Inland Steel Mining Company
Minorca Mine
P.O. Box 1 — U.S. 53 North
Virginia, Minnesota 55792

218 749-5910

Inland Steel Mining

December 30, 1987

U. S. Nuclear Regulatory Commission
Region III
Material Licensing Section
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Gentlemen:

We are requesting an amendment to our license number SMN-1974, expiration date of October 31, 1991, with the addition of:

> Texas nuclear model NOLA system (see attachment) containing 2.9 gram plutonium-238 source. The density system containing 500 millicuries of Cesium-137 is already covered under our by-product materials license number 22-16791-01. In addition to the two primary sources, there is a 0.5 micro-curie Americium-241 source internal to the unit and used for stabilization of the electronics only. Please add it to #SMN-1974 or #22-16791-01.

Your prompt response will be appreciated.

Sincerely,

C. W. Porter
C. W. Porter
General Foreman - Electrical
and Pit Maintenance

CWP:djs

Enclosures

cc: Texas Nuclear Corporation

8903020711 880125
REG3 LIC70
SNM-1974 PNU

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Log Jan 5th
Remitter
Check No. 108031
Amount 360
Fee Category 1J 3P
Type of Fee amd
Date Check Rec'd
Date Completed 1/15/89
By: CP

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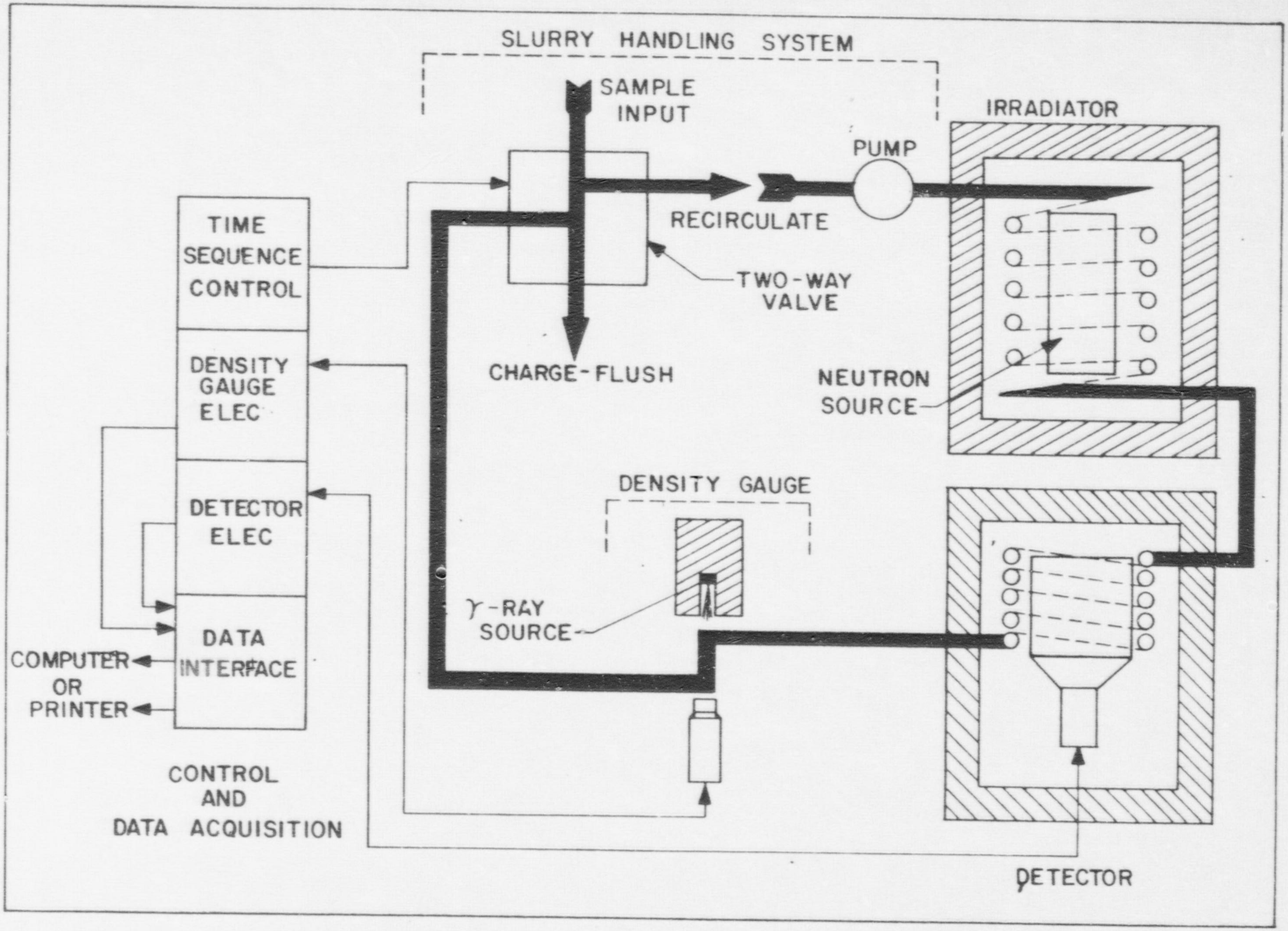
Technical Data

