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TITLE

PROJECT PROPOSAL

EFFLUENT WATER MONITORING IMPROVEMENTS – EXISTING 100 AREAS –

cS-578

AUTHOR

A. A. Janos

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PROJECT PROPOSAL

EFFLUENT WATER MONITORING IMPROVEMENTS

EXISTING 100 AREAS

HANFORD ATOMIC PRODUCTS OPERATION
ENGINEERING DEPARTMENT
DESIGN SECTION

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PROJECT PROPOSAL

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION

DATE December 7, 1953

PROJECT NO. CW-578 REV. NO.

TITLE EFFLUENT WATER MONITORING IMPROVEMENTS - EXISTING 100 AREAS

Estimated Total Project Cost $670,000

Funds Requested $670,000

ATTACHMENTS

Preliminary Plans
Graphic Schedules
Design Cost Estimate
Project Cost Estimate

WORK TO BE COMMENCED

Detail Design: 2 weeks after authorization
Procurement: 6 weeks after authorization
Field Work: 36 weeks after authorization

WORK TO BE COMPLETED

Detail Design: 49 weeks after authorization

Facilities Ready for Use:
100-H Area: 44 weeks after authorization
Last 100 Area: 94 weeks after authorization

Physically Complete: 104 weeks after authorization

ENGINEERING BY	M E Freeman	12/10/53 DATE
PREPARED BY	A A Janos	12/10/53 DATE
CHECKED BY	C. E. Kent	12/10/53 DATE
APPROVED	J L Boyd, Design Planning	12-10-53 DATE
	W Milton, Process Engineering	12-11-53 DATE
	W. Sale, Finance	12.14.53 DATE
DNE	R K Beaton, Design	12-16-53 DATE
	[illegible], Projects	1/5/54 DATE
	O. H. Greager, Technical	1/5/54 DATE
	L. B. Bradley, Work Review	12/18/53 DATE
	J M Smith, Radiological Sciences	12-31-53 DATE
	J. H. Warren, Manufacturing-Reactor	1-27-54 DATE
	[illegible], Manufacturing	1-28-54 DATE
	[illegible], Engineering	1-19-54 DATE

HANFORD ATOMIC PRODUCTS OPERATION
A & B COMMITTEE

APPROVED _____ SECRETARY _____ DATE

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PROJECT PROPOSAL

EFFLUENT WATER MONITORING IMPROVEMENTS

EXISTING 100 AREAS

TABLE OF CONTENTS

		Page
	SUMMARY	4
I.	EXISTING FACILITIES AND TO WHAT EXTENT INADEQUATE	4
II.	DESCRIPTION OF PROPOSED FACILITIES AND WORK	9
III.	ADVANTAGES TO BE GAINED AND JUSTIFICATION FOR PROPOSED WORK	11
IV.	WHY ALTERNATE FACILITIES CANNOT BE USED	15
V.	CLASSIFICATION OF THE PROJECT AND ASSIGNMENT OF RESPONSIBILITY	18
VI.	METHODS OF PERFORMING WORK	18
VII.	PROPOSED STARTING AND COMPLETION DATES	18
VIII.	RELATED TRANSFERRED CAPITAL PROPERTY	18
IX.	REQUEST FOR AUTHORIZATION AND BUDGET STATUS	19
X.	ESTIMATE OF COSTS	19
XI.	REMARKS	19
XII.	ATTACHMENTS	20

PROJECT PROPOSAL
EFFLUENT WATER MONITORING IMPROVEMENTS
EXISTING 100 AREAS

SUMMARY

It is proposed to provide improved effluent water monitoring systems in the 105 Reactor Buildings at 100-B, D, F, DR, H, and C; and to modify or remove portions of the existing monitoring systems. The primary objectives of the proposed work are: to reduce relatively the amount of lost production due to stuck ruptures and leaking tubes; to minimize the amount of water entering the reactor from such tube leaks - such water may shorten the life of the reactor; to provide an improved detection of ruptured slugs under the expected more rigorous reactor conditions; to eliminate operational inadequacies of existing systems and allow confident action based upon instrument readings; and to provide additional information for the slug development program.

The total estimated project cost is $670,000. The proposed work would be performed over a period of about two years, with field work performed by General Electric Plant Forces.

Authorization is requested for project management and for total project funds.

I. EXISTING FACILITIES AND TO WHAT EXTENT INADEQUATE

In the Hanford reactors, the fuel elements under irradiation rest inside the aluminum alloy process tubes and a flow of water is maintained through the tubes, passing from front to rear via the annulus between the fuel element and tube wall. The effluent water flows from the tubes, through flexible connectors (pigtails) into crossheaders. Water from the crossheaders normally flows through the risers, downcomer(s), process sewers, retention basins, and outfall sewers to the river.

The fuel element (slug) consists principally of a uranium cylinder enclosed in a can of aluminum alloy, with a bonding material between the uranium and the can. In the process of irradiation, some slug cans rupture with associated release of fission products to the water. There are various adverse consequences associated with ruptures.

Upon detection and confirmation of a ruptured slug, the reactor is shut down and the rear pigtails and nozzles of the suspected row of tubes are monitored manually with a portable instrument to determine the specific tube containing the ruptured slug. This tube is then prepared for discharge operations. If the ruptured slug is not stuck, all the slugs in the tube are displaced with a new charge. If the ruptured slug is stuck and/or the process tube is leaking, both the tube and its slugs are removed and the tube is replaced. In the event of a leaking tube, subsequent downtime is usually required to partially dry the graphite prior to startup. After startup, in some instances, the reactor must be operated at a reduced level for some time to await further drying of the graphite.

In each existing reactor (105-B, D, F, DR, H, and C), samples of effluent water are piped from both ends of each rear crossheader and from each rear riser to an instrument system for the purpose of monitoring this water in order to detect ruptured slugs and to indicate the horizontal row of tubes containing the ruptured slug. This system is commonly called the effluent monitoring system.

The existing effluent monitoring systems are of two general types: the "Hanford-Beta" type system installed at 100-B, D, F, DR, and H; and the "C-Beta" type system at 100-C. Both systems employ a beta-sensitive ionization chamber but they differ in system design.

The Hanford-Beta systems employ "shim-stock" and saran tubing type ionization chambers. The water sample being monitored flows through an annulus outside this chamber and from there to a drain. Samples from several sources are sequentially fed to one such chamber. The accuracy of readings for two successive samples depends upon the degree of water displacement from the annulus during the time between the two readings. The water samples are carried by tubing from the crossheaders and risers through a hold-up chamber. This hold-up chamber allows partial decay of some interfering high-intensity activity. From the hold-up chamber, the sample flows to a system of solenoid valves and from there into the annulus around the ionization chamber. The solenoid valves are activated by a one-cycle timer per reactor to control the sampling time and sequence. The electrical impulse from the reading of each sample is compared against the reading of an opposite sample coming from a different crossheader. The radioactivity level of reactor effluent is affected by variables other than the existence of a ruptured slug. Difference in local power level is such a variable. In the use of the monitoring system, it is assumed that only one of the two companion samples will represent a rupture at any given time. The purpose of the comparison, or "bucking," system, then, is to provide a measurement reference somewhat free from such other conditions as power level. In the case of the Hanford-Beta, the matching of the signals from the two bucked samples under conditions of no rupture must be achieved by regulation of water flow rate. These signals are amplified and recorded in the sample rooms and the control room in each area.

The B, D, and F reactors have six sample rooms, eight ionization chambers, 39 crossheaders, and 80 sample points. The ionization chambers are located one in each of the six sample rooms, plus one independent chamber for each of the two riser samples. These latter chambers are located in the two lowest sample rooms. In DR and H, there are two sample rooms, six ionization chambers, 23 crossheaders, and a total of 48 sample points. The chambers are located in each of the two sample rooms.

The C-type Beta system is an improvement over the Hanford-Beta system. It contains 94 sample points, one coming from each end of its 46 rear crossheaders, and one from each of its two rear risers. The water samples flow by tubing to their respective individual ionization chambers. The piping system to the ionization chamber contains no hold-up chamber; the time delay for activity decay

In each existing reactor (105-B, D, F, DR, H, and C), samples of effluent water are piped from both ends of each rear crossheader and from each rear riser to an instrument system for the purpose of monitoring this water in order to detect ruptured slugs and to indicate the horizontal row of tubes containing the ruptured slug. This system is commonly called the effluent monitoring system.

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being accomplished by throttling individual sample line water flows. Water from the ionization chambers is piped to drains. A bucking system similar to the Hanford-Beta is employed. Also, this system contains provisions for matching signals from companion sample points under conditions of no rupture by electrical means rather than water flow controls. There are 47 ionization chambers located in each of the two sample rooms.

Other supplemental methods of monitoring the effluent water for fission products include: (1) routine checks of separate samples with portable Geiger Muller survey meters ("VGM"), (2) laboratory measurement of special samples from suspect crossheaders (filtered samples), and (3) ionization chambers located at the 107 retention basin inlets.

At the B, D, F, DR, and H reactors, 85 slugs ruptured during the 16 month period from July 1952 through October 1953. Of these, 37 slugs, or 43.5 percent, became wedged or stuck in their process tubes; these included five slugs, or about 6 percent, which penetrated their tubes and caused water to leak into the graphite. The resultant direct total operating time lost due to these stuck ruptures and leaking tubes was about 1,160 reactor hours. Of the total of 85 ruptures, 30 ruptures, or 35 percent, were not detected ever by the existing effluent monitors.

The 100-C reactor has been in operation since November 1952. In the eleven month period from November 1952 through October 1953, this reactor had 20 ruptured slugs. Of these, ten stuck, one of which penetrated its process tube. The total operating time lost at 100-C due to these stuck ruptures and the leaking tube was 158 hours. C-Beta signals from about four of the slug ruptures at C reactor were uncertain or difficult to recognize during early stages of the ruptures because small, slowly increasing concentrations of fission product activity in the effluent water are of the same order of magnitude, or smaller, than the signal variations during normal operation. Further, about 50 percent of the C reactor ruptures were not detected by the C-Beta system due to flux transient unbalances during shutdowns or startups. Signals during such periods were partially obscured by divergence of patterns.

An appreciable number of process tubes have been replaced because of external corrosion. This is thought to occur by a graphite-aluminum electrolytic couple in the presence of water. It is believed that factors other than slug ruptures have been major contributors to leaking tubes resulting in wet graphite. However, since we know that some tubes have leaked in direct conjunction with ruptured slugs, they must be a contributing factor. The outstanding example of adverse effects of external tube corrosion has been the 1952 experience at F, when about 250 tubes were replaced or taken out of production use. Production loss resulting from that experience was about 27,000 MWD.

The above statistics represent total experience in six reactors during a sixteen month period and include all types of slugs except enriched ones (C-type). During that period there have been increases in power levels, changes in the types of slugs charged, changes in the percentage of the total reactor load made up of

various types of slugs, changes in water treatment, changes in operating procedures, and a significant reduction in the average monthly number of total ruptures. An intensive development program is under way to improve slug quality. Results of this are indicated by the history of Group 9 slugs. Group 9 metal consists of 8-inch slugs, excluding the present production from Fernald. Charging of these slugs was started in January 1952. The number of stuck ruptures and leaking tubes associated with this Group has been significantly lower than the over-all average performance shown above. However, not all of the reactor tubes can be charged with 8-inch slugs; the Group 9 slugs are being displaced currently with later metal groups; and even with the quality of Group 9, there is no assurance that it is adequate for the more rigorous future reactor conditions.

During the months of September and October alone, a rapid increase in the rupture rate of 8-inch slugs, particularly of Fernald slugs, was experienced. Of the eight 8-inch slugs which ruptured in October, one was a Group 9 slug, three were Group 10 (from a batch of Group 9 and Fernald slugs), and four were Group 11 (Fernald only). The total hours lost production attributable to stuck slugs and leaking tubes resulting from stuck slugs in the two months of September and October amounted to 360. This compares with a total of 214 hours lost through similar occurrences in the preceding six months.

If the slug rupture mechanism is such that a rupture can be detected before the slug sticks or before it penetrates the tube wall, and if an adequate effluent monitoring system were available to make such detection, the production losses cited above as attributable to stuck slugs or leaking tubes could be prevented.

In addition to the above direct production considerations, there are several operational inadequacies of the existing effluent monitoring systems.

Hanford-Beta Systems - B, D, F, DR, and H Reactors

*1. During transient periods (startup and shutdown), readings from the current system are erratic and not dependable, and positive detection is improbable. Reactor conditions at such periods are considered to be most favorable to ruptures; consequently, we have the minimum protection when protection is most needed. The intended balance between two companion sample points under conditions of no rupture is frequently upset due to such things as difference in local reactor power, changes in relative flows due to restriction or temperature changes, or introduction of film fragments into the monitoring system. Such occurrences result in false indications.

2. Frequently, the annulus around the ionization chamber does not empty of one sample prior to filling with the next sample. The resultant mixing gives false instrument readings. At best, any given sample is always diluted by the liquid film remaining from the preceding sample.

*Note: Instrument chart sections attached as Figures 1 and 2 illustrate this transient period instability.

3. There is continual malfunctioning of the solenoid valves. Due to the large number of such valves, they are a point of continuing operating difficulty.

4. The flow rates in the sample lines are low. Flow stoppage or irregularity often results from such restrictions as gas bubbles.

5. Operating experience has shown it necessary to employ the filtered sample as a check on the existing effluent monitoring systems prior to shutting down the reactor for a suspected slug rupture. This requires a minimum of one-half hour for the time between suspicion of a rupture and shutting down the reactor. Continued operation with ruptured slugs is believed to contribute to stuck slugs and/or water leaks.

6. The sensitivity of the monitor or its threshold of detection has not been of the degree desired to receive significant rupture indications at early stages of the rupture. There have been many slug ruptures which either were not detected, or were detected only after the ruptures progressed and became severe. Higher sensitivities are possessed by other type of effluent monitors; for example, it is known that the Gamma monitoring system possesses a sensitivity of 15 to 30 times that of the Hanford-Beta monitor.

7. Prior to indication, or during confirmation, of a rupture, large amounts of fission products may be released to the retention basins. Since the timing of switching basin effluent flow from river to cribs is critical, there is always the potential that undesired quantities of fission products may be inadvertantly released to the river.

8. In all existing systems except F, sample water drops a short distance into an open "funnel" prior to entering the monitor chamber. The resultant water vapor causes some contamination of the sample rooms and necessitates time-consuming radiation control procedures.

C-Beta System - C Reactor

Although the C-Beta system is an improvement over the Hanford-Beta system in some respects, the inadequacies indicated in items 1, 4, 5, and 7 are applicable to the C-Beta system. Items 2, 3, and 8 above do not apply. Other inadequacies which vary in degree from those of the Hanford-Beta system are indicated below.

1. Its sensitivity is less than that of the proposed system by a factor of about 5-10.

2. About twelve times the number of ionization chambers used in the Hanford-Beta system are required. Much time is taken to service or repair these chambers.

In general, the reactors are operated to achieve maximum production consistent with safety. All of the above operational inadequacies contribute to a lack of operator confidence in the current systems, which is greater for the Hanford-Beta than for the C-Beta. As a result of this lack of confidence, it is frequently necessary to continue operation for some time after suspicion of a rupture but prior to confirmation. Of course, the longer a rupture exists prior to shutdown, the more likely it is to stick or penetrate the tube.

II. DESCRIPTION OF PROPOSED FACILITIES AND WORK

It is proposed to provide new Gamma-type effluent water monitoring systems in the 105 Reactor Buildings at 100-B, D, F, DR, H, and C; and to modify or remove portions of the existing Beta-type monitoring systems.

The purpose of the proposed systems is to monitor samples of reactor effluent water for traces of fission products which would occur in the event of a ruptured slug. The principal portion of the proposed system is a scintillation detector and associated Gamma Ray Spectrometer. Continuous water samples will be monitored by the scintillation detector. The Gamma Ray Spectrometer will amplify these signals and discriminate between signals of two selected different energies. It will send a resultant signal that is proportional to the difference between these signals to multi-point recorders with accessory alarms. Each scintillation detector will be located in a "turret" (see SK-1-1265), which is a mechanical step switching device that will enable the scintillation detector to view only one water sample at a time. Turrets and recorders will be synchronized by cycle control units. Each turret will have twelve separate monitoring positions. Each position will represent one water sample, except that for a few of the less critical samples, one position will represent two samples. A system of one turret, one scintillation detector, one Gamma Ray Spectrometer, and one multi-point recorder is designated as one monitor channel. Water samples to the turrets will be provided by tubing connections to existing sample lines. Each sample line will be provided with necessary flow indicator, flow control valves, sample taps, and shut-off valves. Existing hold-up chambers in the discharge area will be removed and replaced with tubing in all areas except C, which has no such chambers. The necessary drains, electrical connections, instrument panels, shielding, and other auxiliaries will be provided as required for a complete and operable installation. After completion, connection, and operation of the new systems, the unused portions of the existing Beta systems will be removed from the building. Contaminated parts will be buried; any reusable components such as Beckman amplifiers, recorders, and panels may be stored for future use.

The principal equipment requirements for each area are described below.

105-H and DR

Attached drawings SP-2342, SK-1-8496DR, and SK-1-1265 illustrate the facilities proposed for 105-H and DR. In each of these areas, monitoring equipment will be located in two sample rooms. Four monitoring channels will be provided for a total of about 48 samples in each area; four multi-point recorders with adjustable trip contacts will be located in each control room. New instrument panels will be provided and existing panels altered to accommodate the new equipment in the sample and control rooms. In the discharge area, existing hold-up chambers, including spares, will be replaced with tubing in all sample lines. Concrete or lead shielding will be provided for sample lines, temperature pots, and drains, as required to minimize radiation hazards in the sample rooms and adjacent normal work areas.

