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JULY, AUGUST, SEPTEMBER, 1959

AUTHOR

Members of the Chemical Effluents Technology Operation

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JULY, AUGUST, SEPTEMBER, 1959

Prepared by Members of the
Chemical Effluents Technology Operation

Edited by: W. A. Haney

November 20, 1959

CHEMICAL RESEARCH AND DEVELOPMENT OPERATION
HANFORD LABORATORIES OPERATION

HANFORD ATOMIC PRODUCTS OPERATION
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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS
JULY, AUGUST, SEPTEMBER, 1959

INTRODUCTION

The Chemical Effluents Technology Operation performs research to investigate the chemical and physical aspects of environmental contamination resulting from the disposal of plant effluents or from potential process incidents. This report is primarily concerned with plant assistance research in the field of waste disposal during the quarter July, August, September, 1959.

Ground-water monitoring data utilized in this report were obtained from well-water samples collected routinely by the Regional Monitoring Operation and analyzed by the Radiological Chemistry Analysis Operation.

I. INTERPRETATION OF GROUND-WATER MONITORING DATA (W. A. Haney)

Analytical Detection Limits

The Radiological Chemistry Analysis Operation announced that the following detection limits for routine ground-water sample analyses are in effect as of September 22, 1959. These detection limits are at the 95% confidence level.

TABLE I

GROUND-WATER SAMPLES ANALYTICAL DETECTION LIMITS

Analysis	Volume Analyzed (milliliters)	Detection Limit
Sr^{90}	300	7×10^{-8} μc/ml
Cs^{137}	50	5×10^{-7} μc/ml
Pu	10	1.1×10^{-7} μc/ml
Co^{60}	100	6×10^{-7} μc/ml
U	--	6×10^{-9} μc/ml
Gross Beta	100	8×10^{-8} μc/ml
Gross Beta	10	8×10^{-7} μc/ml
Gross Beta	1	8×10^{-6} μc/ml

Analysis	Volume Analyzed (milliliters)	Detection Limit
Total Alpha	100	7.3×10^{-9} μc/ml
Na^+	--	1.5 ppm
NO_3^-	100	0.1 ppm
NO_3^-	10	1 ppm
NO_3^-	1	10 ppm

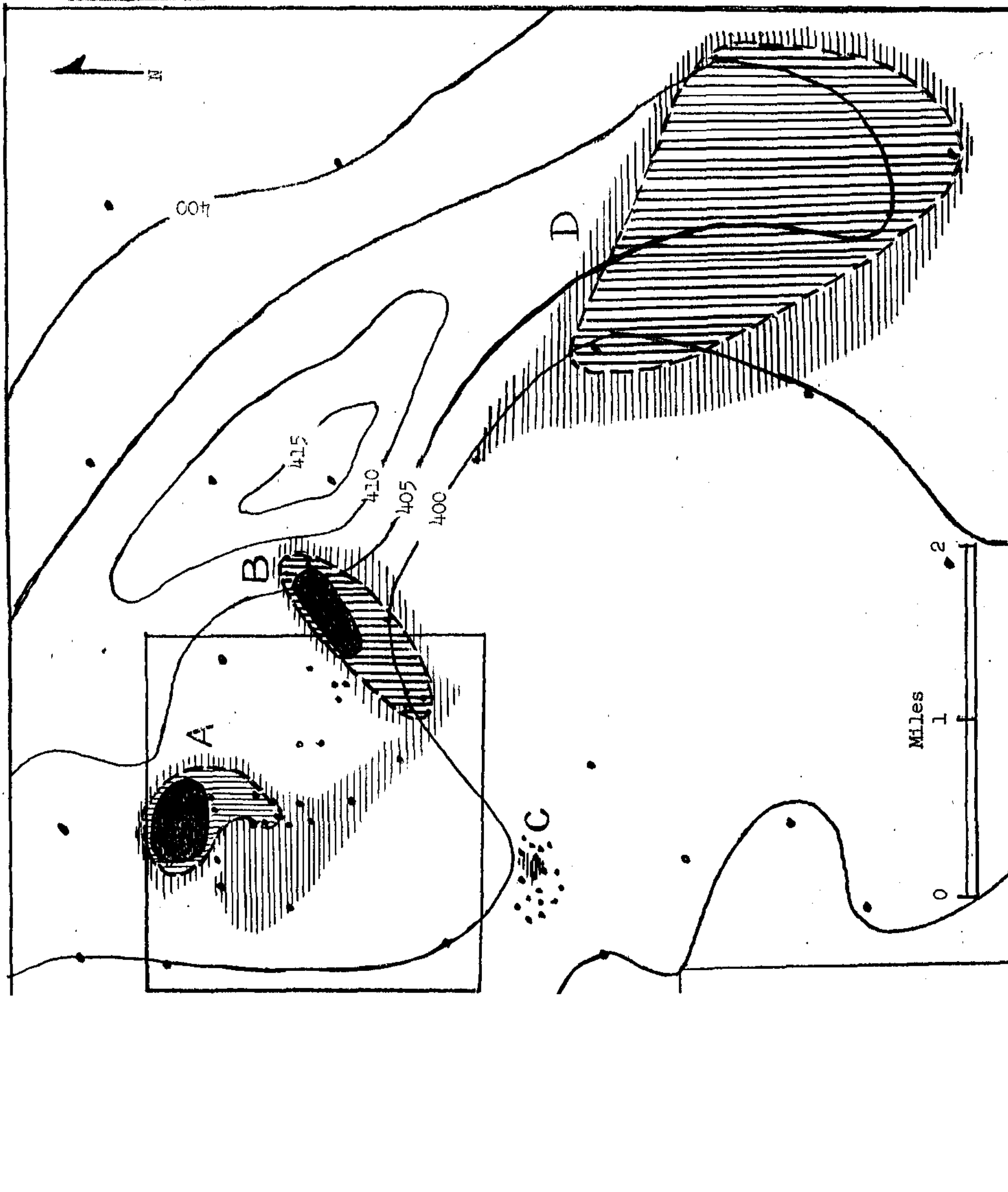
Particularly significant is the lowering of the detection limit for gross beta determinations from 1.5×10^{-7} μc/ml to 8×10^{-8} μc/ml. In this report the former detection limit is used as the basis for plotting contaminated ground-water patterns since most of the samples were analyzed prior to the establishment of the new limit. In future reports it is expected that the new detection limit will be the basis for such evaluations.