This system will be used for elemental determinations in iron ore and is being supplied to Inland Steel Mining, Minorca Mines by Texas Nuclear Corporation 9101 Highway 183, Austin, Texas 78758. The system is shown on a drawing labeled "Schematic Representation of NOLA I". The slurry is cycled continuously through the irradiate cell and the detector for analysis.

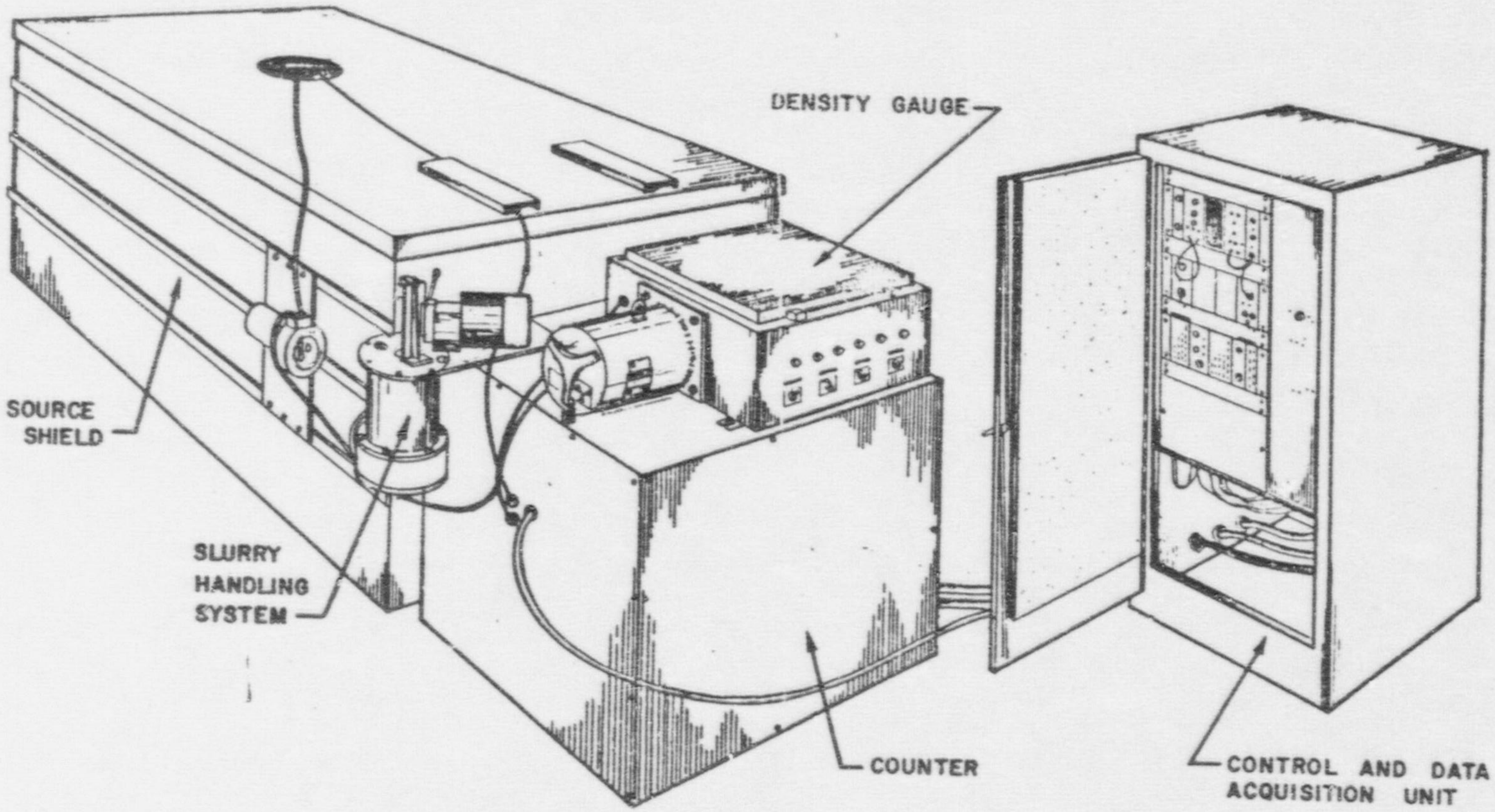
The general layout of the NOLA System is shown on the drawing labeled "Nola I Silica Analyzer". The system will be installed in the NOLA and INSCAN test building being constructed inside our concentrator building

