HASL - 14
CM - 2

ANACONDA COMPANY
GRANTS, NEW MEXICO

OCCUPATIONAL AND NON-OCCUPATIONAL RADIATION AND CONTAMINATION

by

Industrial Hygiene Branch
Health and Safety Laboratory

Issued: January 27, 1958

Distribution:
Cy 1 - W.B. Harris, HASL, NYOO
Cy 2 - J. C. Johnson, Director, RM, Wash.
Cy 3 - G. V. Beard, B&M, Wash.
Cy 4 - R. Barker, L&R, Wash.
Cy 5 - M. Mann, L&R, Wash.
Cy 6 - HASL Publications

U.S.Atomic Energy Commission
New York Operations Office
Health and Safety Laboratory

A-2

TABLE OF CONTENTS

PURPOSE AND SCOPE

During the week of November 26, 1956, a comprehensive survey of uranium milling facilities of Anaconda Company at Grants, New Mexico, was conducted jointly by the New Mexico Department of Health, Occupational Health Field Group of the U.S. Public Health Service (USPHS), and Health and Safety Laboratory (HASL) of the U.S. Atomic Energy Commission (USAEC). This survey is one of a series being conducted by HASL in cooperation with other interested governmental groups, at various uranium ore concentration mills in an attempt to define potential industrial hygiene hazards associated therewith.

A preliminary inspection was made of plant facilities to ascertain generally the nature and extent of these hazards. After an evaluation of findings, it was determined that inhalation of alpha emitting radioactive and silicous dusts were basically major potential hazards as well as direct radiation to the body. The extent of radioactive dust hazard was judged to be plant-wide in extent; inhalation of silica dust was deemed a significant industrial hygiene problem essentially in sandstone comminution areas.

Responsibility for investigation of silica dust hazards was assumed by the New Mexico Department of Health and the Occupational Health Field Group of the USPHS. The latter group also assumed responsibility for assessing external radiation and radon hazards. HASL primarily conducted a radioactive dust survey of the entire milling facility.

Information was sought during the radioactive dust survey both to determine weighted exposures of all employees to airborne radioactive dust and to define sources of excessive dust concentration. During this survey silica dust counts were obtained throughout sandstone crushing areas.

At the time of the survey, mill processes consisted of caustic treatment of limestone ores and treatment of sandstone ores by an acid-leach, resin-in-pulp procedure.

RESULTS OF STUDY

Radioactive Dust

TABLE I

WEIGHTED EXPOSURES TO ALPHA EMITTING DUSTS

Number of employees studied	451
Average of all employees	13×10^{-11} $\mu c/ml$* (290 $d/m/M^3$)
Maximum individual exposure	330×10^{-11} $\mu c/ml$ (7300 $d/m/M^3$)

NUMBER OF EMPLOYEES	PERCENT OF TOTAL	RANGE OF WEIGHTED EXPOSURES 10^{-11} $\mu c/ml$	$d/m/M^3$
242	53.6	<5	<110
32	7.8	5-10	110-220
126	27.9	10-25	220-550
35	7.8	25-50	550-1100
16	2.9	>50	>1100

*Concentrations in air of alpha emitting radioactive dusts are normally reported by this office in units of disintegrations per minute per cubic meter (d/m/M3). In 10 CFR Part 20 units of microcuries per ml of air (μc/ml) are used. Both units of concentration will be used interchangeably throughout this report. The number of microcuries has been determined by dividing the total rate, in dpm of alpha emissions by 2.2×10^6 dpm per μc.

5×10^{-11} μc/ml (110 d/m/M^3) = maximum allowable concentration (MAC) in air for natural uranium.

A discussion of the rationale of the suggested MAC for ore dust appears in Appendix B.

Significant sources of alpha emitting radioactive dust were primarily in limestone (carbonate) crushing, yellow cake processing, and pilot plant areas. A major contributing factor in each case of overexposure was found to originate in one or more of these areas.

Silica Dust

Samples were taken in all areas where relatively high exposure to workers was anticipated, i.e., the sandstone ore dry grinding circuit. Dust counts ranged from 1.9 million particles per cubic foot (mppcf) to 20.2 mppcf and were essentially below the MAC of 20 mppcf assigned to this dust (3-8% free silica by weight).

External Radiation

Gamma radiation levels were measured in areas where relatively high exposure to workers was anticipated. Results ranged from 0.1-0.15 mr/hr. Exposure to these dose rates during a normal work week would not exceed 4-6% of the permissible cumulative dose.