Figure 1 is a map of the 200 Areas showing the extent of detectable ground-water contamination during the period July - September, 1959. Boundaries of the contaminated ground-water zones are rather indefinite, particularly in the case of the lowest contamination-level zones, because of the limited number of monitoring wells.

The map also shows contours on the regional ground water as of June, 1959. The general direction of ground-water movement is normal to the contour lines in the direction of downward slope. Any waste, therefore, that infiltrates to the water table will follow the same general course as that of the ground water.

200-East Area

Three major waste disposal sites are located in 200-East Area (A, B, and C on Figure I). Sites A and C have been inactive for several years, but cribs at B are still in service receiving Purex wastes. Site D is not a waste disposal facility but a zone of contaminated ground water which is discussed later in this report.



a showing probable extent of ground-water contamination
ter table, September, 1959.

(1) 216-BY and 241-B cribs. -- Both of these facilities are inactive (See A, Figure 1). The 241-B cribs were taken out of service in 1953 when B-Plant was deactivated, and use of the 216-BY scavenged waste cribs was discontinued in early 1956 when radiocesium and radiocobalt were detected in the ground water beneath the site. Prior to re-establishment of the B-Swamp ground-water mound in 1956, contaminated ground water originating under the 216-BY cribs was detected several miles southeast of 200-East Area. Re-establishment of the B-Mound soon cut off this escape path, and until this quarter very little movement of the contaminants under the 216-BY facility was noted. Radiocesium is no longer detectable in the ground water under this site, but the poorly absorbed Co^{60} is still detectable in samples from wells immediately adjacent to the cribs at concentrations nearly as high as when it was first detected in 1956. The maximum Co^{60} concentration detected during this quarter was 2.7×10^{-4} μc/cc in well 299-E33-3.

There has been a noticeable southward movement of ground-water contamination from the 216-BY site during this quarter as evidenced by signifcant increases in beta activity in wells south of the disposal facility. This movement is probably due to the decreased disposal of Purex waste cooling water to the B-Swamp. In May, 1958 about 70% of the cooling water discharged from the Purex Plant was sent to B-Swamp. Due to a ruptured dike the disposal trend has been reversed, and in September, 1959 only 20% of the cooling water from Purex was discharged to B-Swamp.