105-B, D, and F

Attached drawings SK-1-1253 and SK-1-1265 illustrate the facilities proposed for 105-B, D, and F. In each of these areas, monitoring equipment will be located in six sample rooms. Six monitoring channels will be provided for a total of about 80 samples in each area; six multi-point recorders with adjustable trip contacts will be located in each control room. New instrument panels will be provided and existing panels altered to accommodate the new equipment in the sample and control rooms. In the discharge area, existing hold-up chambers, including spares, will be replaced with tubing in all sample lines. Concrete or lead shielding will be provided for sample line, temperature pots, and drains, as required to minimize radiation hazards in the sample rooms and adjacent normal work areas.

105-C

Attached drawings SP-7575 and SK-1265 illustrate the facilities proposed for 100-C. Monitoring equipment will be located in two sample rooms. Eight monitoring channels will be provided for a total of about 94 samples; eight multi-point recorders with adjustable trip contacts will be located in the control room. New instrument panels will be provided and existing panels altered to accommodate the new equipment in the sample and control rooms. Existing drains will be extended to the location of the proposed new turrets. Concrete or lead shielding will be provided for drains and sample lines, as required to minimize radiation hazards in the sample rooms and adjacent normal work areas.

Spare Equipment for Existing 100 Areas

The spare equipment to be provided under this project will be seven Gamma Ray Spectrometers.

Shut-down Work

A major portion of the work will be done without affecting the operation of the reactors and the existing effluent water monitoring systems. Work requiring downtime will be scheduled to start during normally scheduled shutdowns for discharge work or other work. Since it is anticipated that discharge-area work for this project will require about 50 hours in each of Buildings 105-H and DR and about 70 hours in each of Buildings 105-B, D, and F, scheduled outages will need to extend beyond normal shut-down time. There will be minor discharge-area work in Building 105-C; however, due to the number of tie-ins that must be made in this building, about 80 outage hours will be required. The amount of required extended shut-down time could be reduced if the work in the discharge areas could start during ruptured-slug shutdowns.

III. ADVANTAGES TO BE GAINED AND JUSTIFICATION FOR PROPOSED WORK

The proposed Gamma monitoring facilities are expected to reduce future production losses from stuck ruptured slugs and tube leaks resulting from ruptured slugs. Operational inadequacies of the existing systems will be eliminated; this will allow prompt, confident action by operating personnel, based on instrument readings. They will provide improved detection under future conditions of more rigorous reactor conditions. Additional important information will be made available to the slug development program.

Production losses caused by stuck ruptured slugs and tube leaks from ruptured slugs accounted for approximately 33,000 MWD during the period between July 1952 through October 1953. At $15 per MWD, the annual value of lost production would be approximately $375,000. The savings of a portion of this loss is expected by the replacement of the Beta monitoring systems with Gamma systems at the existing reactors. At the expected future higher power levels, the losses indicated above would be proportionately higher.

Quick discharge equipment and procedure have been re-initiated throughout the 100 Areas. It is now possible to eliminate minimum downtime outages for ruptures, provided the rupture is detected before it sticks in the process tube. Each successful quick discharge of a ruptured slug, the frequency of which should increase with the use of the gamma monitoring system, will result in a savings of about 24 hours of reactor operation.

The performance of Group 9 slugs has been significantly better than that of all other uranium slugs. (The losses above reflect predominantly the performance of slugs other than Group 9.) However, there is no assurance, as indicated in Section I herein, that the degree of improvement achieved with Group 9 in the past can be expected to continue under future reactor conditions.

Lost operating time attributed to the six stuck slugs and penetrated tube during the period July 1952 through October 1953 ranged from 24.5 hours to 125 hours. Three of these process tube penetrations resulted in downtimes ranging from about 108 hours to 125 hours per tube, due to the introduction of water into the graphite. The introduction of amounts of water that cause such shutdowns does an indeterminate amount of damage to the reactor, and may eventually determine the life of the reactor. Hence, a high premium is placed on the early positive detection of slug ruptures which may penetrate process tubes. The prevention by Gamma monitoring of one very severe tube leak in one area could amortize the cost of the installation of this monitor in that area.

The Gamma monitoring system is considered to be technically superior to the existing Beta monitoring systems. Summarized in the following table are the relative characteristics of the Gamma monitor system compared to the Hanford-Beta and the C-Beta monitoring systems (ref. HW-27629).

Performance Criterion	Hanford-Beta	C-Beta	Gamma
Sensitivity or signal to background ratio	1	3	15 to 30
Local & total flux change independence	Poor (DR Pile slightly better)	Like DR	Excellent
Minimum time delay for water sampling	4-6 minutes	4-6 min.	1 minute
Loss of sensitivity due to detector contamination	Excessive	Some	Very little
Fission product selectivity	Poor	Poor	Good
Water flow rate independence	Poor	Poor	Fair
Space required for equipment	Moderate	3 times Hanford-Beta	Same as Hanford-Beta

A continuing objective of production, research and development activity is to increase reactor power levels to the maximum consistent with safety and economic considerations. A doubling of the accumulative average power level of existing reactors by 1955 is the goal of current development work (HW-29866). Particular conditions associated with these goals include: (1) increase of specific power to about twice current production experience with associated increased uranium core temperatures approaching 660° C.; and (2) increase of outlet water temperatures to as high as 105° C. Separate from power level increases, there are prospects of increasing exposure levels to 900 MWD/T for the obvious reasons of decreased processing and inventory costs per unit of plutonium. Further, an intensive program to improve fuel element quality will be pursued. The expected increase in specific power will result in increased attendant internal slug stresses. These are not clearly understood at present. Higher exit water temperatures will increase corrosion of the can wall. Present data cast question on the adequacy of current type cans to withstand corrosion rates at the higher water temperatures. Extrapolations of slug failure rate of Group 9 metal indicate that the rupture rate may increase by a factor of 4 to 10 with an increase of exposure level to 900 MWD/T. Because of the large amount unknown about rupture mechanics, and because of the variables besides exposure, such as power level, effluent water temperature, and process water treatment, these predictions cannot be considered accurate. However, data used as a function of exposure alone extrapolated smoothly to an indicated four-fold increase in slug rupture rates as goal exposure is increased from 600 MWD/T to 900 MWD/T.

From the above, it is obvious that the probability of rupture incidence from current type fuel elements will be increased appreciably under the conditions associated with goal power levels and prospective exposure levels. Development programs under way are expected to provide the further data and "know-how" to permit reactor operation at the elevated power levels, assuming an adequate fuel element. In the event that the rate of slug ruptures increases with future operating conditions, the characteristics of the proposed Gamma monitor should, by merit of its increased sensitivity and the greater expected confidence, minimize production losses due to ruptures that stick or penetrate process tubes. As a minimum, it provides an added element of insurance against possible adverse conditions during the coming period of increased power levels.

The higher sensitivity of the Gamma system will result in positive and early detection of rupture signals which are below the detection threshold of the Beta systems, or which are only suspects on the Beta systems. This is particularly important since the proportion of ruptures that are cleavages is increasing and the increased sensitivity is expected to contribute greatly to early detection of cleavage-types. Almost all ruptures at 105-C have been characterized by a relatively rapid release of large amounts of fission products into the effluent stream. This kind of rupture has been called a "cleavage" type and has been thought to be a rapid burst due to the release of stresses within the slug core. If these "cleavages" do happen instantaneously, there would be little to gain by use of the more sensitive Gamma monitoring system. However, as the result of a recent study of rupture experience at 105-C (ref. HW-29827), it was found that small concentrations of fission products do exist in the effluent stream from 10 to 70 minutes before the burst. In this study, it was concluded that the Gamma monitor might significantly reduce the number of ruptures that stuck or penetrated process tubes because: (1) it is probable that the slug does not stick or penetrate the tube before the burst; (2) the Gamma monitor is independent of flux transients which "unbalance" the existing system, particularly during transient periods; and (3) the higher sensitivity of the proposed system may indicate the pre-burst release of fission products in a manner that allows confident action.

Good stability and detection of rupture signals can be achieved at full sensitivity during transient periods (shutdowns, startups, and other periods of rapidly changing power levels), as well as during normal operation. Since the slug rupture frequency rate has been consistently higher during transient periods, this advantage is considered a very important one.

The proposed system is expected to eliminate most of the operational inadequacies of existing systems and to allow prompt, confident action based upon instrument readings. Factors contributing to operational improvements include the following:

*1. As indicated above, improved stability and detection during reactor transient periods is expected.

2. False readings due to cross-contamination between samples are highly improbable;** the system is less susceptible to contamination buildup.

3. The system is compact and simple. It incorporates the piping advantages of the C-Beta system and eliminates electrical switching; space requirements are less than one-third those for the equivalent C-Beta system. The existing** difficulties with large numbers of solenoid valves will be eliminated.

4. Higher sample flow rates will be maintained (3000-4000 cc/minute, as compared with 200-600 cc/minute). This will reduce errors due to flow restrictions or temperature unbalance.

5. Operating experience may result in the elimination of confirmatory checks such as the filtered water sample prior to shutting down the reactor for a slug rupture. This would decrease the time that a slug in the process of rupture resides in the reactor and consequently reduce the probability of sticking or penetrating the tube.

6. The sample piping system is a closed one; airborne contamination from ** the existing funnels will be eliminated in the sample rooms. Also, such a closed system would lend itself to pressurization in the future, if required.

7. It will be impossible to cancel out, inadvertently, a true rupture signal by flow rate or electronic adjustment.

8. Improper readings resulting from other radioactivities (such as from film fragments or corrosion products) will be minimized because of the ability to compare two different preselected energy bands from one sample.

*Instrument chart section attached as Figure 3 illustrates this transient period stability. It should also be noted that this chart can be compared directly with Figure 1, since these recordings were made simultaneously.

**These factors do not apply to the existing C-Beta system.

IV. WHY ALTERNATE FACILITIES CANNOT BE USED

Several alternate effluent water monitoring methods have been considered. These include:

1. C-Beta monitoring for B, D, F, DR, and H reactors, with no change to this system at the C reactor.

2. Delayed-neutron monitor.

3. duPont-type Beta monitor.

4. duPont Gamma water monitor.

5. Noble gas monitor.

6. Improvements to Hanford-Beta type at B, D, F, DR, and H reactors.

7. Improved Hanford-Beta type as the primary monitor, plus the delayed-neutron monitor as an auxiliary for confirmation purposes at B, D, F, DR, and H reactors.

Each of the above systems is discussed separately as an alternate below.

C-Beta Monitor

The installation of the C-Beta system would require about three times the space now used for the Hanford-Beta system. This space is not available in the 105-B, D, F, DR, and H Areas. Further, the cost of installing the C-Beta system would be appreciably greater than the cost of the proposed system. This system has several inadequacies relative to several of the important requirements of an effluent water monitor. These inadequacies are discussed in a previous section of this project proposal, since the C-Beta monitor is in use. While it is an improvement in some respects to the Hanford-Beta system, it is still only sensitive to changes in total Beta activity and these are not caused uniquely by rupture fission products. It compares the activity levels of samples from two different sources in the reactor; this leads to false indications due to power distribution shifts or control rod movements.

Delayed-Neutron Monitor

This system, which has been under test, has demonstrated very good long time stability. Its detection of delayed neutrons in the effluent water constitutes a means for detecting slug failures. Research and development work has indicated that it possesses a sensitivity of 5 to 10 times that of the Hanford-Beta system. The delayed neutron monitor would be sensitive to local flux unbalances because the water sources would be from different locations in the reactor. Two options would exist for monitoring the total reactor effluent. The first would have individual continual water-flow, neutron-detector units for each crossheader sample line. This system would require three times the existing available space in the B, D, F, DR, and H Areas. A second method for delayed neutron monitoring would be analogous to the Hanford-Beta system. This would, however, again introduce water mixing and dilution and solenoid valve maintenance problems. It would also be essential that the hold-up time of the water be the same each time sampled, which, in this type of system, would be difficult to accomplish.

duPont-Type Beta Monitor

This type was tested at the H reactor. A fundamental obstacle to adapting this technique to the Hanford reactors exists. From the data available, there is no reason to believe that this method would have advantages for Hanford. (Ref. HW-28566)

duPont Gamma Water Monitor

Prototype units of this system were tested at the H reactor. The duPont Gamma system differs from the Hanford Gamma monitor in several respects. One main difference is the use of a replaceable filter in the water sample line to catch and retain particulate material from a ruptured slug, and the activity from the filter is measured in relation to the activity of the filtered water. Local tests of this system have shown a gradual increase of filter activity for about a week under conditions of no rupture; an equilibrium seems to be reached in about a week. This is not entirely a radioactive equilibrium, but is partly a mechanical saturation effect which would result in a continually changing unbalanced signal for the first week. The main objection, then, to using this type of Gamma monitoring at Hanford is the filter problem, plus the difficulties and manpower costs involved in continually changing and disposing of large numbers of radioactive filters and in rebalancing the monitoring systems after these filter changes.

Noble Gas Monitoring

In the use of this method, Noble gases such as krypton and xenon formed in fission would be continuously separated and measured in order to detect ruptured slugs. Initial tests have indicated that this type of monitor possibly could be used; however, it has not been developed sufficiently for complete or final evaluation.

Improvements to Hanford-Beta Type at B, D, F, DR, and H Reactors

Several major changes could be accomplished in the Hanford-Beta monitoring system which should improve the performance of the system. These include (1) remounting of throttling valves in an inclined or offset position to eliminate air entrapment, or the replacement of these valves with needle valves; (2) addition of an adequate number of ionization chambers to each existing chamber with suitable valving and switching equipment in order to lengthen the period of flushing in the chamber; (3) the installation of an independent electrical point adjustment which will not alter the sensitivity of the system; and (4) replacement of the present trace recorders with multi-point recorders in order to allow direct point identification. It is felt that these improvements, though significant, would not improve the selectivity and sensitivity of the monitoring system to the degree desired for early ruptured slug detection. Based on a preliminary estimate, the total cost of making such improvements at the B, D, F, DR, and H reactors would be about 110 percent of the cost for installing Gamma monitors at these reactors.

Improved Hanford-Beta Type as a Primary Monitor Plus the Delayed Neutron Monitor as an Auxiliary

This system would incorporate the use of the improved Hanford-Beta monitor with the delayed neutron monitor as an auxiliary, for confirmation of ruptured slug purposes at the B, D, F, DR, and H reactors. Although the use of a confirming auxiliary would add to the performance of a monitoring system, the objections to each component of this system advanced above rules it out as an alternate. Furthermore, a combination system of this type would cost about 140 percent of the cost for Gamma monitoring installations at the above reactors.

V. CLASSIFICATION OF THE PROJECT AND ASSIGNMENT OF RESPONSIBILITY

It is proposed that this project be classified as Plant Improvement and that it be charged to plant capital accounts. This project is classified as process.

It is recommended that Management Responsibility for this project be assigned to the General Electric Company, that Using Department Responsibility be assigned to the Manufacturing Department, and that Project Management Responsibility be assigned to the Engineering Department, General Electric Company.

VI. METHODS OF PERFORMING WORK

It is recommended that design, field engineering, and procurement be performed by the General Electric Company. It is proposed that the physical performance of all work be by Plant Forces of the General Electric Company. It is planned that the major portion of the work be done without plant shutdowns and that modifications in the discharge areas and all connections to existing systems be made during scheduled shutdowns.

VII. PROPOSED STARTING AND COMPLETION DATES

The following are the proposed starting and completion dates, in weeks after the authorization requested herein.

Start detail design	2
Complete detail design	49
Start procurement	6
Start performance of work	36
105-H installation ready for use	44
Last Area ready for use	94
Physical completion	104

It is planned that installation in the second Area will start about two months after the first installation is ready for use. The purpose of this interim period is to gain operating experience with the first system, so that minor changes of detail that may be shown desirable in operating the first installation can be incorporated in subsequent installations.

An interim period of two to three weeks will be required to calibrate and "run in" the Gamma installation in each Area after the installation is ready for use. This will amount to 12 to 18 weeks of the total project schedule. During these periods of reactor operation, water samples will be monitored by use of Geiger Muller survey meters and, in order to check suspects, by laboratory measurement.

VIII. RELATED TRANSFERRED CAPITAL PROPERTY

There is no related transferred capital property.

IX. REQUEST FOR AUTHORIZATION AND BUDGET STATUS

The total estimated project cost is $670,000. Authorization is requested to manage this project and to incur costs in the amount of $670,000 in accordance with the provisions of Contract W-31-109-Eng.-52.

This project was included in the FY 1954 budget as approved by Congress as Budget Item 2041-F in the amount of $550,000. The estimated cost of this project does not exceed the budget amount by 35 percent or more.

X. ESTIMATE OF COSTS

The total estimated project cost is $670,000, of which $49,000 is for design and $54,500 is for construction contingency.

Estimates are based on a 40-hour work week for design and field work, except that shut-down work is based on working three shifts per day, with occasional overtime.

The estimated direct costs are based upon "Special Work Permit" operation for all discharge area work and for a minor portion of the sample room work. An allowance of $2,000 is included for additional Radiation Monitoring work necessitated by this project.

The estimate was prepared by the Estimating and Unit Cost Unit, and back-up details are in their possession.

XI. REMARKS

This project proposal was prepared by Design Section, Engineering Department, as requested by Manufacturing Department in Work Order B-99393.