as shown on drawings Inland Steel Mining Co. Dwg 04-FF-002.

This room has solid floors and walls and can easily be secured against unauthorized entry. The environmental conditions at the installation site are dry - temperature variation for winter is 50°-70°F., for summer is 75°-90°F.



SCHEMATIC REPRESENTATION OF NOLA I



NOLA I SILICA ANALYZER

The principal hazards of concern in this system are:

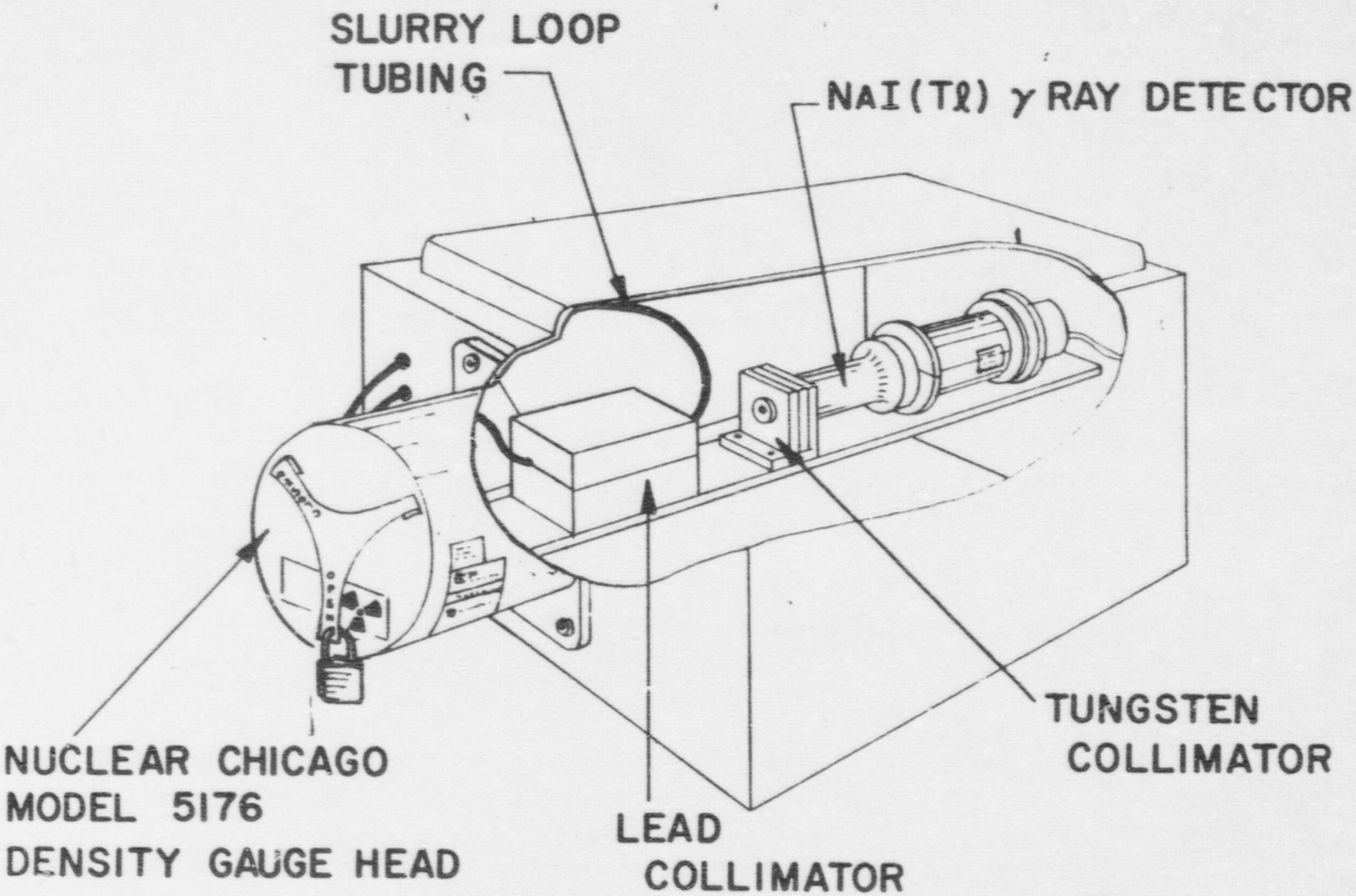
a) Exposure to radiation outside the shield under normal operating conditions;
b) Failure of the source capsule inside the shield;
c) Exposure to radiation under emergency conditions;
d) Disposal of the activated materials.