(2) 216-A cribs. -- The major cribs now contributing contamination to the ground water at the Purex Plant are the 216-A-5 (process condensate) and the 216-A-24 (tank farm condensate). The 216-A-8 tank farm condensate crib removed from service in 1958 also contributed appreciably to the present status of ground-water contamination at Site B. Isotopic analyses of samples from wells in this area show no concentrations of Co^{60}, Sr^{90}, or Cs^{137} above the analytical detection limits. The volume of waste discharged to the aforementioned three cribs is of a considerable magnitude. For comparison purposes it is equal to 10% of the volume of waste cooling water discharged to the B-Swamp since the start-up of Purex.

A definite southward movement of contaminated ground water at Site B has also been noted during the past quarter. The southern boundary of this contamination is rather obscure due to the absence of wells immediately south and southeast of the eastern portion of the 200-East Area.

(3) 216-BC cribs and trenches. -- This facility was removed from active service at the cessation of the waste scavenging program several years ago. None of the wells consistently show contamination, and when present it is quite close to the detection limit. Based on well-probe data, only one of the twenty wells monitoring this site showed continuous contamination through the vadose zone to the regional ground-water table. This was the 299-E13-20c well at the southeast corner of the 216-BC cribs. There is, however, a definite probability that waste entered the ground water elsewhere without its downward migration path being detected by the probe.

Ground-water movement under this particular site is subject to effects exerted by both the 200-East Area and 200-West Area ground-water mounds. This probably accounts for the rather frequent fluctuations in well sample results.

(4) Contaminated ground water southeast of 200-East Area. -- Site D represents a contaminated ground-water zone from two to five miles southeast of 200-East Area. Two wells within the zone, 699-34-39A and 699-24-33, first showed detectable contamination from the 216-BY crib site in 1956. After re-establishing the B-Mound the contamination slowly dropped to below the detection limit. About one year ago, these two wells and a newer well 699-31-30 again showed detectable beta contamination which has been consistently increasing in concentration. The quarterly gross beta concentration average for well 699-34-39A was 7.4×10^{-6} μc/cc, about a two-fold increase over the past quarter's average. Nitrate ion analyses generally varying between 10 and 20 ppm indicate that the source of the contamination is a high nitrate waste.

Attempts to ascertain the source of this waste have not been successful, but the probable source is either the 216-BY cribs or the 216-A cribs. If the source is the 216-BY crib site, it is probably radioactive material that migrated to this locale 3 1/2 years ago and is now appearing in the wells at these relatively high concentrations.

If the 216-A cribs are the source of this contamination (probably 216-A-5, 8 and 24), it is difficult to explain how the contamination entered wells 699-31-30 and 699-24-33 which, based on ground-water elevation measurements, are up-gradient from the sources. Analyses of several special samples for Ru^{103} showed this radioisotope to be below its detection limit. In this particular case it indicated the minimum age of the waste to be about 1.5 years which does not rule out either of the two potential sources. Several wells scheduled to be drilled in this area within the next year may assist in establishing the source of ground-water contamination at Site D.

200-West Area

Three major areas of ground-water contamination in 200-West Area are shown on Figure 1 as sites E, F, and G. There has been little change in the contaminated ground-water pattern over the past quarter in this area. The southeast movement trend of wastes from sites F and G is somewhat more noticeable now than it was last quarter, and the lowest contamination level zones at these two locations have probably merged as a result of this movement.

(1) T-Plant cribs and trenches. -- Radioactive liquid waste disposal facilities servicing T-Plant have been inactive for several years, but continual drainage of several of the cribs results in ground-water contamination at Site E, Figure 1. The original source of this contamination was the second-cycle, cell drainage, and 224 Building waste that was cribbed while T-Plant was in operation. A noticeable increase in the beta activity in Well 299-W15-1 over the past quarter may be the result of waste discharged to the nearby 216-TX-5 trench in 1954 entering the ground water. It is planned to probe this well to determine if appreciable lateral movement of the waste in the vadose zone occurred. Movement of contaminants from Site E into

Well 299-W15-1 is not a likelihood since this would require flow against a rather steep ground-water gradient.

(2) 216-WR cribs. -- Contaminated ground water designated as Site F on Figure 1 originated at the 216-WR cribs which received process condensate from the Uranium Recovery Plant and now receives several hundred thousand gallons per month of UO_3 Plant condensate. Low-level contamination several miles east of this site probably originated from T-Plant cribs several years ago when the hydraulic gradient was toward the southeast from T-Plant. A special ground-water sample taken recently from Well 299-W19-2 monitoring the 216-WR cribs contained Sr^{90} at a concentration of 2.2×10^{-8} µc/cc. This confirmed earlier predictions, based on laboratory soil column results, that break-through of Sr^{90} into the ground water was imminent at this facility.