The proposed Gamma monitoring system was developed by Technical Section, Engineering Department, under the Reactor Research and Development Program. It is being tested at 105-H under PT-105-523-A.

UNCLASSIFIED

XII. ATTACHMENTS

A. Preliminary Schematic Plans, Details, and Sections of Recorder Charts

1. Sections of Recorder Charts from Existing Effluent Water Beta Monitors and Prototype Gamma Monitor

Section of Recorder Chart from H Reactor Effluent Water Beta Monitor	-	Figure 1
Section of Recorder Chart from C Reactor Effluent Water Beta Monitor	-	Figure 2
Section of Recorder Chart from H Reactor Prototype Effluent Water Gamma Monitor	-	Figure 3

2. Preliminary Schematic Plans and Details

SK-1-1253	-	Gamma Type Water Monitor System, 105-B, D, F Areas
SK-1-8496DR	-	Gamma Type Water Monitor System, 105-DR Area
SP-2342	-	Gamma Type Water Monitor System, 105-H Area
SP-7575	-	Gamma Type Water Monitor System, 105-C Area
SK-1-1265	-	Gamma Type Water Monitor System, Details - 105-B, D, F, DR, H, and C Areas

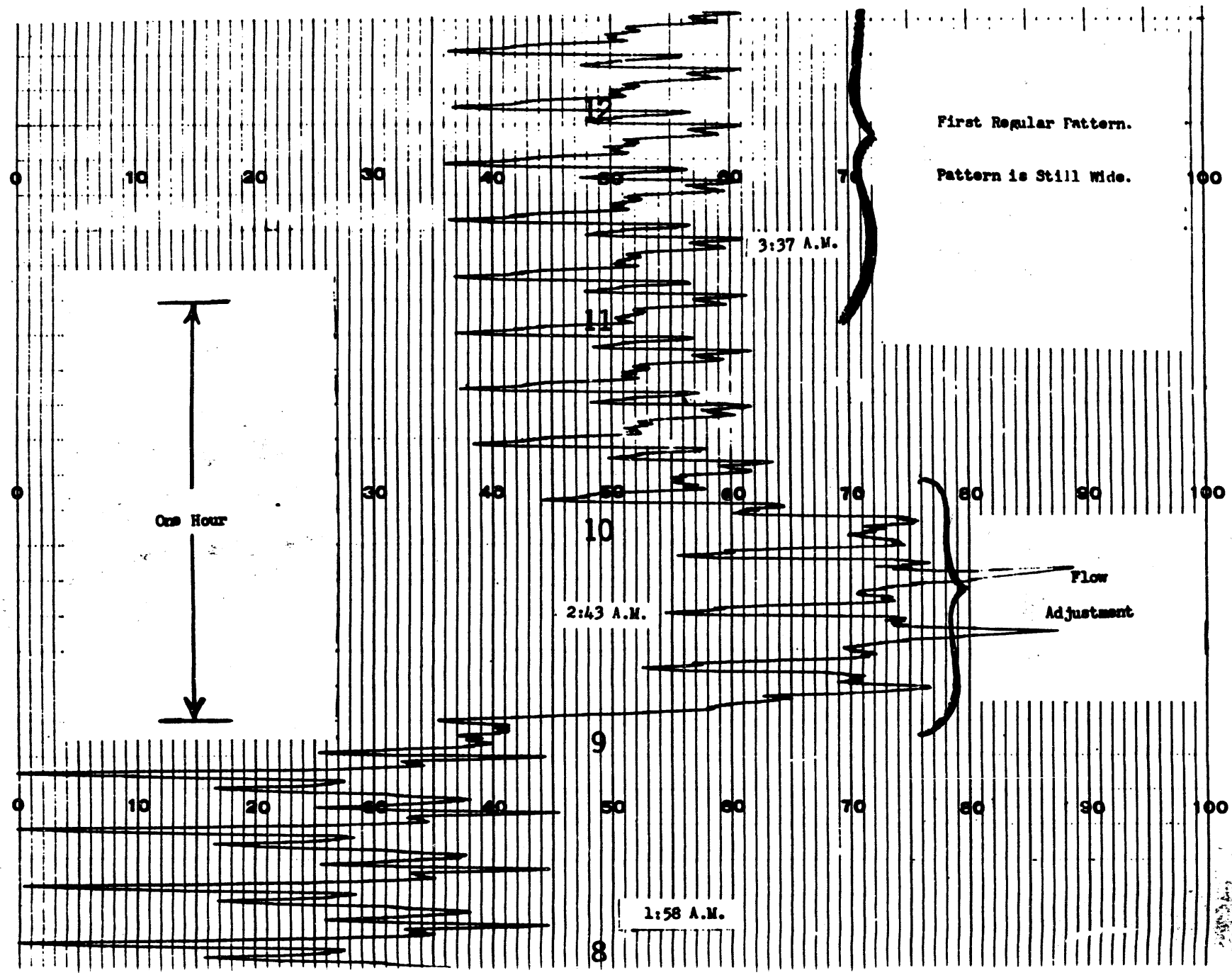
B. Proposed Completion Schedule

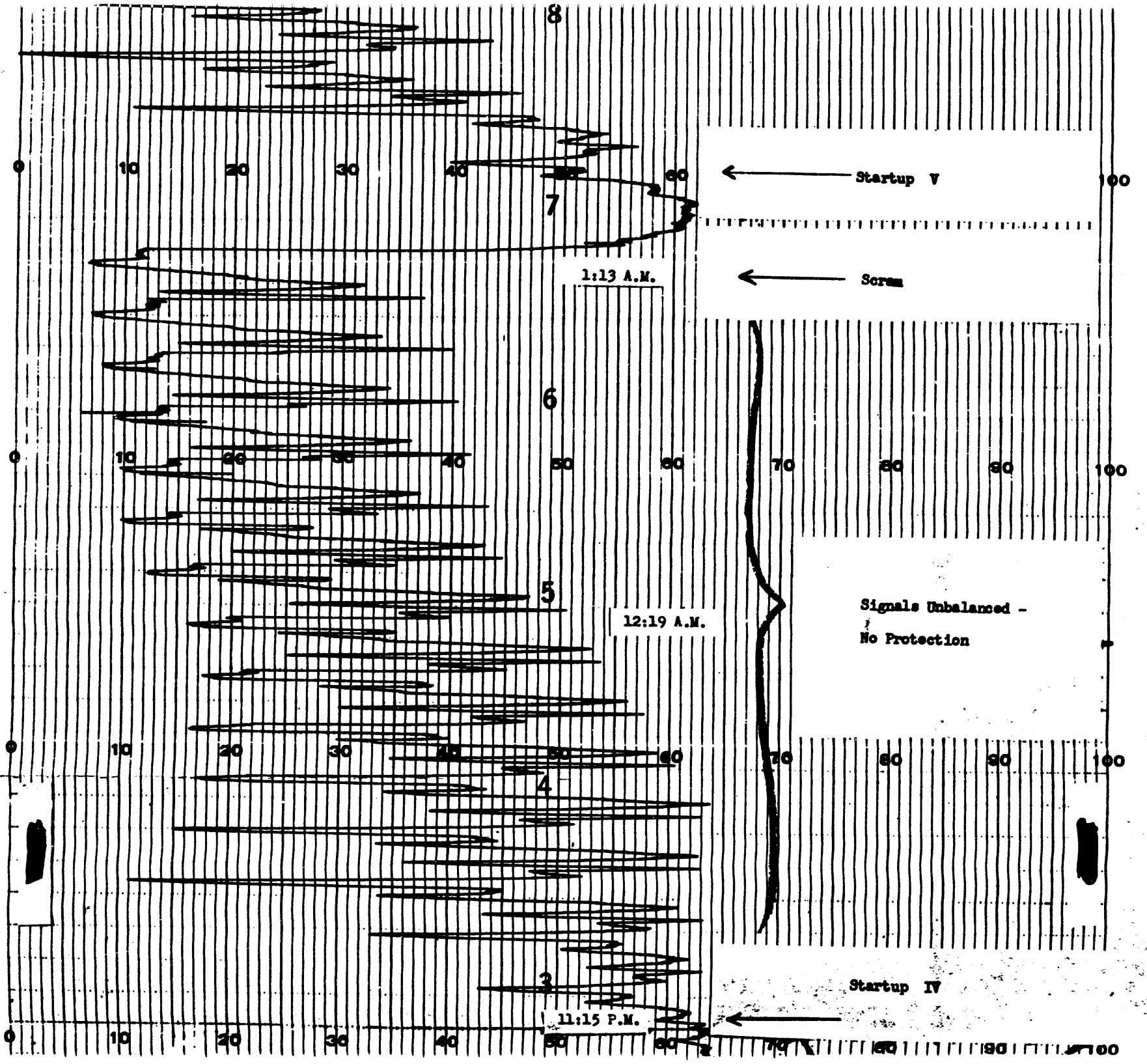
C. Estimated Force Requirements

D. Schedule of Critical Materials and Equipment

E. Design Cost Estimate

F. Project Cost Estimate


First Regular Pattern.
Pattern is Still Wide.
3:37 A.M.
One Hour
Flow
Adjustment
2:43 A.M.
1:58 A.M.
12
11
10
9
8
0
10
20
30
40
50
60
70
80
90
100


8
7
6
5
4
3
0
10
20
30
40
50
60
70
80
90
100
Startup V
Scram
1:13 A.M.
12:19 A.M.
Signals Unbalanced -
No Protection
Startup IV
11:15 P.M.

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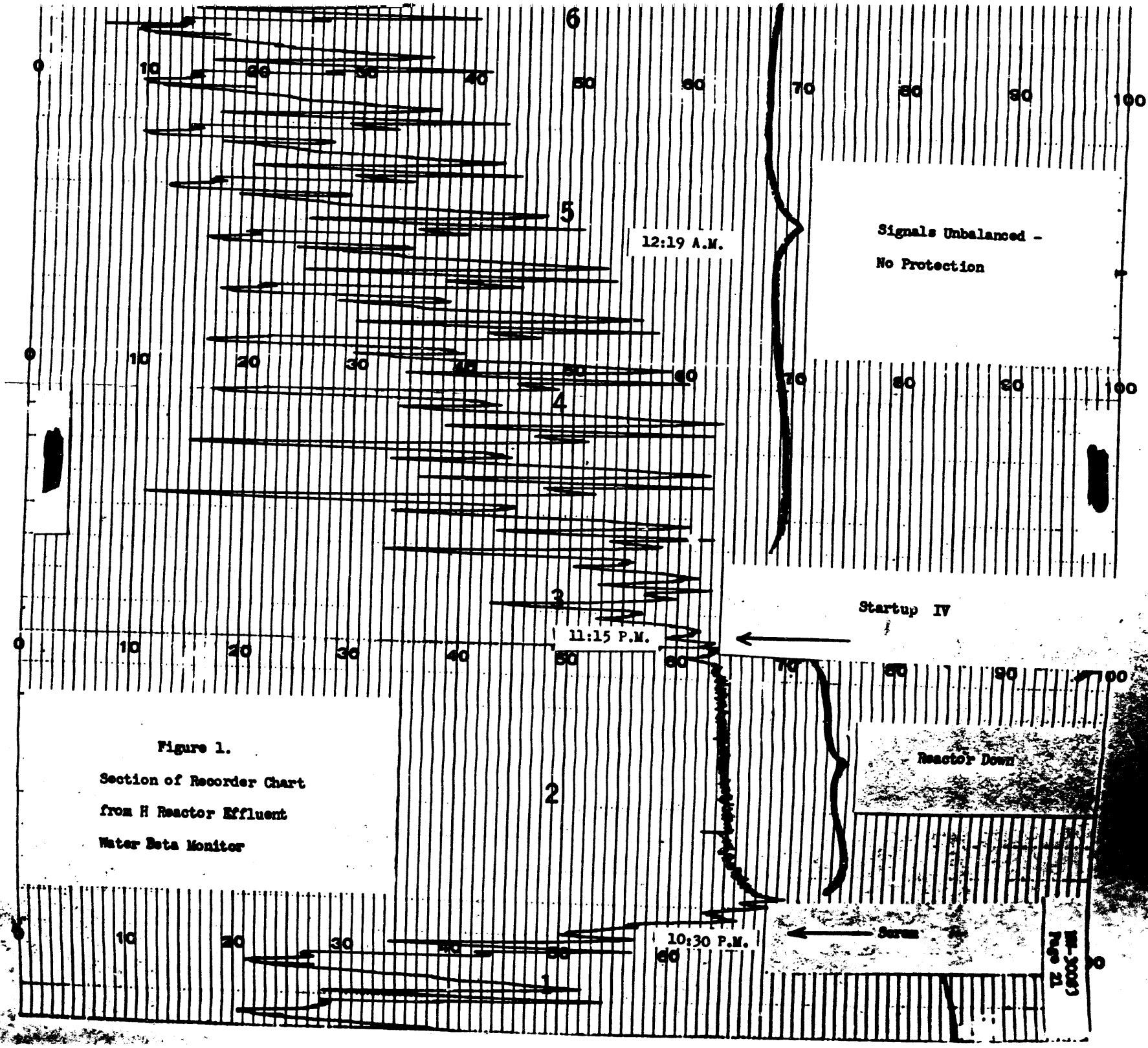

Figure 1.

Section of Recorder Chart

from H Reactor Effluent

Water Beta Monitor

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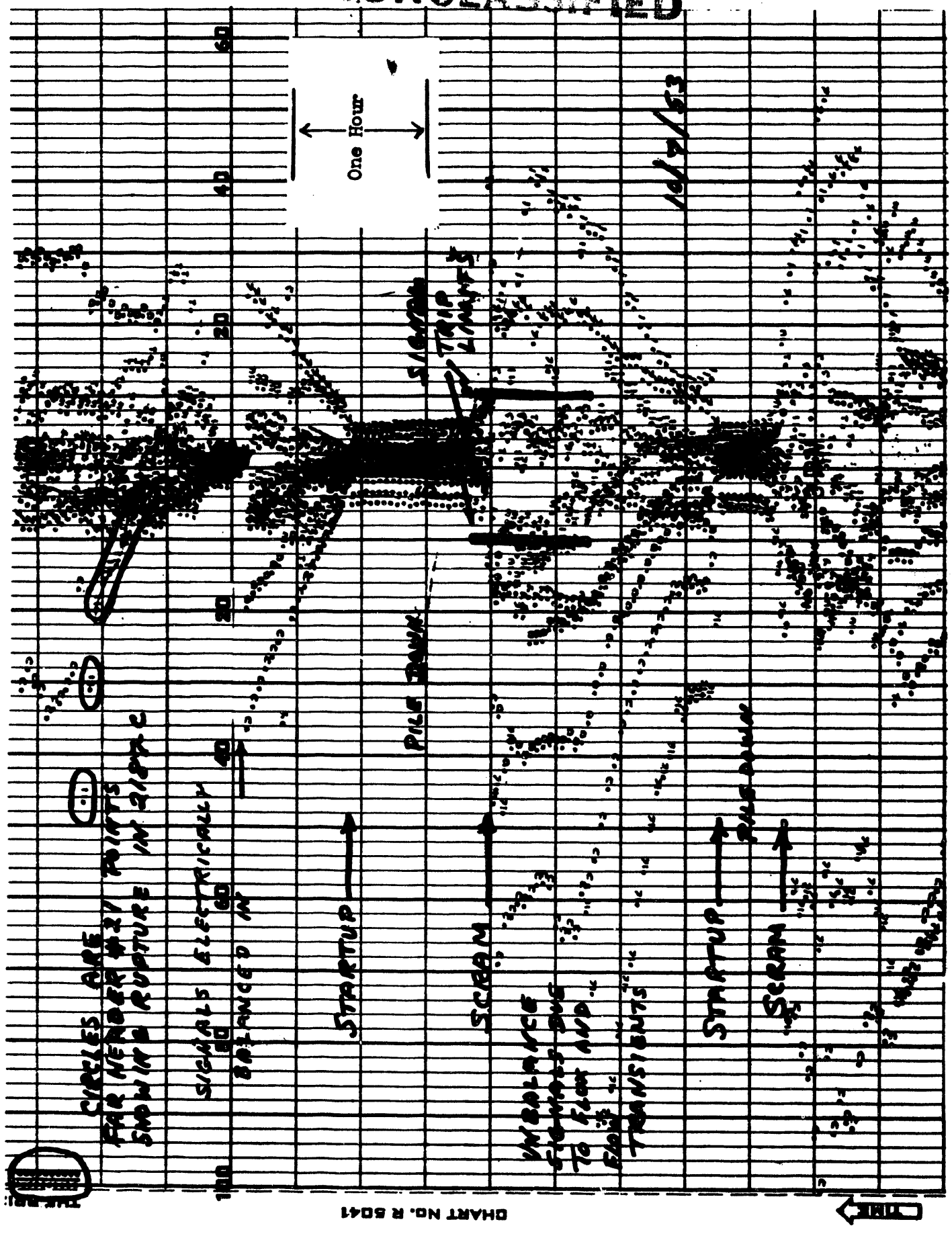
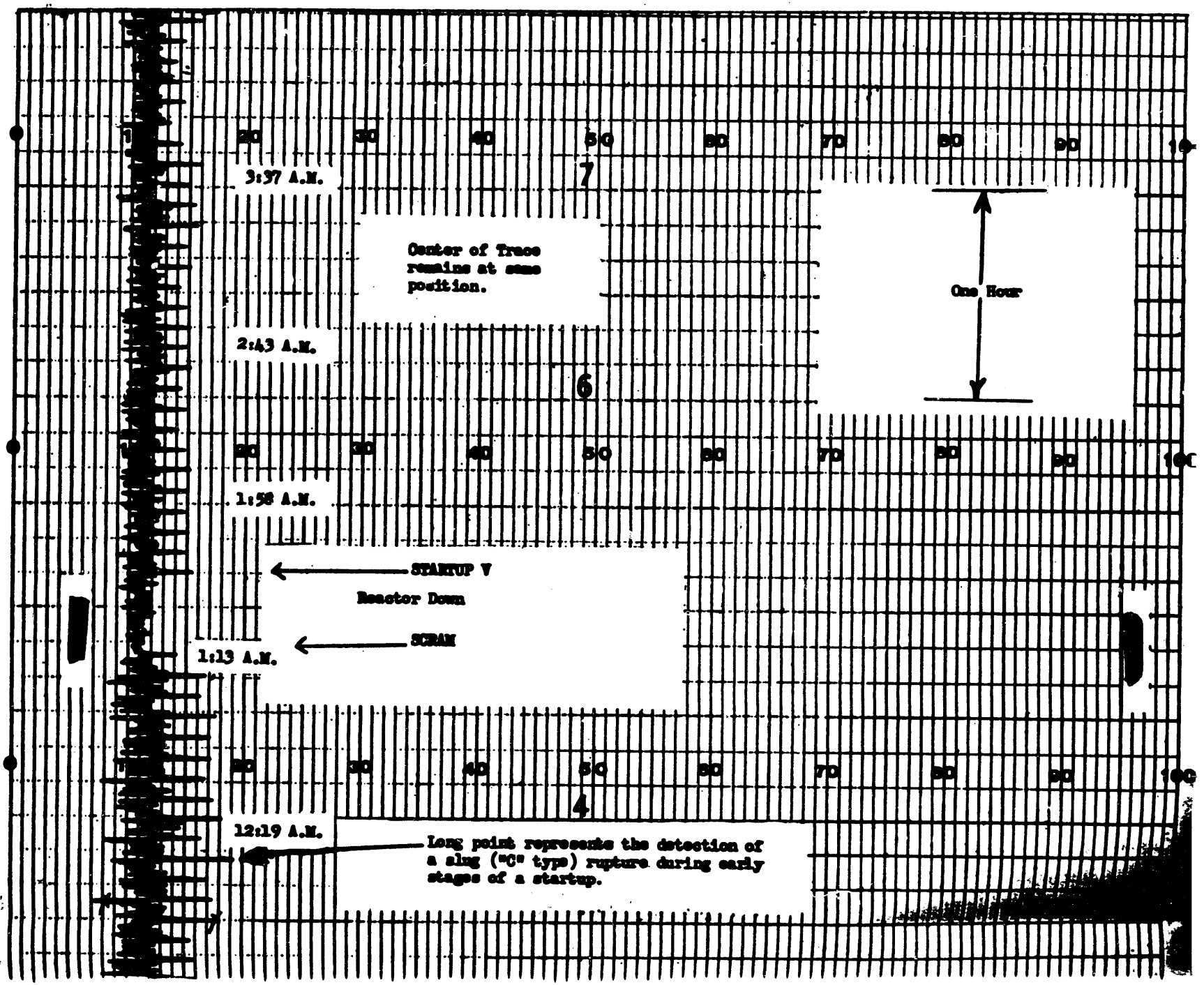