Density Channel

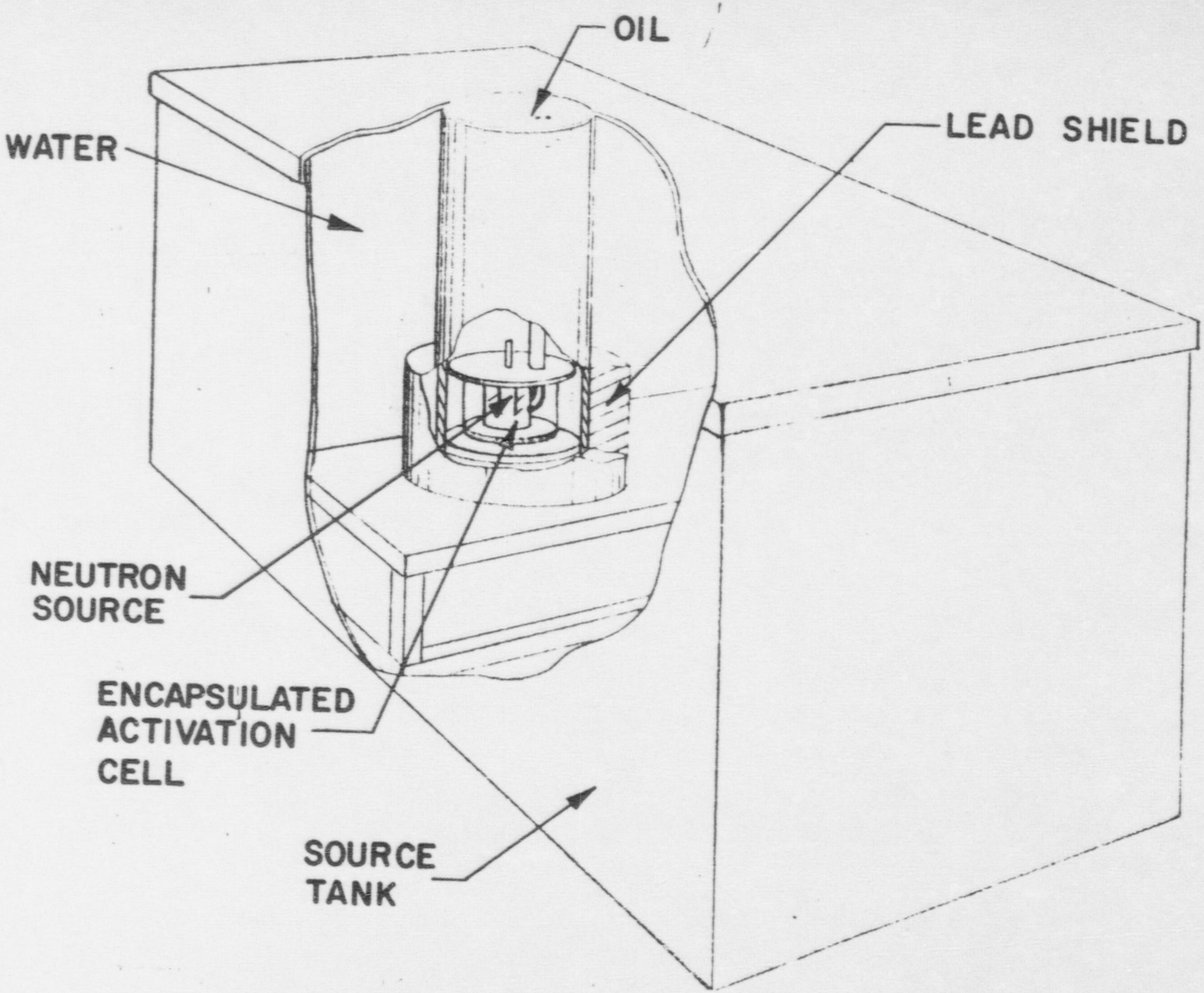
The density channel is shown in the drawing titled "Nola I Density Gauge". The 5176 source head acts as a complete storage container for the 500 mCi Cs-137 sealed source, Texas Nuclear Model 570-57157C, both prior and subsequent to installation of the system. The radiation levels one foot from any accessible surface are less than 0.5 mR/hr. In the event work must be done inside the detector box, the shutter will be closed and locked before such work begins. This source will be leak tested at least once every three years in accordance with Texas Nuclear procedure QT/1K (see appendix). No waste disposal is involved. If the use of the gauge is discontinued, the source will be returned to Texas Nuclear for disposal.