(3) Redox cribs. -- The major contributors of contaminants to the ground water in the region designated G on Figure 1 have been the Redox process condensate cribs, 216-S-1 and 2, and 216-S-7. The S-1 and 2 cribs were abandoned early in 1956 when the S-7 crib, which is still in service, was activated. Well 299-W22-2 monitoring the S-1 and 2 cribs is the only well in the fairly close network of wells at this site to show detectable Sr^{90} concentrations. This particular radioisotope has continuously appeared in Well 299-W22-2 for the past 2 1/2 years at a fairly constant concentration. The average during this quarter was 8.2×10^{-7} µc Sr^{90}/cc.

II. PLANT WASTE DISPOSAL PRACTICE

Chemical Processing Department (W. A. Haney)

Disposal to ground. -- Recent probing of wells near the unused 216-T-27 and 28 cribs revealed significant concentrations of radioisotopes from 30 to 80 feet beneath the site. Undoubtedly this contamination resulted from the lateral spread of T-Plant scavenged waste discharged to the adjacent 216-T-26 crib, the northernmost crib in the series. Uncertainties relative to the remaining life of the unused cribs resulted in a recommendation to the Chemical Processing Department that the facility be used for the disposal of relatively small volumes of T-Plant decontamination facility waste. It was also recommended that UO_3 Plant process condensate be routed to a new crib instead of the 216-T-27 and 28 facility. Neutralization of this waste should not be necessary if the Sr^{90} concentration is maintained below 8×10^{-8} µc/cc as has been the case for the past several months.

Analytical results of a special ground-water sample from Well 299-W19-2 monitoring the UO_3 Plant process condensate cribs showed Sr^{90} to be present at a concentration of 2.2×10^{-8} µc/cc. This confirmed earlier indications of Sr^{90} break-through at this facility and resulted in a recommendation to the Chemical Processing Department that construction of the planned replacement crib be expedited.

300-Area Cribbed Wastes

A film-badge survey of cribbed waste headers in the 325, 329 and 327 Buildings confirmed earlier findings that practically all of the fission product activity in this waste stream is discharged from the cells in the Radiometallurgy Building.

A liquid-level recorder installed on the 340 Building waste tanks revealed a steady addition of waste at a rate of 200 gallons per hour, 24 hours a day. The source of this waste was found to be a leaking solenoid valve on the "C" cell aspirator in the 327 Building. Replacement of the faulty valve resulted in a decrease in the volume of waste collected to 25% of the average over the past several months. Further studies of present and anticipated volumes may show that additional tankage for 300-Area cribbed waste is not required at this time.

Irradiation Processing Department (W. N. Koop)

Decontamination of reactor coolant. -- Engineering effort was continued to determine the feasibility of a proposal by the Chemical Research Operation to decontaminate reactor effluent by passing the waste through an aluminum bed prior to discharge to the river. An important consideration is the operating period prior to depletion of the aluminum bed by corrosive forces. The preferred bed life is on the order of ten years. Thus the minimum dimension of the packing units would be about 60 mils based on the corrosion rate of aluminum in effluent water. Scrap "alsi" castings from an obsolete Hanford canning process might be machined into appropriately shaped packing units for such a bed. The possibility of recasting this material does not appear attractive since the "alsi" does not melt uniformly enough to permit flow into a thin mold at temperatures as high as 800° C.

Assistance was provided the Biology Operation in setting up equipment to determine changes in the uptake of radioisotopes by fish and other river life resulting from the passage of spent coolant through beds of aluminum.

Fission Product Release Experiments (A. J. Scott)

Steam atmosphere. -- Experiments on the release of fission products from irradiated uranium in a steam atmosphere were continued with 18 tests completed during the quarter. Procedures were developed to measure the extent of oxidation for each release experiment, and to analyze the unoxidized uranium and uranium oxide separately for fission product content.

The oxide formed by the reaction of steam and uranium at 990° C and 1215° C was shown to be UO_2. A linear relationship was noted between the amount of uranium oxidized and release of the volatile fission products, iodine, tellurium, and xenon. Analyses of the UO_2 formed during fission product release experiments have shown xenon to be retained in significant amounts by the oxide, even at 1440° C.