Radon

Radon concentrations were determined in areas where maximum exposure to workers was considered to be most likely. Measurements of airborne radioactivity of radon as determined from activity measurement of RaC[1] on dust filtered from air in core storage rooms was in the range of $0.5-1 \times 10^{-9}$ μc/ml or 0.5-1% of the maximum permissible level.

PRESENTATION OF DATA

A summary of results for the radioactive dust survey is indicated in Table I. Recommendations are included in Appendix A. A detailed discussion of radioactive components of airborne dust appears in Appendix B. Flowsheets of the processing of sandstone (acid) and limestone (carbonate) ores are shown in Figures 1-2 and 3-4 respectively, in Appendix C. Table II and III in Appendix D indicate uranium-radium ratios and comparisons between chemical and radiometric results. Daily average gross alpha exposures are listed in

Table IV in Appendix E. Table IV-A in Appendix E lists general air concentrations in selected locations. Table V lists yellow cake area breathing zone results. Appendix F contains Tables VI, VII, and VIII which are respectively, Results of Petrographic Analyses, Chemical Settled Dust, and Atmospheric Silica Dust Concentrations. Job Analysis Sheets are contained in Appendix G.

METHOD OF STUDY

Alpha Emitting Dust

Air-dust samples were collected by drawing air through 1 1/8" diameter Whatman #41 filter discs at rates of 25 or 30 liters per minute. Filter discs were analyzed for gross alpha activity on scintillation counters at the HASL. Radioactive dust concentrations (alpha $d/m/M^3$) were computed by dividing gross alpha analyses by respective total sample - air volumes.

Two types of air-dust samples were collected: 1) Breathing Zone (BZ) samples were obtained to measure dust concentrations in air breathed by employees engaged in specific jobs suspected of being dusty; 2) General Air (GA) samples were obtained to measure average dust concentrations in all areas routinely occupied by employees.

Repetitive samples were collected wherever feasible. General air and breathing zone samples were weighted to compute a daily exposure for each occupation.

Radioactive Components of Airborne Dust

Selected air-dust samples were analyzed photofluorimetrically and by alpha counting for uranium and radium respectively. Radioactivity attributable to these components was compared and ratios determined in terms of $\frac{g\ Ra}{g\ U}$. In addition radioactivity attributable to uranium was compared, where applicable, to total activity originally counted and ratios determined in terms of $\frac{\mu g\ U}{d/m}$. From these ratios one can estimate to what degree these components approach theoretical equilibrium.

Silica Dust

Silica dust samples were collected by drawing air through a midget impinger containing 10 ml of distilled water at a rate of 0.1 cfm. Each sample was transferred to a 1 mm deep cell shortly after collection and counted by standard light-field technique at a magnification of 100 times.

Free Silica Analysis of Airborne Material

Two methods were used to determine this material. The first of these used a sample of dust which had settled on rafters and ledges, assuming the material to be representative of an average condition. The other method was to sample enough air to permit performance either of a chemical analysis for free silica or a petrographic analysis.

Direct Radiation

Gamma radiation was measured with a Juno Survey Meter (Model SIC-17C) and reported in terms of mr/hr.

Radon

Air was drawn through Whatman #41 filter paper (1 1/8" diameter) at a rate of 14-23 liters per minute for either a five or ten minute period. Forty to ninety minutes after the end of sampling, the alpha activity on the paper was measured by a Juno Survey Meter which was cross-calibrated against a laboratory counter using an Ra C^1 source. The radon concentration was computed using the method of Kuznetz as described in American Industrial Hygiene Association Quarterly, 17:85, 1956.

PROCESS DESCRIPTION

Sandstone (Acid) Circuit

Uranium ore in this circuit is processed by the Resin-in-Pulp (RIP) ion exchange method. Referring to Figures 1-2 in Appendix C, uranium bearing ores are delivered by railroad gondolas to an outdoor shakeout and bin storage area. A front-end loader conveys ore to a grizzly where it is dumped onto a belt feeder and transported to a jaw crusher. Crushed ore then is passed through a vibrating screen with oversize returning to an impact breaker. Ore passing the screens is fed to a sample tower and then to a series of storage bins. As needed, properly blended ores are wet ground in a rod mill, classified, and leached in sulfuric acid. A mechanical sand-slime separation is made with sands going to tailings.

The slime portion is neutralized with soda ash. A proper EMF is obtained by reducing with ferrous sulfate. Pulp then passes to RIP tanks where uranium is separated. Pregnant eluate is clarified, treated with magnesium oxide to precipitate a complex uranium salt (yellow cake) which is then filtered, dried, and packed for shipment.