Silicon Channel

The construction of the shield is detailed on the drawing titled "Neutron Source Shield" (see appendix) and schematically shown in the figure titled "Nola I Irradiator". The source is threaded onto a stud at the bottom of the inner cell. The irradiate cell slips over the source and can be installed and removed without moving or unshielding the source.



NOLA I ~~DENSITY~~ GAUGE



NOLA I IRRADIATOR

The Plutonium 238-Beryllium neutron source contains approximately 2.9 grams of Plutonium-238 as an oxide mixed with 15.2 grams of Beryllium. The neutron emission rate of the source is 1.1×10^8 n/sec., and the source was fabricated to the specifications shown on the drawing labeled "Pu8Be-Source Capsule" by Monsanto Research Corporation, Dayton, Ohio.

An analysis of pressure build-up due to alpha particle decay of the contained Pu-238 was made. This analysis was based upon a maximum loading of 4.24 grams of PuO_2, 80% enriched in Pu-238 at an initial pressure of one atmosphere. We assumed that the Helium obeyed the Ideal Gas Law and that ambient temperature was 70°C. We additionally said that 30% of the internal volume was void due to the approximate 70% compaction of theoretical density that one gets after pressing the PuO_2-Be pellet.

In the activation analysis system one can estimate the useful life of the source to be 80 years, based on the required sensitivity of the measurement. This would mean a pressure build-up of approximately 400 psia. One can calculate the bursting pressure of the inner capsule, using the tensile strength of 304 SS as 85,000 psi, to be greater than 6,400 psia. Prototypes of this capsule have been tested under American National Standards Institute procedures and classified E43333.

Radiation exposure rates outside the neutron source shield are shown at typical survey points on the drawing labeled "Neutron Source Shield". The source itself is shielded as shown, with lead and water on all sides except the top, which is covered by 33 inches of oil. This filling insures access to install or remove the teflon irradiation cell without undue radiation exposure (reference Cell Check and Removal Procedure). The cover plate has a cable and lock to insure that only authorized personnel have access to the cell. As usual, the shield is massive and the exposure rates are very low due mainly to the high sensitivity of the system detectors rather than personnel exposure considerations. The sensitivity of these detectors also provides an additional margin of safety, since they will indicate a change in performance if some abnormality occurs. Clearly, exposure to radiation outside the shield is minimal.

The large water shield also had a low water warning system consisting of a Cutler-Hammer Level Probe, located approximately one-half inch below the tank top, and connected to a Cutler-Hammer standard duty fail safe relay. The alarm circuit will indicate when the water level is approximately one inch below the tank top. At that time, one would not observe any appreciable increase in the dose rates as presented. Lights on the control panel indicate the status of the water level. A contact closure is also provided for remote alarms if desirable.

