28	Air sampling
November 10	Control points and use of anti-C's
18	Handling and shipping of radioactive waste and radioisotopes
23	Personnel contamination monitoring and decontamination
30	Radiation work permits
December 2	Personnel exposure records -ALARA computer
7	Decontamination of areas and equipment
9	Bioassays (liquid scintillation counting)

CHEMISTRY SCHEDULE

INSTRUCTOR: DENNIS PARKS

Monday, September 19 12:30 - 4:30	Chapter #1 - Introduction	Questions: 26, 2 30, 31, 32, 33, 3 39, 40, 41, 42, 4 44, 45, 46, 49 Problems: 52, 54 62, 64, 67, 70, 7 73, 74, 76, 77, 7 79, 80
Tuesday, September 20 12:30 - 4:30	Chapter #2 - Physical Properties of Gases	Questions: 19, 2 21, 23, 24, 25, 3 31, 32, 33, 36 Problems: 37, 41, 42, 47, 48, 49, 5 55, 56, 57, 58
Wednesday, September 21 12:30 - 4:30	Chapter #3 - Atoms and Molecules. A Quantitative Approach	Questions: 24, 2 26, 27, 31, 36, 3 38, 39, 41, 42 Problems: 43, 44, 45, 47, 49, 51, 5 55, 56, 61, 69, 7
Friday, September 23 12:30 - 4:30	Chapter #4 - Quantitative Aspects of Chemical Reactions	Questions: 33, 3 36, 37, 38, 39, 4 45, 47, 50, Problems: 54, 56, 58, 60, 64, 68, 7 78, 80, 82, 85, 8
Monday, September 26 12:30 - 4:30	Review EXAM #1 Chapters 1, 2, 3, 4	
Tuesday, September 27 8:00 - 4:30	Go over EXAM #1	
	Chapter #6 - The Properties of Elements and the Periodic Table	Questions: 10, 1 15, 21, 22, 24, 2 28, 34, 35, 41, 4 47, 51, 53, 56, 6
	Chapter #7 - Atomic Structure and the Formation of Ionic Compounds	Questions: 13, 1 27, 28, 29, 31, 3 36, 43, 46, 49, 6 62, 63, 65, 71, 7 77, 78

Wednesday, September 28 12:30 - 4:30	Chapter #8 - The Formation of Molecular Compounds: Covalent Bonding	Questions: 24, 26, 27, 28, 29, 34, 44, 49, 53, 56, 57, 59, 60, 61, 62, 63, 64, 66, 68, 69, 70, 71. 72, 73, 74, 76, 77,7
Friday, September 30 12:30 - 4:30	Finish Chapter #8	
	Chapter #10 - Liquids, Solids, and Changes of State	Questions: 8, 9, 10 11, 12, 16, 18, 19, 23, 30, 34, 50, 52,5 Problems: 62,63
Monday, October 3 8:00 - 4:30	Finish Chapter #10	
	Review Chapters 6, 7, 8, 10	
	Chapter #11 - Solutions and Colloids	Questions: 27, 34, 35, 36, 37, 38, 39, 40, 41, 42, 53, 54, 55, 56, 58, 60, 63, 64, 66 Problems: 67, 74, 77, 85
	Review	
Wednesday, October 5 8:00 - 4:30	Review Chapters 6, 7, 8, 10, 11	
	EXAM #2 Chapters 6, 7, 8, 10, 11	
	Go over EXAM #2	
	Chapter #16 - Equilibrium	Questions: 26, 28, 30, 34, 40, 43, 44, 47, 49, 50, 51, 54,5 Problems: 66, 68, 72, 76, 79, 82, 84,8
Friday, October 7 8:00 - 4:30	Finish Chapter #16	
	Chapter #17 - Acid- Base Equilibria	Questions: 38, 39, 40, 41, 45, 50, 53, 56, 61, 62, 63, 64 Problems: 65, 67, 73, 77, 80, 87, 94, 96, 100

Monday, Octtober 10
8:00 - 4:30

Finish Chapter #17

Chapter #18 - Electrochemistry

Questions: 20, 25, 30, 31, 33, 45, 47, 49, 55, 56, 57, 58

Problems: 64, 67, 69, 72, 76, 80, 81

Wednesday, October 12
8:00 - 4:30

Finish Chapter #18

Review Chapters 16, 17, 18

Exam #3 Chapters 16, 17, 18

Go over Exam #3

SCHEDULE

CHEMISTRY LABORATORY

DATE	EXPERIMENT	
October 14	CHM-02-230A	Determination of pH
17	CHM-02-072A	Determination of chloride
21	CHM-02-130	Determination of fluoride
24	CHM-02-100	Determination of conductivity
28	CHM-02-101	Determination of cation conductivity
31	CHM-02-052	Determination of boron
November 7 10	CHM-02-[illegible]61	Determination of sodium (AA)
14 18	CHM-02-250	Determination of silica (UV)
21 23	CHM-02-090	Determination of oxygen and/or nitrogen (GC)