Figure 2. Section of Recorder Chart from G Pile Effluent Water Beta Monitor.


20
30
40
50
60
70
80
90
100
3:37 A.M.
7
Center of Trace remains at same position.
One Hour
2:43 A.M.
6
1:58 A.M.
STARTUP V
Reactor Down
SCRAM
1:13 A.M.
4
12:19 A.M.
Long point represents the detection of a slug ("C" type) rupture during early stages of a startup.

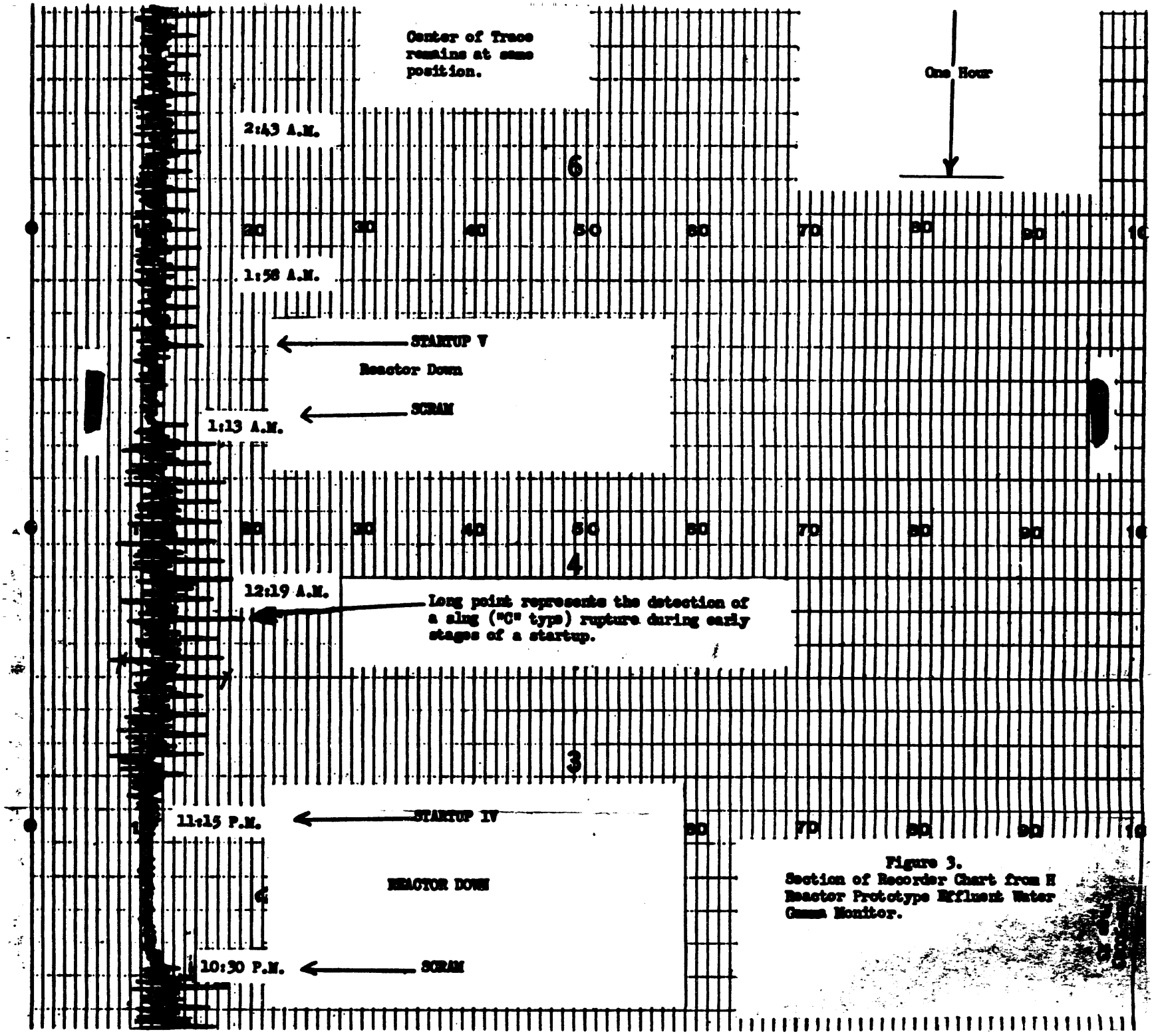
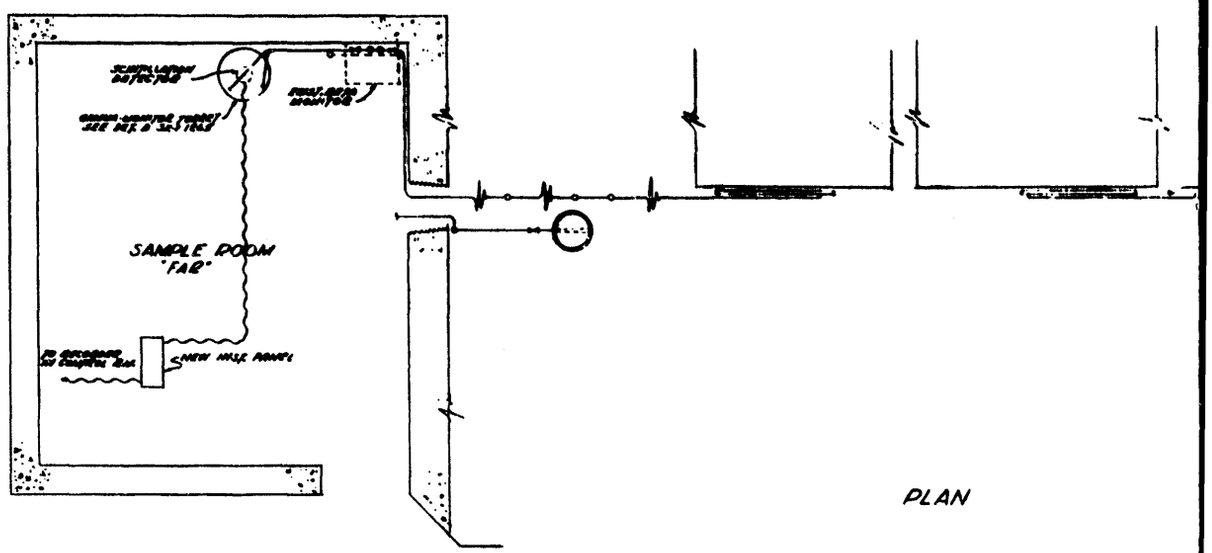
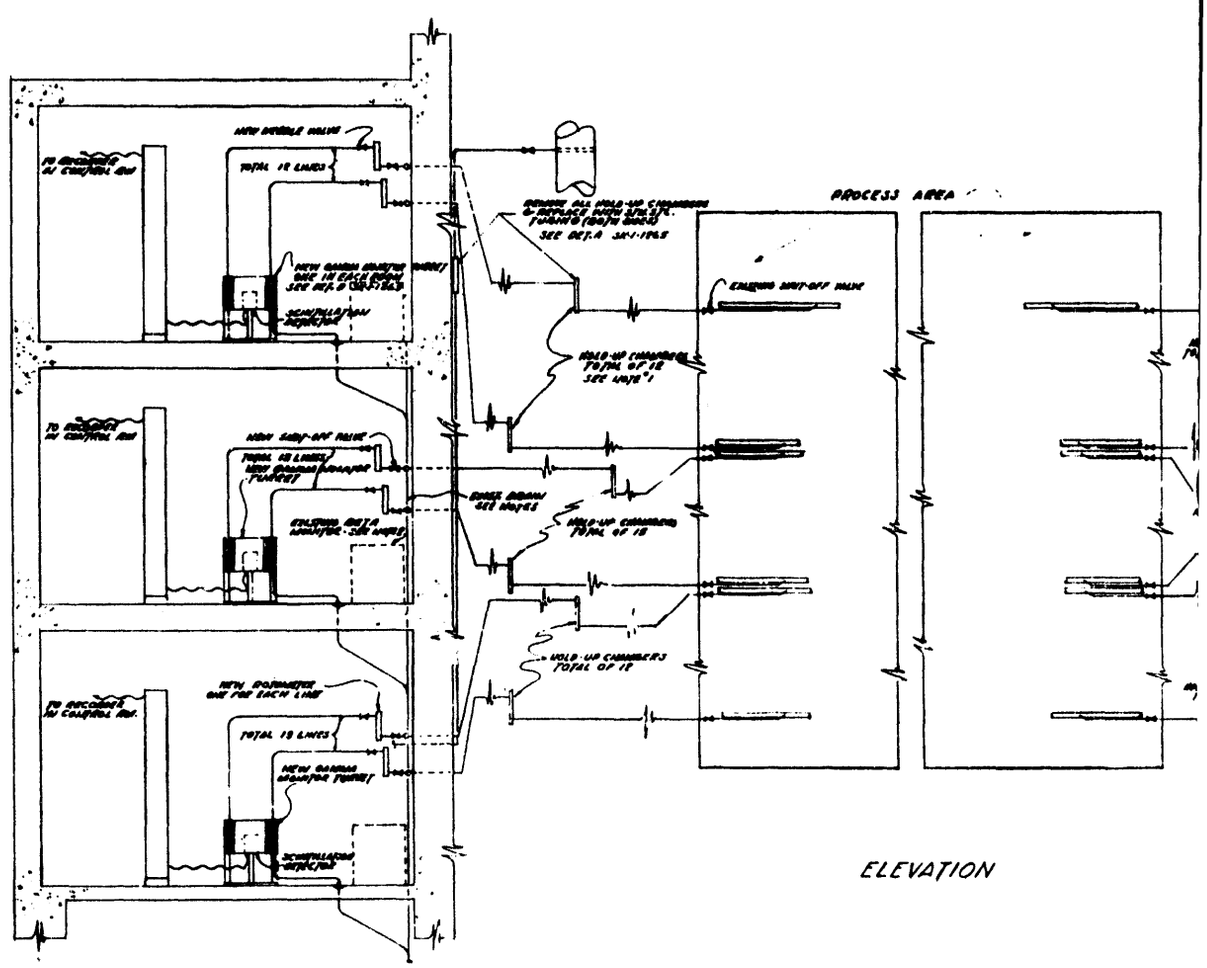


Figure 3.
Section of Recorder Chart from H Reactor Prototype Effluent Water Gamma Monitor.



PLAN



ELEVATION

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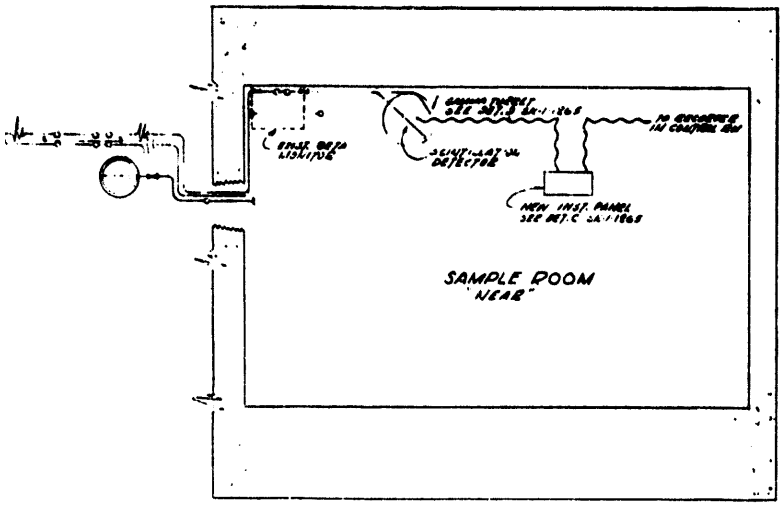

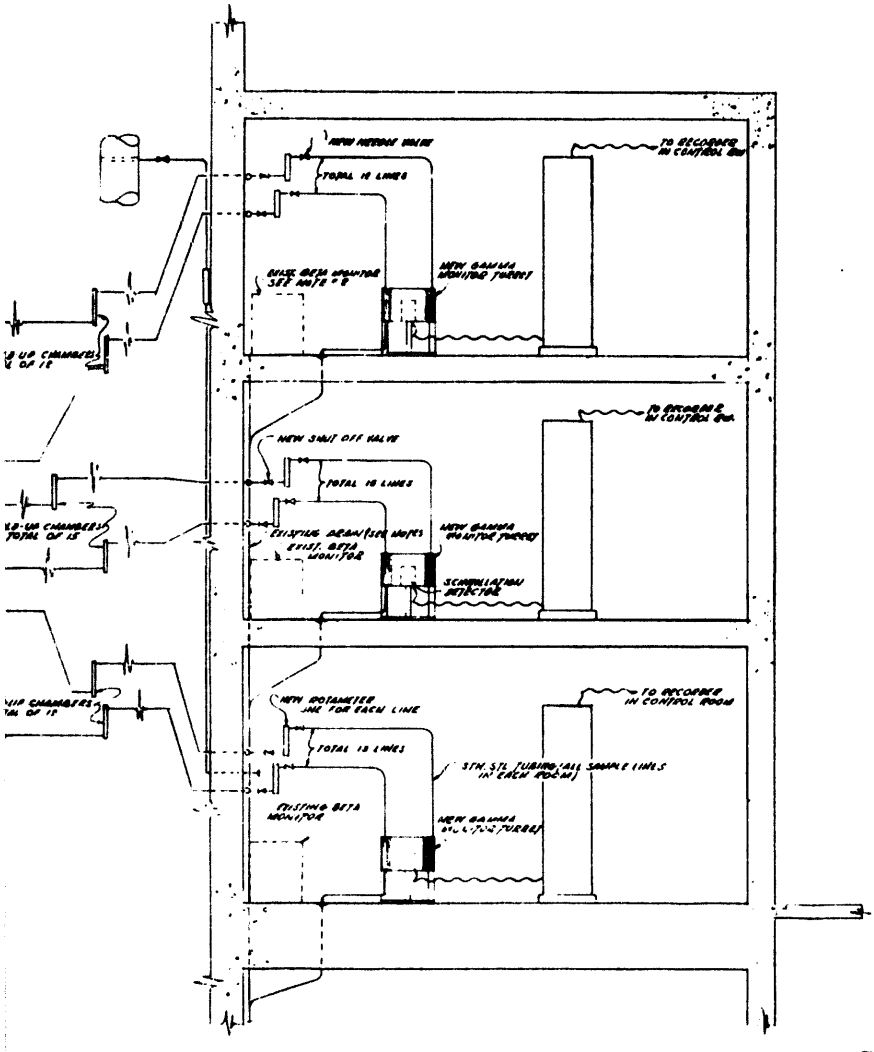

NOTES:

1. All Hold-Up Chambers In Sample Lines To Be Removed
2. Beta-Monitor Equipment In Sample Rooms To Be Removed Before Installation Of Gamma System Is Complete.
3. Vertical Panels In Middle & Lower Sample Rooms To Be Shielded With Concrete.
4. All Lines In Sample Room To Be Gathered & Shielded With Concrete Where Possible.
5. Remove Room Turrets To Be Closed To Sample Room Atmosphere & Vented To Discharge Area.
6. Each Sample At Turret Will Have Spigot For Taking Water Samples.
7. Sample Lines In 105-B Area 5/8" Stn. Stl. Tubing. The Sample Lines In 105-D & 105-F Are 5/8" Stn. Stl. Tubing. Tubing Replacement Or Hold-Up Chambers Will Match Existing Tubing In Size & Type.