The water shield has a chemical additive to inhibit corrosion and organic growth identified as NALCO 39-L, and supplied by

Nalco Chemical Company
5757 Bellaire Blvd.
Houston, Texas.

Water replenishment, if ever necessary, would be a manual operation as there is no provision for automatic filling.

The physical location of the sample room, the building construction and general house-keeping conditions make it unlikely that conditions could exist which would endanger the shielding properties of the primary container. Although we cannot envision the accident, if such occurred, we would attempt to evacuate personnel from the area of the source, notify the Radiation Safety Officer and Texas Nuclear Health Physics, and await instructions and/or the arrival of trained personnel to evaluate the situation. However, the dose rates are not so high as to preclude maintenance on the tank. One can estimate the unattenuated dose rate at a meter to be slightly more than 100 mrem/hr by using:

a) neutron emission = 10^8 n/sec,
b) average first collision dose in tissue = 4.0×10^{-9} rad/n/cm^2,
c) mean quality factor = 8.5 for Pu8-Be neutrons,
d) adding the gamma contribution from both the 4.43 MeV state of C-12 and the 2.2 MeV emission from neutron capture in Hydrogen.

Additionally, note that the source is not unshielded if all the water is out of the tank. There is a 5 inch oil bath plus the irradiation cell and the 20 inch O.D. lead half-annulus to consider. In fact, except for near the floor level, and the tank end away from the large crystal detector, the total dose rates would not exceed 15 mrem/hr at the nearest point of the shield tank with no water.

Failure of the source inside the shield is remote at best. This type of capsule construction has been used for some time with few failures. Also, a failure of the source would change the optimized geometry and this would immediately affect the operation of the system. Therefore, we propose to leak test this source using the procedure entitled "Leak Test of Activation Analysis Sources", (see Appendix) at least once every six months under normal conditions, and at any other times the operational data lead us to suspect that some source or cell abnormality has occurred. In the event the leak test is positive, we will discontinue use of the system, secure the room and await further instructions from Texas Nuclear and the Inland Steel Safety Officer. We believe that even a ruptured source could be safely contained for some time in the shield with little probability that contamination would be a hazard outside the container.

The following are additional items that are an integral part of our program:

a) The system will be installed by trained personnel of Texas Nuclear Corporation.
b) Personnel will receive training in the operation and hazards of the activation analysis system by Texas Nuclear personnel.
c) Radiation surveys will be made at the time of installation by Texas Nuclear and copies will be retained for inspection.
d) Personnel working around the activation analysis system will not use personnel monitors. It is unlikely that any individual can approach a whole body dose of 0.125 rem per quarter.
e) Personnel will not remove the source from the primary shield. In the event that circumstances lead us to believe that the shield is no longer an integral unit, personnel will be removed from the area and Texas Nuclear will be notified.

f) The pumping system will not be turned off with material in the irradiate cell during normal operation. Prior to shutdown, we will flush the system with water. To insure that no material remains in the irradiate cell, we will continue to flush and drain until the gamma spectrometer count rate approaches background.

g) In the event the use of the system is discontinued, the removal and disposal of the radioactive material will be handled by Texas Nuclear.

These points and included procedures will be incorporated in the operations manual provided by Texas Nuclear.

There is only very low-level radioactive waste generated in this system. In operation (reference "Schematic Representation of Nola I") a small sample of iron ore slurry is recirculated through the activate cell and count cell for five minutes. It can then be dumped either into a waste line or back into the produce line. None of the activated material is ever released to any area that directly connects to any life support chain.

The iron ore slurry has as its principal constituents Fe_2O_3 (60-70%) and SiO_2 (3-20%). Table I lists some data on the more prominent activation reactions possible. Consider that in operation we put in 100 grams of iron ore for a five minute irradiation every cycle. For neutron irradiations of this type, the formula

$$A = \frac{N n_f \sigma S}{(3.7 \times 10^{10})}$$

where A = Activity in curies
n_f = Neutron flux
S = Saturation factor - $(1-e^{-\lambda t})$
N = Number of target atoms available
σ = Activation cross section

will estimate the amount of activity produced per irradiation within an order of magnitude.