Measurements were made of the efficiency of MSA ultra-filter media in removing radioisotopes from superheated steam. Over-all efficiencies of 98% were obtained for filtration of iodine and tellurium. Particles characteristic of UO_2 were identified on one of the filters with sizes ranging from 17 to less than 1 micron.

Three fission product release tests using helium atmosphere and one using air were made to collect needed additional data for investigating the influence of these atmospheres. Millipore filters placed in the off-gas stream collected particles in the size range found during the steam run.

III. LABORATORY EVALUATION OF WASTES (A. E. Reisenauer)

Ground Disposal Evaluation Procedures

A procedure for estimating the capacity of a ground disposal facility for radioactive waste was issued as HW-57897. This report presents the methods used in the construction, operation, and data interpretation of soil columns.

Core Sampling of 216-Z-9 Crib

In order to provide data for CPD to review the criticality control limits on the 216-Z-9 crib, four one-inch soil core samples were taken from the bottom of the crib. The cores were 14.8, 34.4, 43.0 and 44.4 cm. in length.

It is estimated from analyses of the samples that approximately 70% of the plutonium disposed to this crib may be located in the upper few centimeters of soil beneath the crib. Maximum concentrations of 1.5 mg Pu/cc of soil were found in the cores. The condition of the samples suggests that the crib bottom may not be entirely level and that part of it may not normally be contacted by waste liquid.

Laboratory and Process Waste -- 234-5 Building

The annual flow to the 216-Z-12 crib is about 13 million gallons or one column volume. The elements of concern in this waste are Pu, Am, and Cm. In soil column tests, over 100 column volumes of this waste were passed through each of four 20 cm soil columns operating at a flow rate of 0.35 gal/ft^2/hr with no break-through of Pu, Am, or Cm. The soil was composited samples from a well in the vicinity of the 234-5 Building. The influent activity of the critical radionuclides was increased to double that occurring in the waste to permit easier detection of break-through. The excellent adsorption of the Pu is consistent with data reported by Rhodes on the "Adsorption of Pu on Soils", HW-24548, 1952.

Redox Steam Condensate -- 216-S-6 Crib

Over 35 column volumes of waste were passed through each of two 40 x 1.9 cm soil columns with no break-through of Sr^{90}, the critical radionuclide in this waste. The flow rate to the column was 0.88 gal/ft^2/hr. The concentration of Sr^{90} was increased from 7.5×10^{-4} µc/cc to 3.1×10^{-3} µc/cc for easier detection of break-through. The soil used was composited from a well in the Redox area. This crib has received 9.5 column volumes of waste and at the present time is receiving waste at a rate of about one column volume per year.

IV. PARTICLE STUDY -- 234-5 Building Ventilation Exhaust (A. K. Postma, L. C. Schwendiman)

A study to determine the size and kinds of radioactive particles appearing in the 234-5 Building ventilation exhaust was completed. A secondary objective was to review present routine sampling of the stream with regard to the nature of the solids in the stream to be sampled. The methods used and the detailed results obtained were reported in document HW-61082, "Radioactive Particles in the 234-5 Building Ventilation Exhaust", by A. K. Postma and L. C. Schwendiman.

The conclusions reached from this study were the following:

(1) Radioactive material presently discharged from the 234-5 Building ventilation exhaust stack is carrier-free plutonium or plutonium compound particles unassociated with inert particles.

(2) The particles are smaller than one micron in diameter.

(3) The present sampling system is capable of withdrawing representative samples of one micron or smaller particles.

(4) The presence of significant quantities of uncontaminated rust in the air stream was not explained, but suggests a source of corrosion products in the ventilation system. It is significant that the rust particles were virtually free from plutonium or its compounds.

V. WELL DRILLING SUMMARY (J. R. Raymond)

Bach Drilling Company

Well	Ft. Drilled	Finished	Total Ft.	To Water	To Basalt
699-62-43E	85	8-7-59	85	Yes	No
699-62-43F	80	8-12-59	80	Yes	No
699-62-43G	81	8-19-59	81	Yes	No
699-62-43H	90	8-20-59	90	Yes	No
699-62-43I	79	8-27-59	79	Yes	No
699-62-43J	80	9-4-59	80	Yes	No
699-62-43K	83	9-10-59	83	Yes	No
699-62-43L	75	9-23-59	75	Yes	No
699-38-65	266	Not Completed	266	When Completed	When Completed