No.	Description	Ind. By Date	Appd By	For	Date
	REVISIONS				

APPROVALS

	By	Date	For	Date
Drawn	[illegible]	[illegible]	Lead Tech. Designer	[illegible]
Checked	[illegible]	11-18-53	Design Engr.	11-20-53
Issued	[illegible]	[illegible]	Tech. Section	11-20-53

Scale: 1/8" = 1'-0"
Dwg. Size: B
Unit: [illegible]
Dwg. No. 105-H-P-6098
Project No. 00-100638
Approved [illegible] Date 4-30-52

U. S. ATOMIC ENERGY COMMISSION
HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC

GAMMA-TYPE WATER MONITOR SYSTEM
105 B, D & F AREAS

Bldg. No. 105 B, D & F
Dwg. No. SK-1-1253

Line: Gamma Type Water Monitor System 105 B, D & F Areas
Dwg. No.
Drawing Title
Reference Drawings
Next Used On

Official Use Only
Classified by [illegible]

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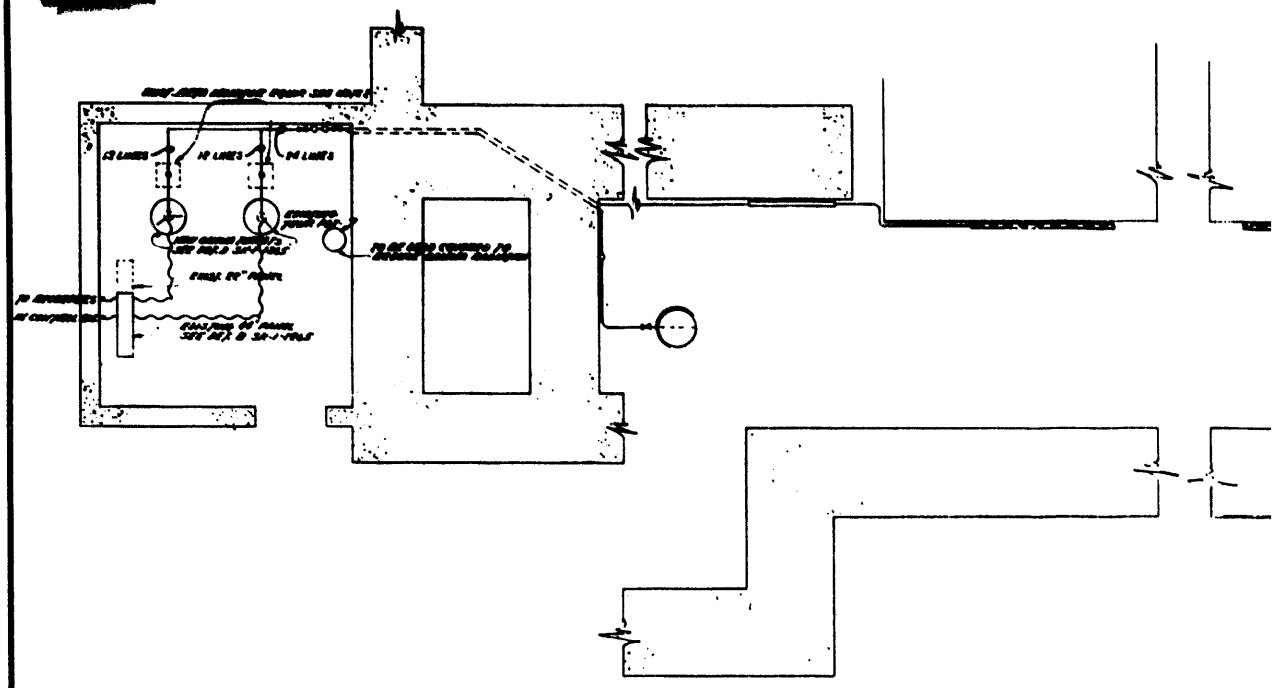

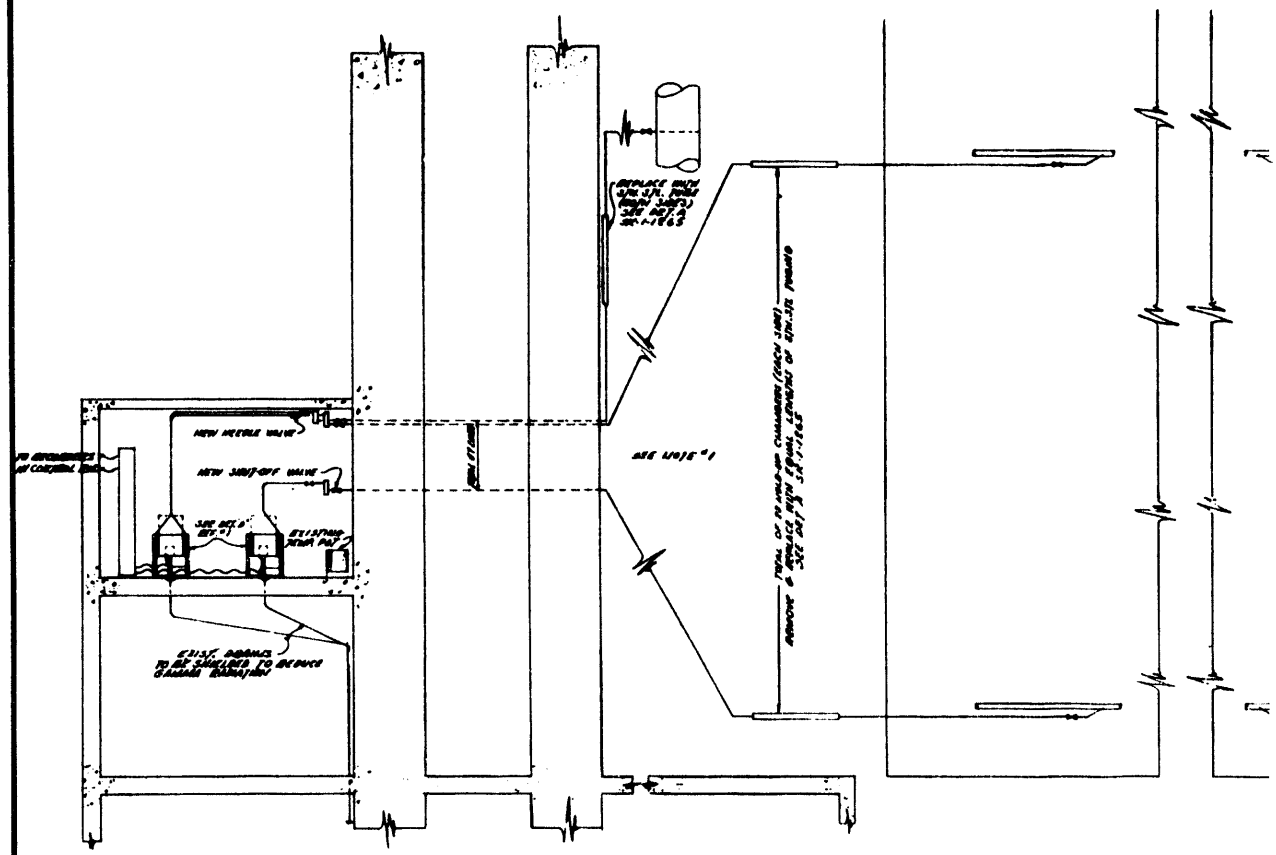

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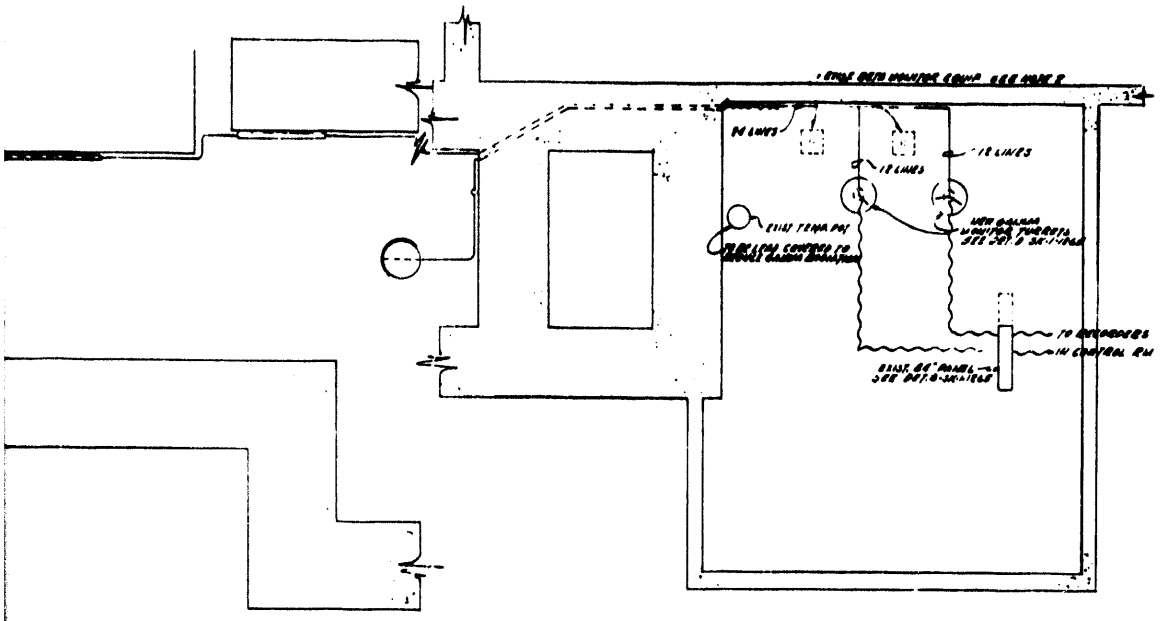

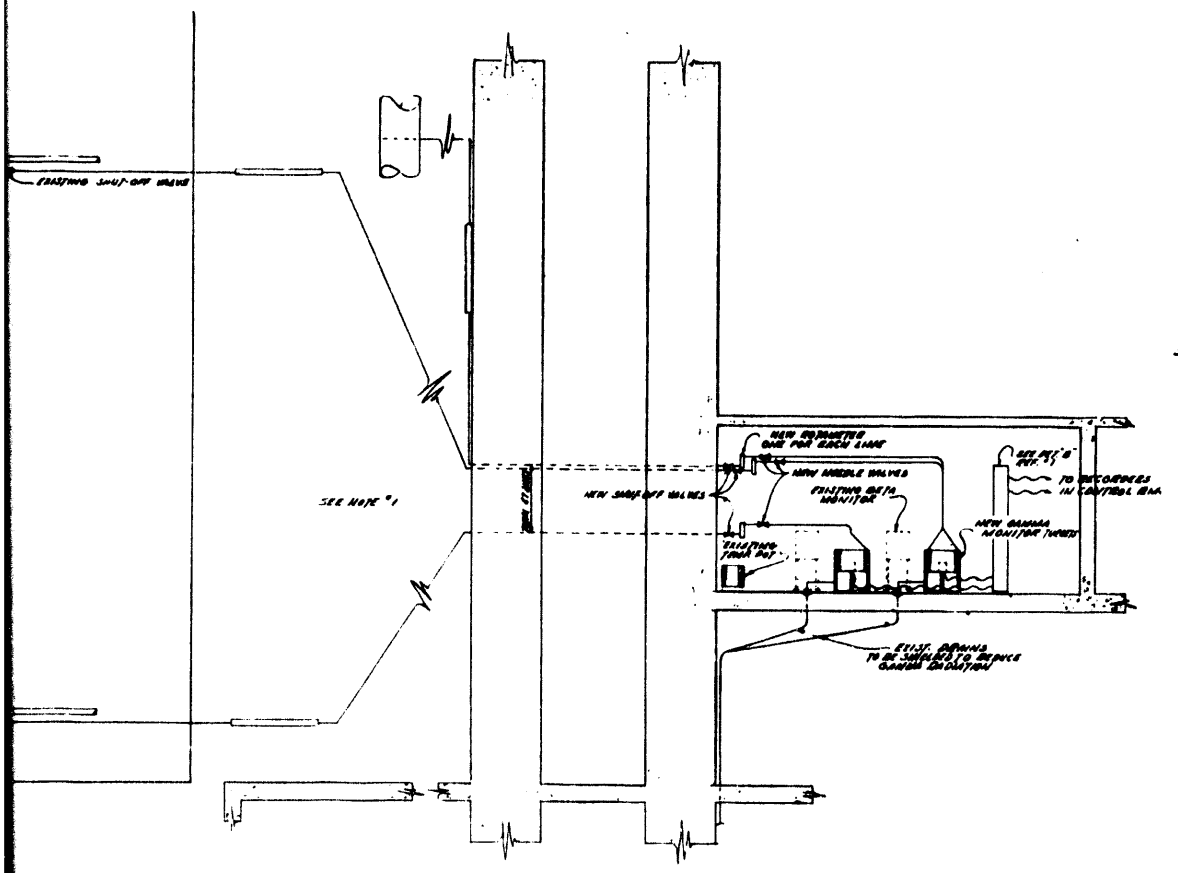

NOTES:

1. Hold-Up Chambers In All Spare Sample Lines To Be Removed.
2. Both System Equipment In Sample Rooms To Be Removed Upon Completion Of Gamma System.
3. All Lines In Sample Room To Be Capped & Supplied With Connects Where Possible.
4. Primary Flow Indicators To Be Closed To Sample Room Atmosphere & Moved To Discharge Area.
5. Each Sample Line At Turbines Will Have Spigot For Partial Water Samples.

NO.	DESCRIPTION	DR. BY DATE	APP'D BY	PCN	DATE
	REVISIONS				

SCALE: 1/4" = 1'-0"