However, experimentally it has been determined, in a five minute count period, that the Si^{28} $(n,p)Al^{28}$ reaction produces about 1.5×10^{-2} μCi of Al^{28} in the system.

All the other reactions, except Fe^{54} $(r,\gamma)Fe^{55}$ have comparable cross-sections, but will not produce as much radioactive material as the above reaction because their half-lives are long compared to the irradiation time. Therefore, the saturation factor for these reactions is much smaller.

In summary, we propose that no significant hazard exists either to employees or the general public, in the routine release of the amounts of radioactive material produced in this system. We, therefore, will not make routine monitoring or sampling part of our safety program.

Element	Isotope Activated and Abundance	Type of Reaction and Cross Section at 14 MeV (mb)	Activation Threshold (MeV)	Product Nuclide	Half-Life of Activity	Gamma-Ray Energies (MeV) and Relative Abundances
O	O^{16} (99.8%)	(n,p), 40	10.0	N^{16}	7.14 sec	6.1, 7.1
Si	Si^{28} (92.2%)	(n,p), 160	3.8	Al^{28}	2.3 min	1.77
Si	Si^{30} (3.09%)	(n,γ), 110 *	-	Si^{31}	2.62 hrs	1.26 (0.1)
Fe	Fe^{54} (5.82%)	(n,γ), 2500 *	-	Fe^{55}	2.7 yrs	0.006
		(n,p), 375	2.0	Mn^{54}	290 days	Cr X-rays
Fe	Fe^{56} (91.7%)	(n,p), 110	3.9	Mn^{56}	2.58 hrs	0.845 (100) 1.81 (30) 2.13 (20)

* Thermal cross section

TABLE I

SUMMARY OF RADIATION SAFETY PRECAUTIONS

A. NOLA Density System

1. Cs-137; 500 mCi in a lead-filled source head.
2. Radiation survey provided at installation and need not be repeated.
3. Leak test once every three years. (QT/1K)*
4. Insure that the source shutter is closed during all maintenance on the electronics and leak testing.

B. NOLA Activation Analysis System

1. Pu-238-Be emitting 1.1×10^8 n/sec.
2. Radiation survey provided at installation . need not be repeated.
3. Leak Test once every six months. (Leak Testing of Activation Analysis Sources)*
4. Radiation fields under normal conditions of use are very low.
5. The source is affixed to a plate at the bottom of the oil bath.
6. Loss of the entire water shield does not preclude repair with the source in place. The maximum radiation levels without the water shield would be approximately 15 millirem per hour at the tank.
7. Inland Steel Mining will not remove the source.
8. The slurry loop is always to be flushed with water prior to any shutdown.
9. Removal of the irradiate cell requires the handling of slightly radioactive materials. The activation products built-up will not create radiation fields that are high in terms of significant dose. One should be aware of them and, if appropriate instrumentation is available, monitor these fields during handling of the irradiate cell. Gloves should be worn during handling and the hands washed upon completion. All components should be cleaned and stored away from occupied areas until reassembly. Familiarization with the "Cell Check and Removal Procedure" is advised.

APPENDIX

TABLE OF CONTENTS

Item No.

LEAK TEST PROCEDURE - QT/1K

The gauge or instrument should not be dismantled or disassembled in order to leak test. Testing of the external seams, flanges, and surfaces is usually adequate. Each kit is designed and supplied to test one source.

1. If the device(s) to be tested has a movable shutter, position the shutter to the closed position, if it does not interfere with process. Try to determine if the shutter is free and movable. In the event that the shutter is frozen, difficult to rotate, or appears damaged, notify:

   Texas Nuclear Corporation
   Health Physics Section
   512/836-0801, ext. 310 or 311

2. Visually inspect the source head with particular attention to welded seams. If discontinuous welding is observed or any cracks suspected, notify Texas Nuclear. Inspect gauge tags. They must be clear and legible. If gauge is chain mounted, inspect chain and/or seams for any signs of stress. If stress is evident, notify Texas Nuclear immediately.

3 Read Carefully and understand the information contained in "Additional Instructions" and on any sketch or drawing. Make sure one has the correct procedure by matching the Model Number of the device with that on the instruction sheet.

4. Remove the two cotton-tipped applicators and the bottle containing the wash solution.

5. Moisten the applicators in the solution and wipe the source holder surfaces, around seams and bolts, where contamination is most likely to appear. The areas to wipe test will be better defined in a drawing or in the "Additional Instructions."

6. After wiping, place the applicators in the bottle (cotton down) and break the wooden stems off against the bottle edge so that the top can be resealed. Care should be taken not to touch the cotton end of the applicators with the fingers following the wiping operation.

7. After securely sealing, place the bottle containing the cotton tips and solution back in the mailing tube. Identify (verify) the device tested by Model and Serial Number on the enclosed Leak Test Certification sheet.

8. Place the information sheets back in the mailing tube and reseal.

9. Use the self-addressed label to return to Texas Nuclear.

10. Post Office department regulations prohibit the shipment of radioactive material through the mail if the level of radiation at the outer surface of the mailing tube exceeds 0.5 milliroentgens/hour (mR/h). Therefore, the mailing tube should be surveyed with an appropriate radiation detector, if such is available, prior to mailing, and if the level exceeds 0.5 mR/h, notify Texas Nuclear for further instructions.

11. If after reading these instructions there is still some question as to procedure, please contact Texas Nuclear Health Physics before proceeding.

MANUFACTURER: TEXAS NUCLEAR

MODEL NO.: ALL MODELS

Notes:

Upon receipt, the applicators will be counted on appropriate laboratory instrumentation that has a demonstrated sensitivity and accuracy for the particular isotope being tested. If the applicators are found to be free of contamination, a notice will be sent via mail in the form of a leak test certificate. If the applicators are found to contain significant amounts of radioactive material, an emergency notification will be sent, via telephone or telegram, advising that the unit must be taken out of service and what additional action should be taken. The sensitivity of the measurement will be stated on the leak test certificate.

Additional Instructions:

CELL CHECK AND REMOVAL PROCEDURE

This procedure is utilized only after the counting data leads one to believe that some abnormality has occurred to the source or irradiate cell.

1. The operator should shut off the input of slurry, actuate the main valve, and open the water flush valve to clean the system.

2. Leak test the source according to the Leak Test Procedure, and do not proceed on cell removal until the results of the test are received.

3. If leak test results are negative, proceed with cell removal as outlined below and in the section titled "Removal of Activate Cell" (reference Inner Source Shield Assembly Drawing).

4. Cover the working area at the top of the tank with absorbent material.

5. Position a plastic pan nearby so that the encapsulation cell can be lifted up through the oil and placed in the pan with no spillage. Handle the cell with rubber gloves which can be easily washed.

6. Measure the radiation exposure rates from the encapsulation cell to insure that the levels are low enough to proceed. For example, exposure rates at the surface of the cell up to 25 mR/hr should be considered acceptable.

7. The components of the encapsulation cell assembly should be monitored as disassembly proceeds, and all parts should be cleaned thoroughly as soon as practicable.

Texas Nuclear Corporation

LEAK TEST OF ACTIVATION ANALYSIS SOURCES

The system should not be dismantled to leak test the source.

1. Check the oil level with the dip stick. In the event the oil level is significantly below normal, close and lock the cover and notify Texas Nuclear Corporation Health Physics, immediately at 512/836-0801, extension 310.
2. With the source and cell in position, dip out two to four ounces of shield fluid from down near the top of the cell, and pour it into the sample bottle supplied with the test kit. Close and lock the top cover plate.
3. Cap the bottle and tape the top closed to provide a positive seal.
4. Fill in the provided sheet with full identification, including model number, serial number, and date.
5. Place the bottle in the mailing tube and send as follows:

   Texas Nuclear Corporation
   P.O. Box 9267
   Austin, Texas 78766
   ATTN: Health Physics

Upon receipt of the oil sample, the fluid will be diluted in HCL (1-normal) and then filtered. It will then be evaporated to dryness and counted for alpha contamination. If found free of contamination, a notice will be sent via air mail, in the form of a leak test certificate, that the source is leak free. If the oil is found to contain detectable amounts of alpha contamination, notification will be sent, via telephone or telegram, advising that the oil bath should not be opened and that an additional leak test sample is to be taken and sent by air to Texas Nuclear for analysis. If the second sample contains alpha contamination, notification will be sent advising that Texas Nuclear personnel will be sent to remove the source for return to the manufacturer. Under no circumstances is the shield to be opened during this period of time.