APPROVALS

	BY	PCN	DATE
DRAWN			
CHECKED			
APPROVED			
ENG. SUPV.			
UNIT Design			

WORK NO. 105-HP-6098

PROJECT NO. DO-100638

U. S. ATOMIC ENERGY COMMISSION
HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC

GAMMA-TYPE WATER MONITOR SYSTEM 105 DR AREA

SK-1-8496 | GAMMA TYPE WATER MONITOR SYSTEM 105 DR AREA
DWG. NO. | DRAWING TITLE

REFERENCE DRAWINGS

NEXT USED ON

Official Use Only

BLDG. NO. 105DR | DWG. NO. SK-1-8496 DR

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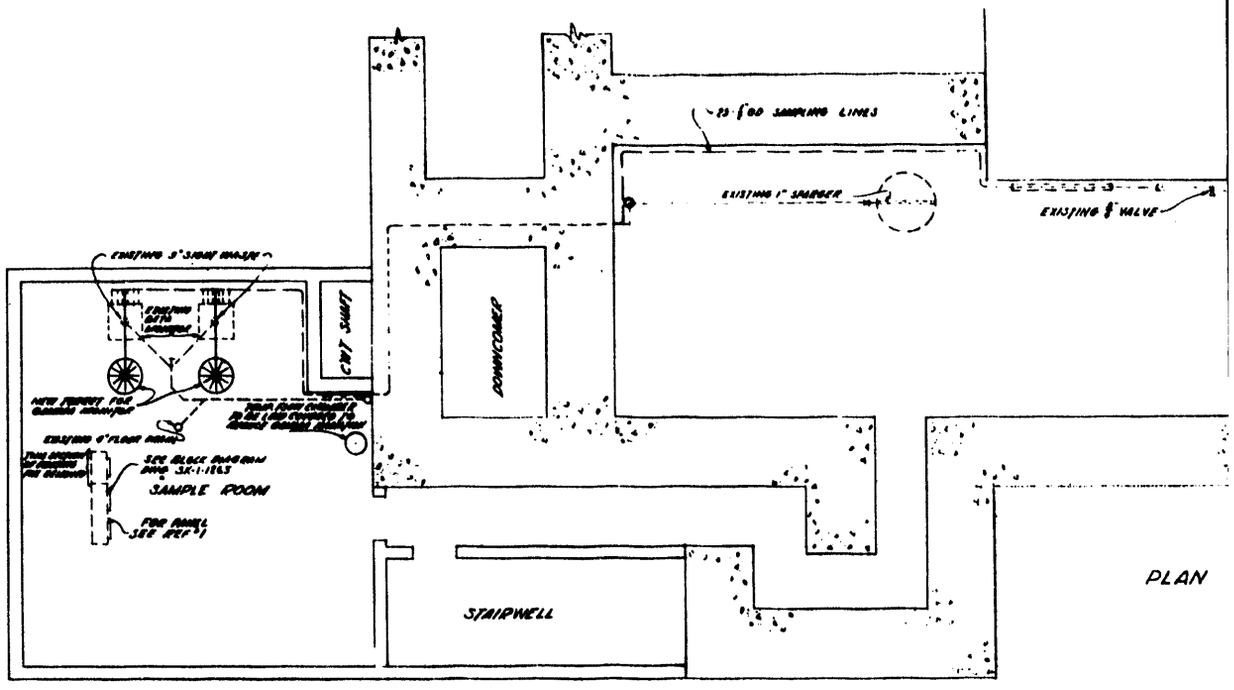
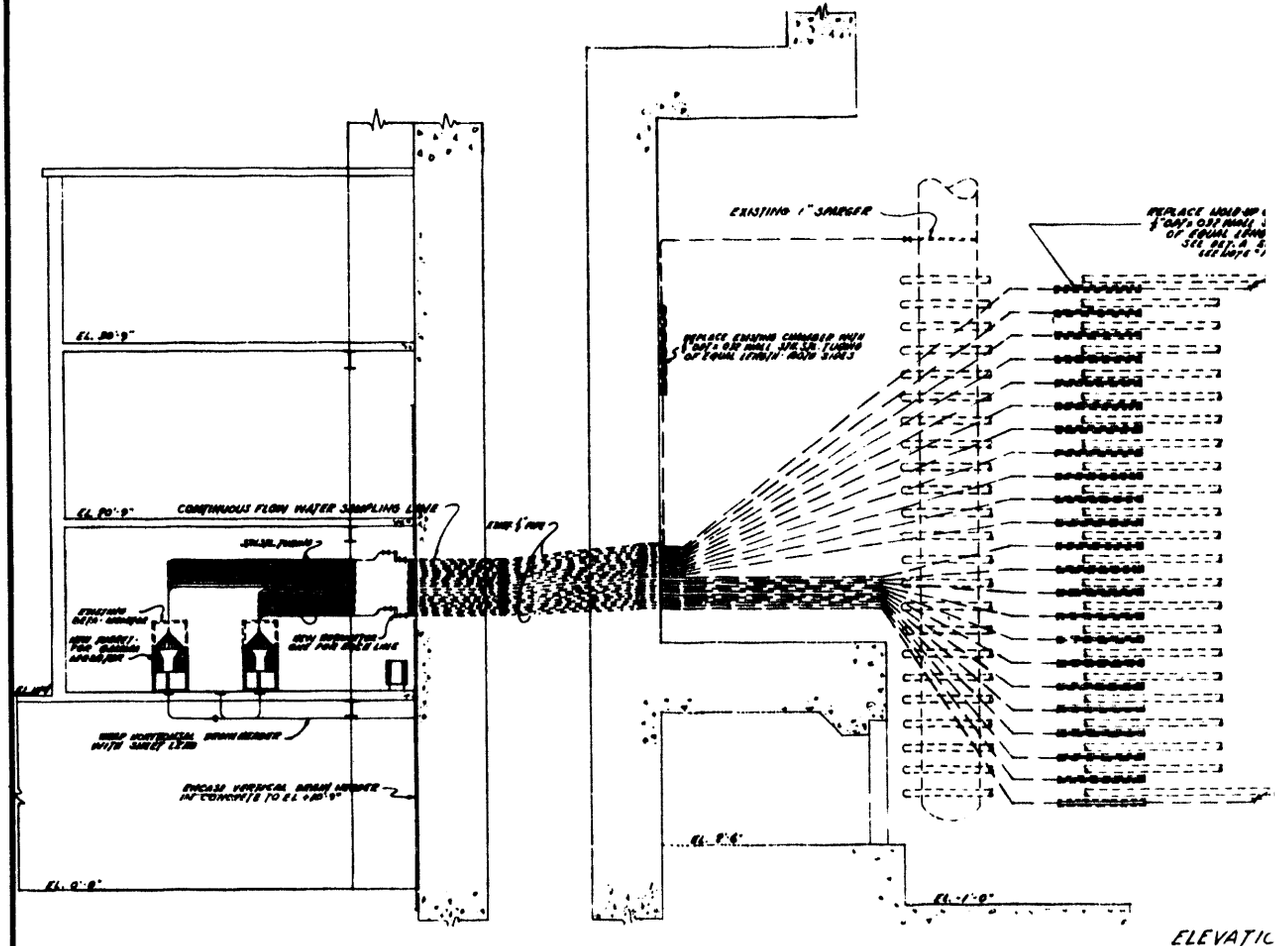
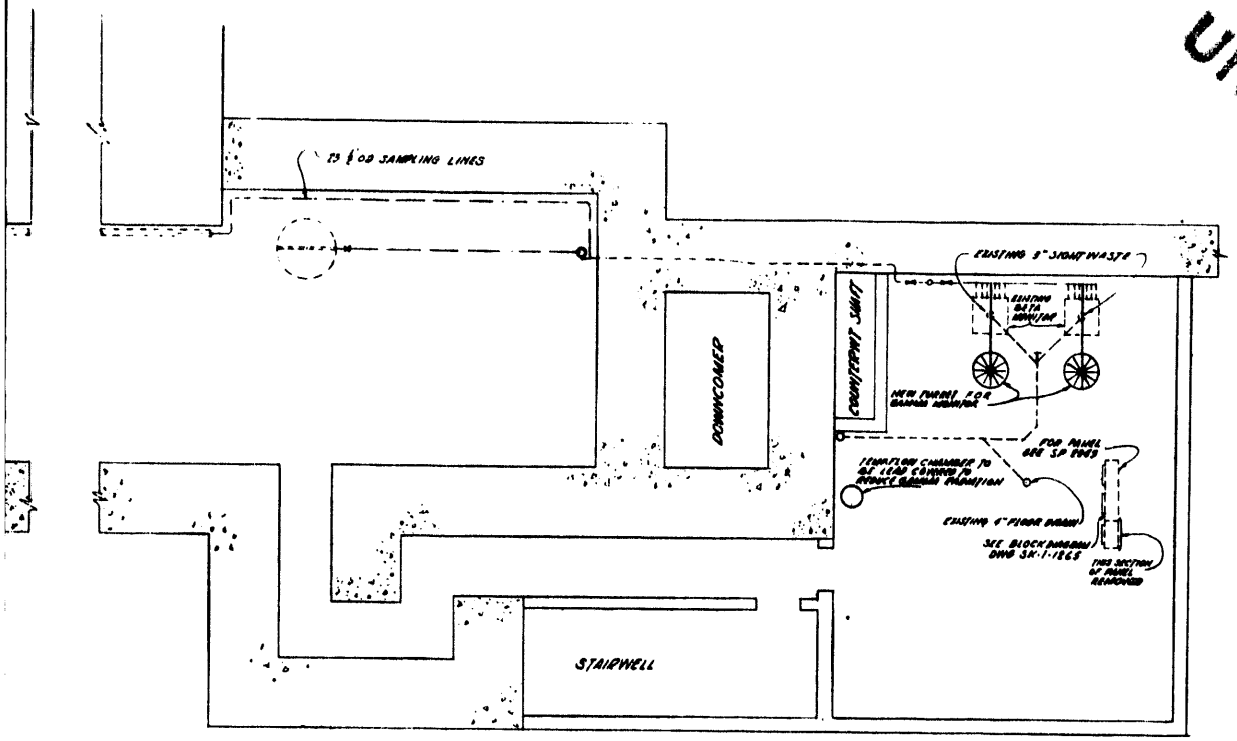


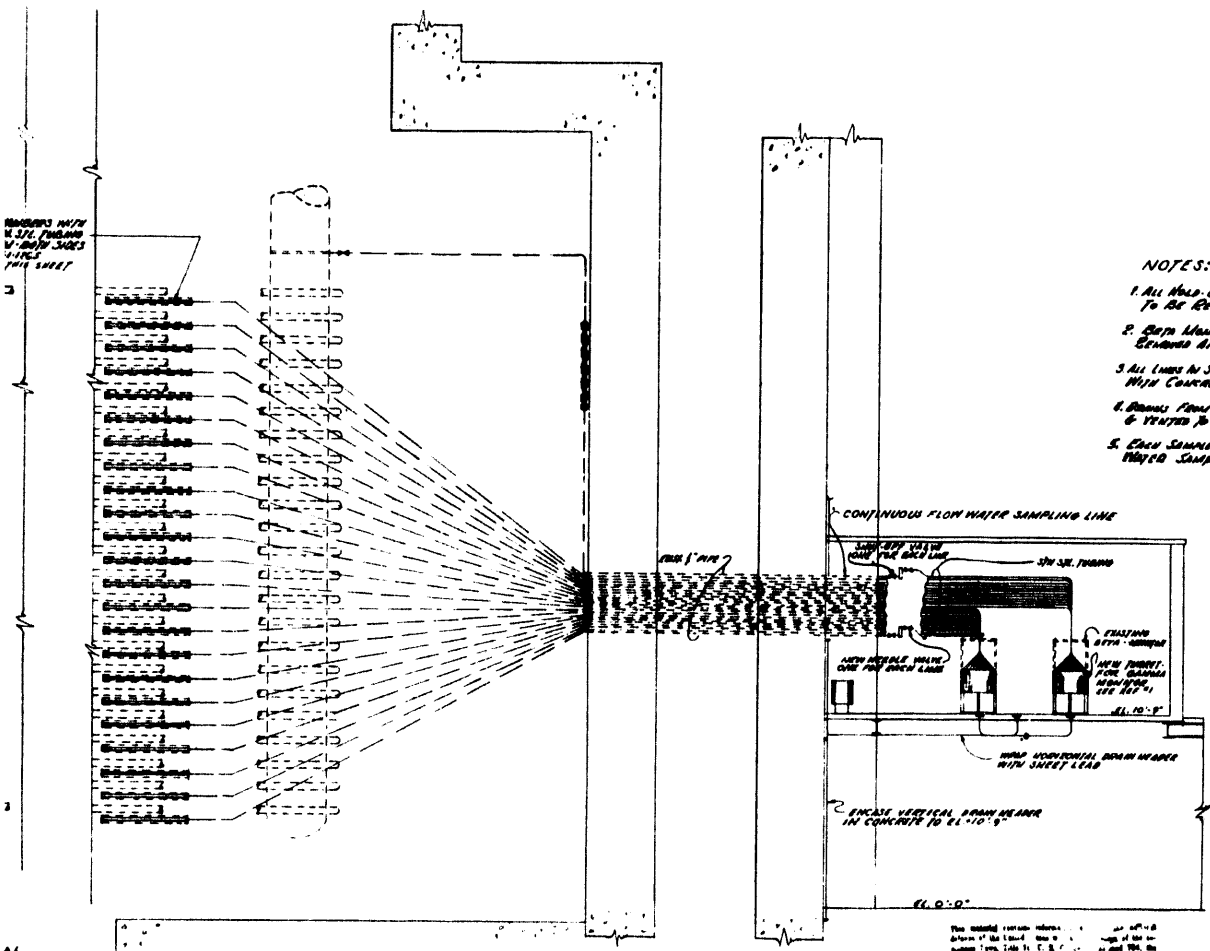
EXISTING 1" SPARGER
EXISTING ⅜" VALVE
CWT SHAFT
DOWNCOMER
SAMPLE ROOM
STAIRWELL
PLAN



EXISTING 1" SPARGER
CONTINUOUS FLOW WATER SAMPLING LINE
EL. 20'-9"
EL. 0'-8"
EL. 9'-6"
EL. -1'-0"
ELEVATIC

UNCLASSIFIED





NOTES:

1. All Hold-Up Chambers In Spare Lines To Be Removed
2. Data Monitor Equipment In Sample Rooms To Be Removed After Installation Of Gamma System Is Completed
3. All Lines In Sample Room To Be To Be Gathered & Supported With Contract Where Possible.
4. Drains From Pumps To Be Closed To Sample Room Atmosphere & Vented To Ductwork Area.
5. Each Sample Line At Thirty Wall Have Spigot For Taking Water Samples.

REVISIONS				
NO.	DESCRIPTION	REV. BY DATE	APP'D BY	FOR	DATE

SCALE: 1/4" = 1'-0"

APPROVALS	BY	FOR	DATE
DRAWN			
CHECKED			
ISSUED			

SUBJ. ENG. | UNIT Design
UNIT NO. 105-H-P-6098
PROJECT NO. DO#100-638

U. S. ATOMIC ENERGY COMMISSION
HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC

GAMMA-TYPE WATER MONITOR SYSTEM
105H AREA

DWG. NO.	TITLE
SK-1-1863	GAMMA-TYPE WATER MONITOR SYSTEM-105H AREA

REFERENCE DRAWINGS
NEXT USED ON

BLDG. NO. 105H | DWG. NO. SP-2342

Official Use Only [redacted]

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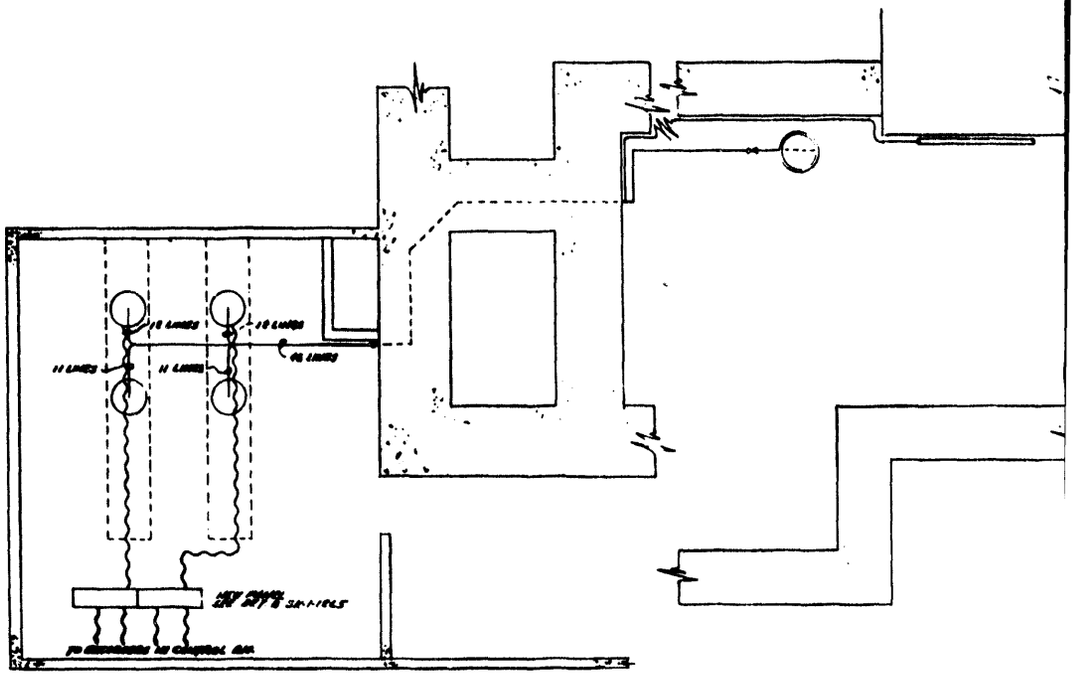
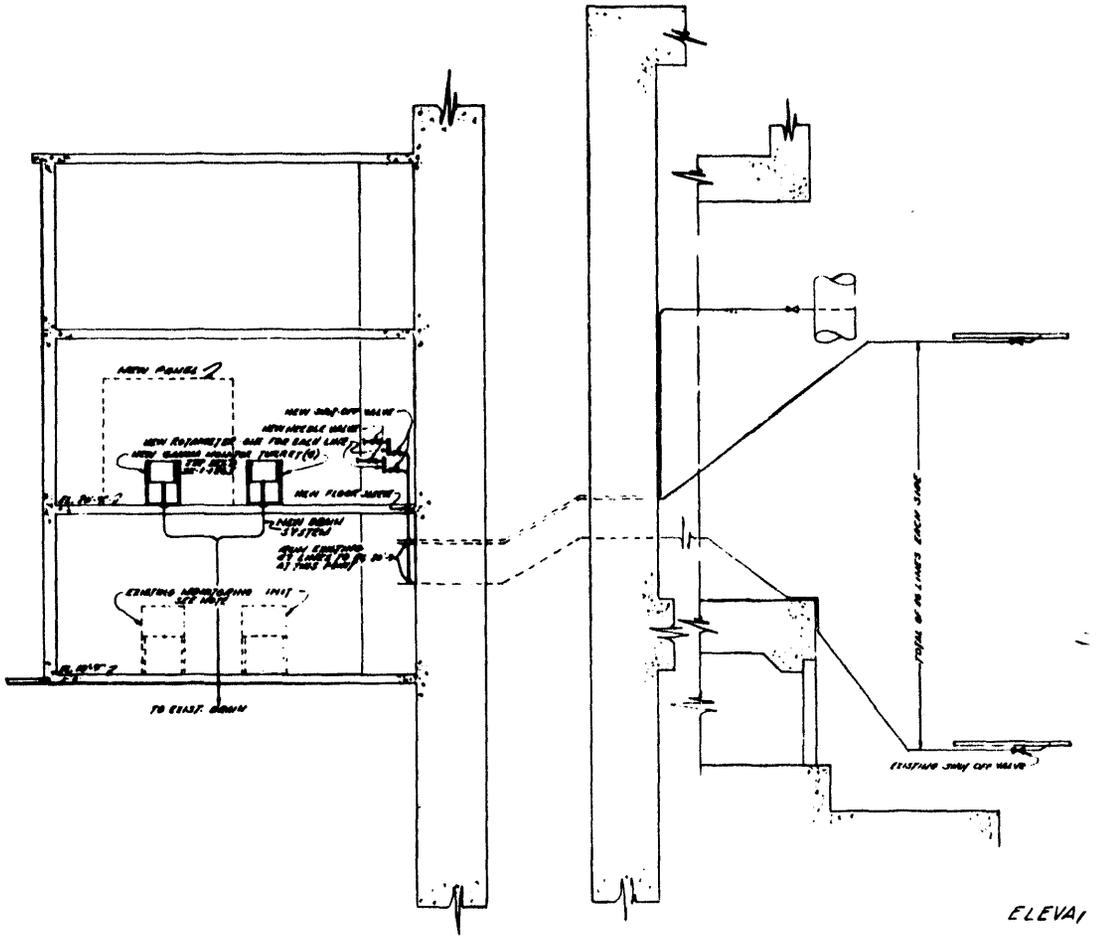
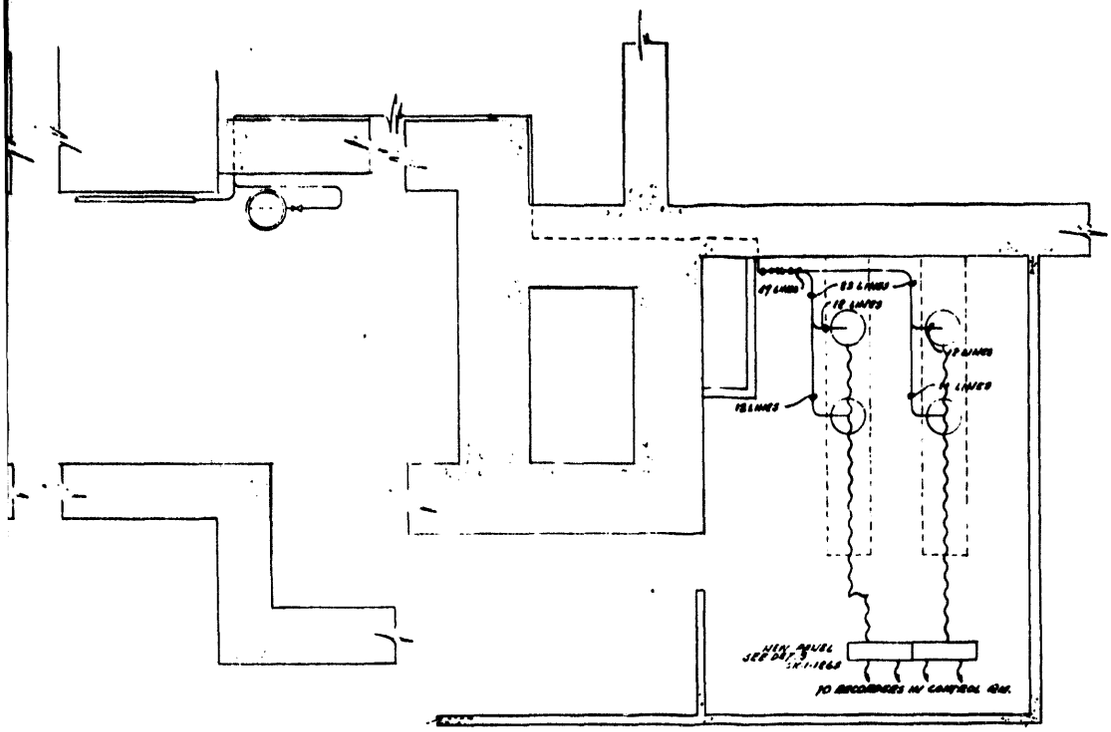
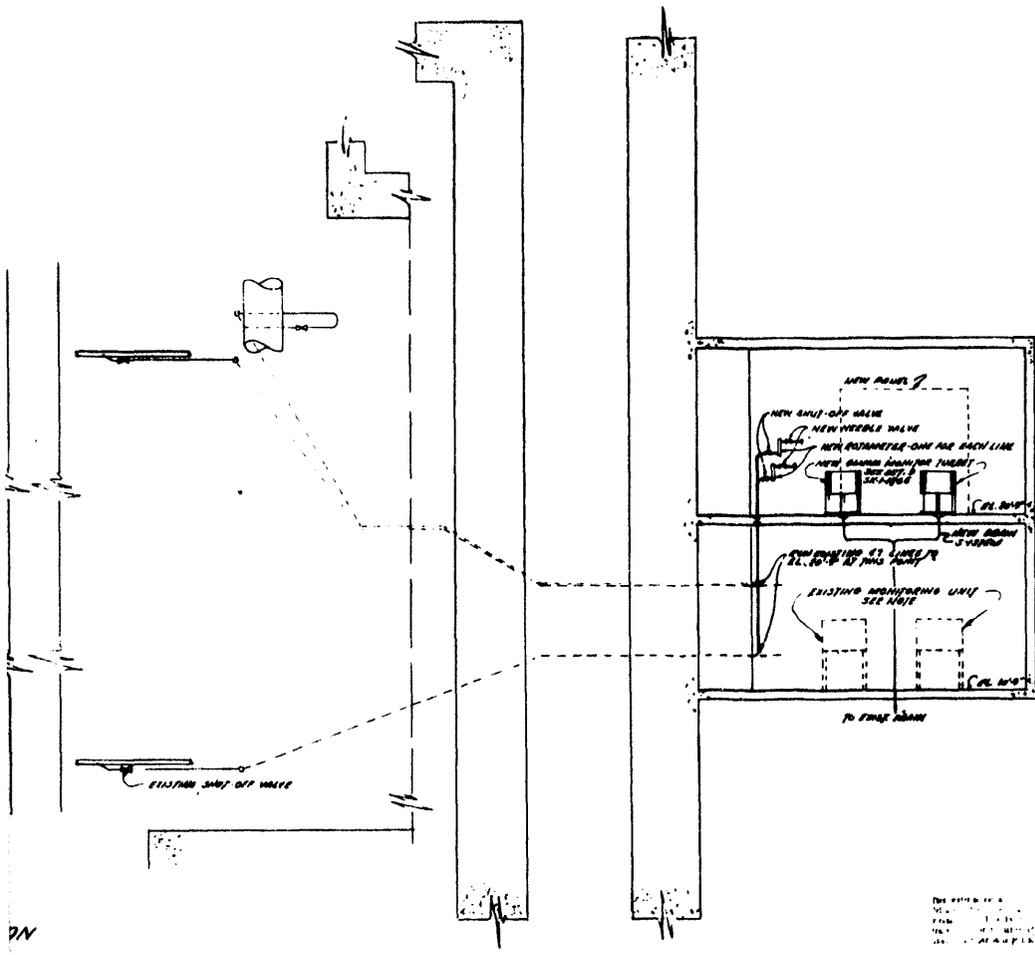

11 LINES
11 LINES
PL


NEW PANEL 2
NEW SHUT-OFF VALVE
NEW NEEDLE VALVE
NEW FLOOR SLEEVE
NEW DRAIN SYSTEM
EXISTING MONITORING INIT
TO EXIST. DRAIN
EXISTING SHUT OFF VALVE
ELEVA

UNCLASSIFIED



AN



ON

NOTE:

1. Existing Beta-Monitoring Equipment To Be Removed After Completion Of Gamma-System.
2. All Lines In Sample Rooms To Be Gathered & Shielded With Concrete Where Possible.
3. Drains From Turrets To Be Closed To Sample Room Atmosphere & Vented To Discharge Area.
4. Each Sample Line At Turret Will Have Spigot For Taking Water Samples

NO.	DESCRIPTION	REV. BY DATE	APP'D BY	FOR	DATE
	REVISIONS				

SCALE: NONE

		APPROVALS BY	FOR	DATE
DRAWN	DATE 11-4-53		INST. DESIGN	11-20-53
CHECKED	DATE 11-19-53		REVIEW	11-20-53
ISSUED	DATE 11-19-53		DESIGN	11-20-53
DES. ENG.	UNIT DESIGN			
INST. NO.	105-H-2-6098			
PROJECT NO.	DO-100-638			

U. S. ATOMIC ENERGY COMMISSION
HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC

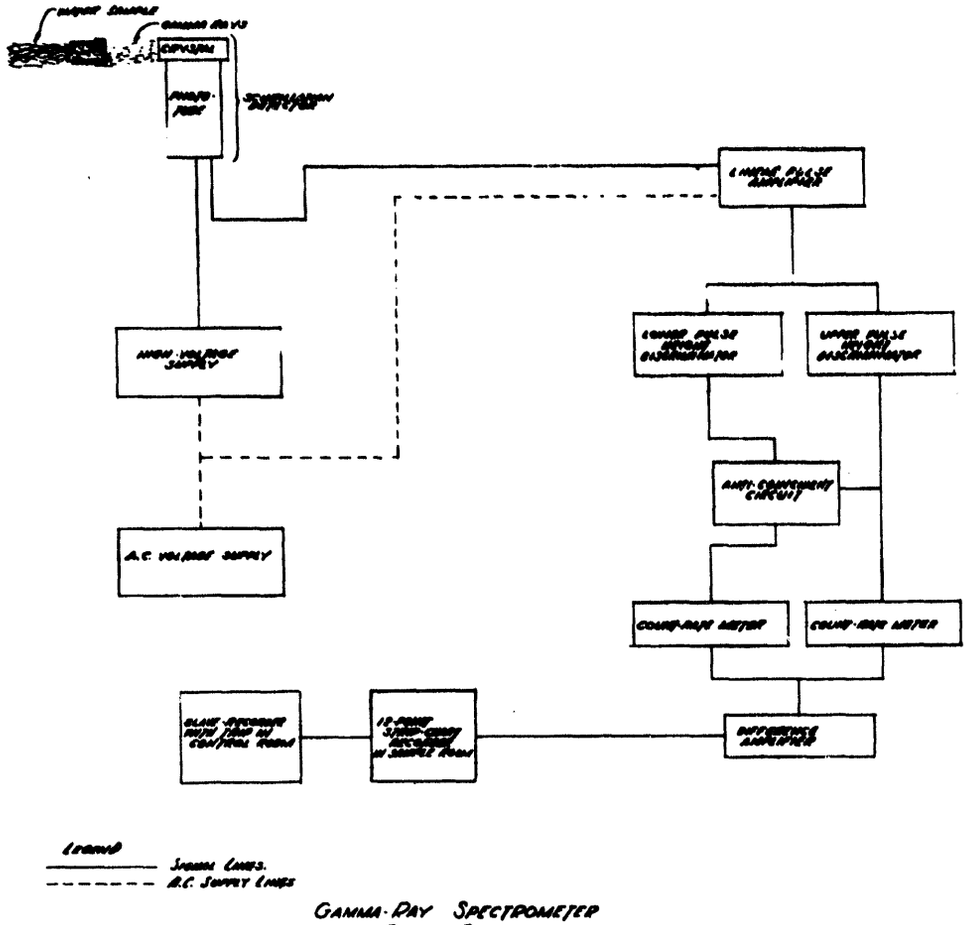
GAMMA-TYPE WATER MONITOR SYSTEM 105 C AREA

DWG. NO.	DRAWING TITLE
	REFERENCE DRAWINGS

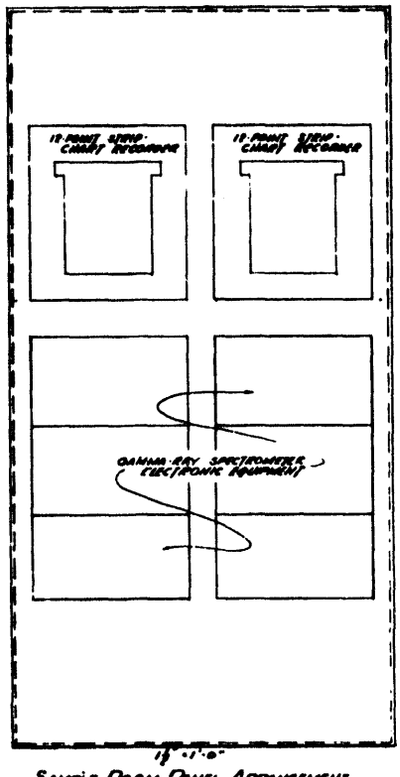
NEXT USED ON

Official Use Only

BLDG. NO. 105C DWG. NO. SP-7575

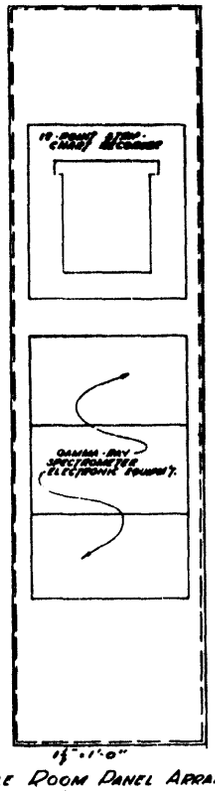


GAMMA-RAY SPECTROMETER
BLOCK DIAGRAM
NO SCALE



1½"=1'-0"

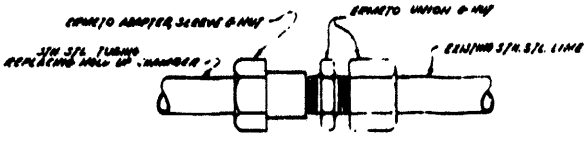
SAMPLE ROOM PANEL ARRANGEMENT
44" PANEL
DETAIL "B"



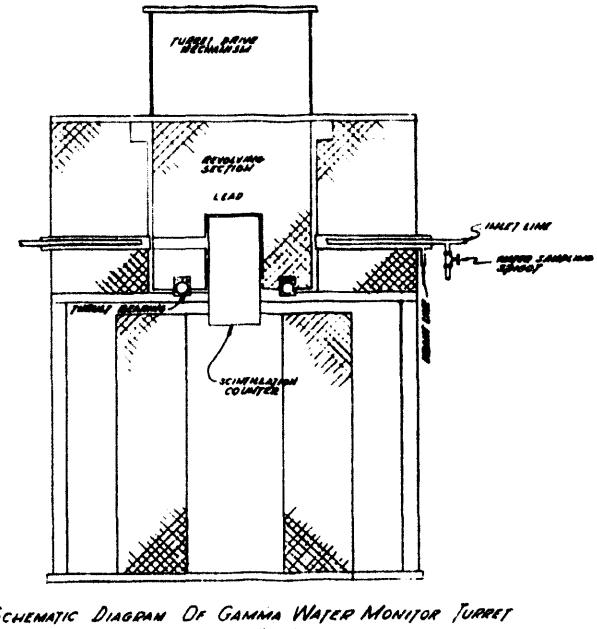
1½"=1'-0"

SAMPLE ROOM PANEL ARRANGE-
22" PANEL
DETAIL "C"

UNCLASSIFIED



CONNECTION FOR STN. S/L. LINES
REPLACING HOLD-UP CHAMBERS
SAME FOR BOTH SIDES
NO SCALE
DETAIL "A"



SCHEMATIC DIAGRAM OF GAMMA WATER MONITOR TURRET
DETAIL "D"

REVISIONS				
NO.	DESCRIPTION	REV. BY DATE	APPD BY	PROJ	DATE

SCALE: AS NOTED

APPROVALS

	BY	PROJ	DATE
DRAWN			8-28-61
ENGINEERED			8-28-61
ENGINEERED			11-20-61

DWG. CODE | SHEET | SHEET CODE
SHEET NO. 105H-P-6098
PROJECT NO. DO-100-638

U. S. ATOMIC ENERGY COMMISSION
HANFORD ATOMIC PRODUCTS OPERATION
GENERAL ELECTRIC

GAMMA TYPE WATER MONITOR SYSTEM DETAILS
105 B, D, F, DR, H, & C AREAS

NO.	DESCRIPTION
3	S.P.I.-P.S.D. GAMMA TYPE WATER MONITOR SYSTEM NOT A.A.T.
2	S.P.I.-P.S.D. GAMMA TYPE WATER MONITOR SYSTEM NOT A.A.T.
1	1P 7162 GAMMA TYPE WATER MONITOR SYSTEM

DWG. NO. | DRAWING TITLE
REFERENCE DRAWINGS
SHEET USED ON

GENERAL ELECTRIC CLASSIFICATION

BLDG. NO. | DWG. NO. SK-1-1965

XXX

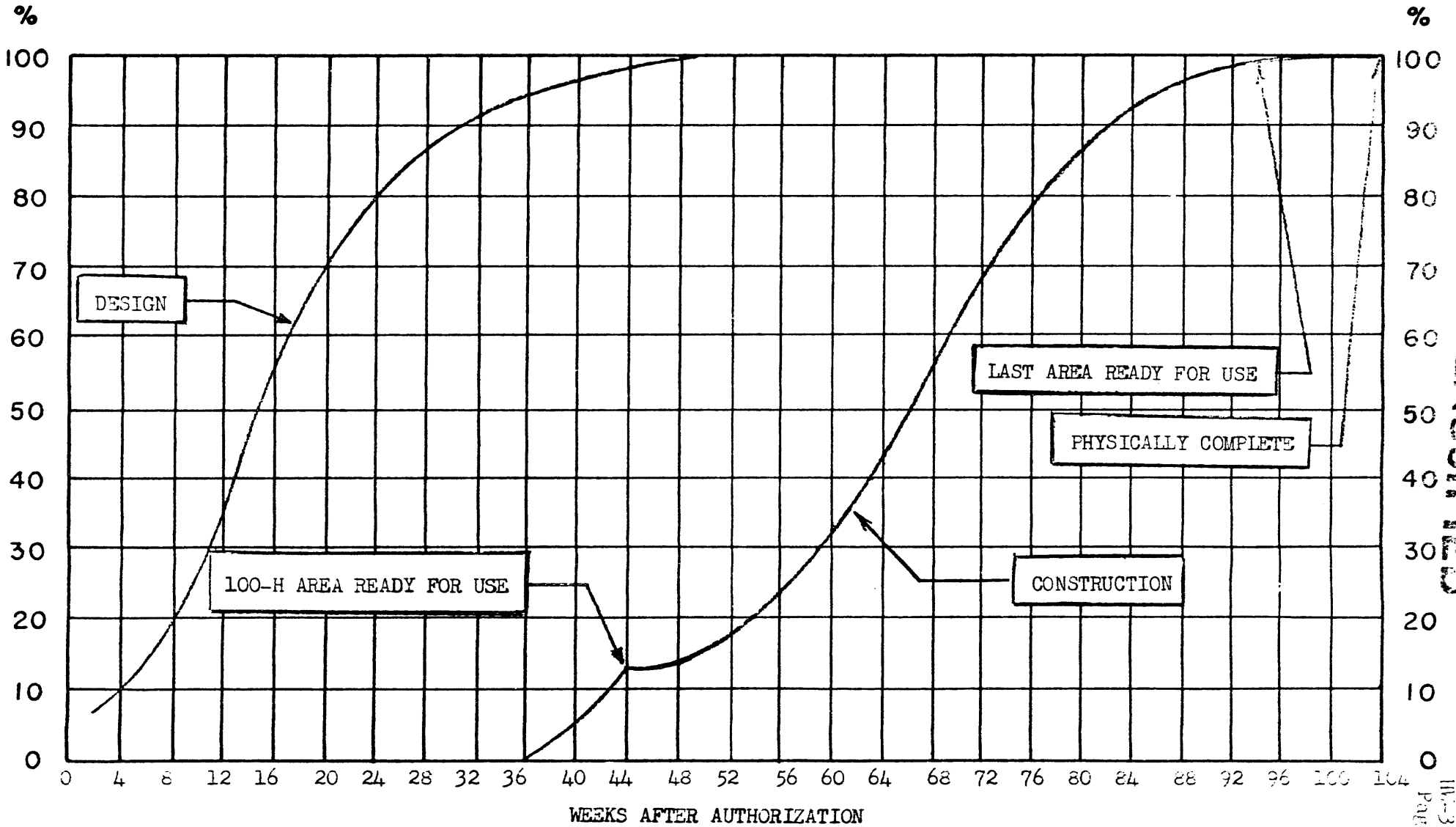
EXHIBIT "A"

OFFICIAL USE ONLY

PROPOSED COMPLETION SCHEDULE

Based on a 40 hour work week

PROJECT TITLE: EFFLUENT WATER MONITORING IMPROVEMENTS - EXISTING 100 AREAS



[redacted]

UNCLASSIFIED

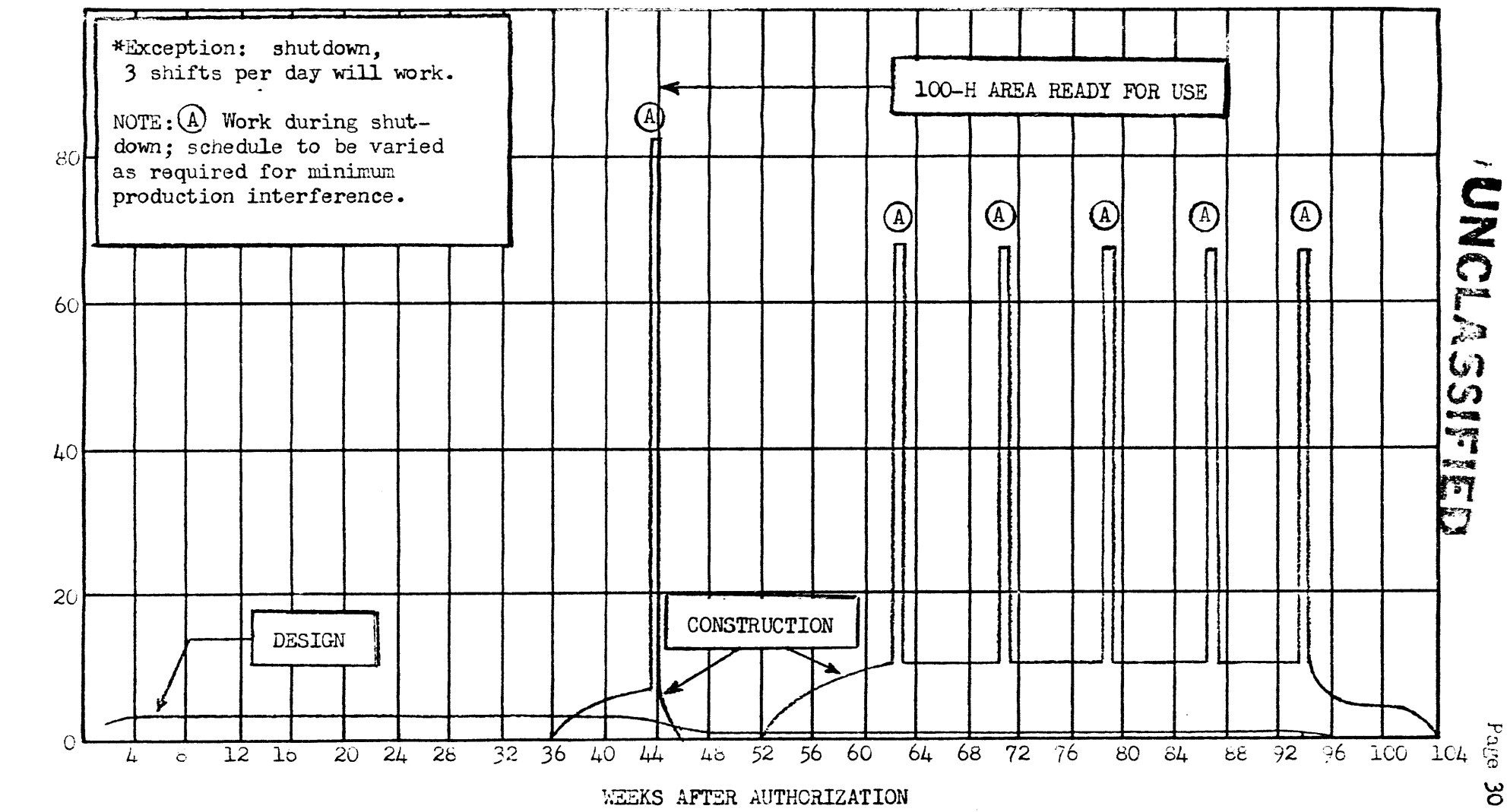
EXHIBIT "B"

OFFICIAL USE ONLY

ESTIMATED FORCE REQUIREMENTS

Based on a 40 hour work week*

PROJECT TITLE: EFFLUENT WATER MONITORING IMPROVEMENTS, EXISTING 100 AREAS



[redacted]

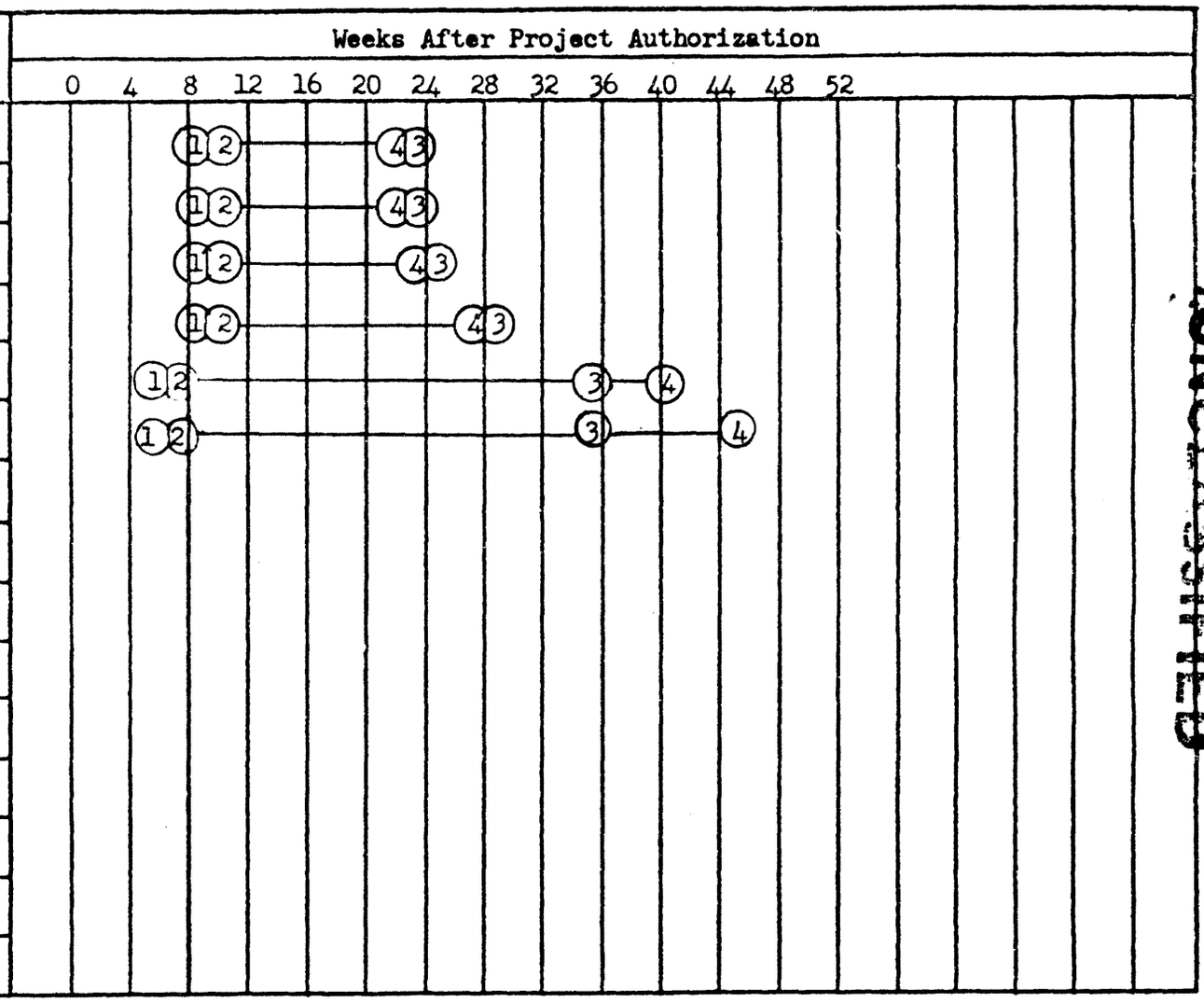
UNCLASSIFIED

EXHIBIT "C". OFFICIAL USE ONLY

SCHEDULE OF CRITICAL MATERIALS AND EQUIPMENT

PROJECT TITLE: EFFLUENT WATER MONITORING IMPROVEMENTS - EXISTING 100 AREAS

ITEM	DESCRIPTION
1	Stainless Steel Tubing
2	Rotameters
3	Gate Valves
4	Needle Valves
5	Recorders
6	Spectrometers
7	
8	
9	
10	
11	
12	
13	
14	
15	



(1) REQUISITION DATE (2) ORDER DATE (3) REQUIRED DELIVERY (4) ESTIMATED DELIVERY

UNCLASSIFIED

[redacted]

[redacted]

PROJECT DESIGN ESTIMATE

GENERAL ELECTRIC COMPANY HANFORD WORKS

Project Title: Effluent Water Monitoring Improvements - Existing 100 Areas

DATE PREPARED and Estimated by: 11-25-53 D.O. Webb

TYPE OF ESTIMATE
(A) ☐ STUDY STAGE
(B) ☒ FULLY SCOPED
(C) ☐ FINAL DESIGN % COMPLETE

ENGINEERING, INCLUDING SCOPING, DETAILED DESIGN, AND DESIGN SERVICES IN THE FIELD		
DESIGN	$ 24,500	
PROJECT	2,500	
OTHER (HANFORD)	- - -	
SUB-TOTAL		$ 27,000
ARCHITECT ENGINEERS		- - -
ENGINEERING ASSISTANCE TO HANFORD, INCLUDING CONSULTANTS, ENGINEERING ASSISTANCE CONTRACTORS, KAPL, GEL, ETC.		
ENGINEERING SERVICES (HANFORD)		
DRAFTING	$ 14,800	
REPRODUCTION	2,200	
ESTIMATING	1,000	
LAYOUT AND SURVEY	- - -	
OTHER	- - -	
SUB-TOTAL		$ 18,000
TEST MATERIALS AND EXPERIMENTAL TESTS		- - -
CONTINGENCIES		4,000
TOTAL		$ 49,000
DISTRIBUTION BY DESIGN STAGE		
DESIGN SCOPE		$ 5,000
DETAILED DESIGN		38,000
DESIGN FIELD LIAISON, AND DESIGN SERVICES IN THE FIELD		2,000
CONTINGENCIES		4,000
TOTAL		$ 49,000

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[redacted]

PROJECT NO.	CONSTRUCTION BY	PROJECT MANAGED BY	GE
D.O. 100638	Plant Forces	[x] G. E. [ ] HOO, AEC	

ESTIMATED BY	DATE PREPARED	TITLE	OFFICICAL USE ONI
R. L. Lysher	11-27-53	EFFLUENT WATER MONITORING IMPROVEME	

	PROPERTY ACCOUNTS		WORK PERFORMED BY: Plant Forces				W.O.
	DESCRIPTION	NO.	LABOR	MATERIAL	EQUIP.	TOTAL	
1							
	STRUCTURAL, PIPING,						
	ELECT. &INSTRUMENTS						
	105-C		14,000	78,200		92,200	
	105-H		11,000	45,500		56,500	
	105-DR		9,300	45,500		54,800	
	105-B		14,000	65,500		79,500	
	105-D		14,000	65,500		79,500	
	105-F		14,000	65,500		79,500	
	SUB-TOTAL DIRECT CONST. COSTS		76,300	365,700		442,000	
2	(A) OTHER DIRECT COSTS (% OF LABOR - ITEM 1)						
	(B) PAYROLL BURDEN (% OF LABOR - ITEMS 1 & 2A)						
	(C) CLOSE OUT RESERVE (% OF LABOR - ITEMS 1 & 2A)						
3	TOTAL DIRECT CONST. COSTS		76,300	365,700		442,000	

ITEM (1) INCLUDES $ _____ FOR EQUIPMENT PURCHASED BY G. E.

F-1568, 1-H (8-52)

.RAL ELECTRIC COMPANY - HANFORD WORKS

PROJECT COST ESTIMATE

HW-30083
Page 33

3-EXISTING 100 AREAS

TYPE OF ESTIMATE	
(A) ☐	STUDY STAGE
(B) ☒	FULLY SCOPED
(C) ☐	FINAL (DESIGN % COMP.)

. PERFORMED BY:				JOB TOTALS			
BOR	MATERIAL	EQUIP.	TOTAL	LABOR	MATERIAL	EQUIP.	TOTAL

PROJECT NO.	TITLE OFFICIA EFFLUENT WATER MONITORING IMPROVEMENTS -				
	WORK PERFORMED BY: Plant Forces				W
		LABOR	MATERIAL	EQUIP.	TOTAL
3	TOTAL DIRECT CONSTRUCTION COSTS	76,300	365,700		442,000
4	(A) CPFF SUB-CONTRACTOR INDIRECT COSTS (% OF LABOR - ITEM 3)				
	(B) G. E. CONSTRUCTION DEPT. INDIRECT COSTS (% OF LABOR - ITEM 3)				
	(C) G. E. FORCES INDIRECT COSTS (120 % OF LABOR - ITEM 3)				91,000
5	(A) FEE FOR CPFF SUB-CONTRACTOR				
	(B) FEE FOR LABOR SERVICE GROUP (% OF LABOR - ITEM 3)				
6	CONSTRUCTION FIELD SUPV. AND INSPECTION (% OF ITEM 3)	Fixed Amount			12,000
7	SUB - TOTALS				545,000
8	GENERAL OVERHEAD (4 % OF ITEM 7)				21,800
9	OPERATION AND MAINT. OF NO. RICHLAND CAMP (% OF ITEM 7)				
10	~~XXXXXXXXXXXXXX~~ Radiation Monitoring Services				2,000
11	MISCELLANEOUS WORK ORDER				
12	CONSTRUCTION CONTINGENCY (10 % OF ITEM 7)				54,500
13	TOTAL CONSTRUCTION COST				623,300
14	ADJUSTED TOTAL CONSTRUCTION COST				621,000
15	ADJUSTED TOTAL DESIGN - ENG. COST (FORM F-1569 -G)				49,000
16	ADJUSTED TOTAL PROJECT COST				670,000

APPROVED (ENGINEERING)	DATE	APPROVED (ESTIMATING)
M.E.F. W D Nixon	12-11-53	W O Garetson

AAJ
12/10/53

OFFI

SE ONLY
STING 100 AREAS

HW-30083
Page 34

DATE PREPARED
11-27-53

PERFORMED BY:				JOB TOTALS			
IOR	MATERIAL	EQUIP.	TOTAL	LABOR	MATERIAL	EQUIP.	TOTAL

END

DATE FILMED

3/10/94