Limestone (Carbonate) Circuit

Referring to Figures 3-4 in Appendix C, high-lime ores are transported to the limestone primary crushing building by truck, dumped, swamped to a pan feed, and conveyed to a jaw crusher. Crushed ore is screened in the secondary crushing building. Oversize is passed through an impact breaker; screen undersize is processed through a short head crusher, conveyed to the sampling tower and then removed to storage bins. Limestone and sandstone crushers are in separate buildings, and both circuits are kept independent of each other. On occasion, however, sandstone ore may be crushed in limestone buildings when material demand warrants.

Blended ore from storage bins is wet ground in rod and ball mills, and caustic leached in autoclaves. It is then filtered, clarified, and precipitated with sodium hydroxide. Resultant yellow cake is filtered, dried, and packed for shipment.

DUST CONTROL AND PERSONNEL PROTECTION

For the most part, processing equipment in the ore plants was enclosed and ventilated except in the limestone primary crusher building where dust control facilities were essentially minimal. The survey team was informed that moisture content of limestone (carbonate) ore often was as low as 0.036%; it usually was 4-5% in sandstone (acid) ores. Variations in moisture content of ores undoubtedly influenced the extent of air dustiness in these areas. Exhaust air from ore processing facilities was discharged through Type N Wet Rotoclones. Sample processing equipment in the sample preparation building was hooded and ventilated.

Yellow cake final product from the sandstone circuit was packaged simultaneously in six individual drum filling units housed in a single enclosure ventilated by an exhaust fan located in the rear thereof. A similar type enclosure housing two individual drum filling units was used for yellow cake final product from the limestone (carbonate) circuit. Exhaust air from all yellow cake ventilation facilities was discharged through either a Wet Impact Dust Collector or a Microdyne.

Ventilation facilities were not checked for performance characteristics.

Dust respirators were worn by operators at essentially all of the dustier operations in the plant. Specific jobs for which respirators were worn are identified with asterisks on Job Analysis Sheets in Appendix G.

DISCUSSION

The maximum allowable concentrations for alpha emitting dusts is discussed in Appendix B.

Exposures to Alpha Emitting Dust

Total alpha exposures expressed as daily average gross alpha count are listed in Table IV in Appendix E. Approximately 47% of all employees were exposed to alpha emitting dust concentrations in excess of the maximum allowable. The average general air concentration for the plant was 420 $d/m/M^3$ (19×10^{-11} $\mu c/ml$). The main sources of radioactive dust contributing to both high plant general air and personnel overexposures were essentially in three general areas, namely, limestone (carbonate) crushing, yellow cake processing and pilot plant. Twenty percent of all employees were overexposed by virtue of time spent in or near these areas as well as throughout the entire plant.

Dust respirators were worn by operators at essentially all of the dustier operations in the plant. However, it is recognized that there are limitations inherent in protection afforded by most filter type respirators and for this reason calculated exposures presented in this report are not adjusted for respiratory protection.

Sources of Excessive Exposure

Carbonate Crushing Areas

High concentrations of airborne radioactive dust in both the primary and secondary limestone crushing buildings contributed directly to overexposures of twenty-four workers and indirectly to 125 workers. Average general air concentrations of 3400 d/m/M3 (160 x 10^{-11} μc/ml) and 720 d/m/M3 (33 x 10^{-11} μc/ml) were noted in the primary and secondary crushing buildings respectively. These high results were in striking contrast to average concentrations of 35 d/m/M3 (1.6 x 10^{-11} μc/ml) detected in sandstone (acid) crushing areas. Differences in ore moisture content undoubtedly had a direct bearing on these results. The survey team was informed that moisture content of limestone (carbonate) ores often was as low as 0.036%; it usually was 4-5% in sandstone (acid) ores.

Dust control facilities were essentially minimal in the primary crushing building. At the crusher level (1st sub-level) and transfer point, dust clouds were of such magnitude as to restrict vision to a few feet. Average general air concentrations of 7300 d/m/M^3 (330 x 10^{-11} μc/ml) were detected in these areas. Results of three breathing zone samples taken during pushing of ore through the grizzly averaged 1300 d/m/M^3 (61 x 10^{-11} μc/ml). Operators wore respirators during ore processing operations, which afforded some measure of protection against overwhelming dust concentrations encountered. Housekeeping procedures were almost entirely lacking. One operator was observed sticking his head into a clean-out door of a hopper to view the progress of ore down from the grizzly to the crusher feed pans. The survey group was informed that this was not an uncommon practice by various crusher operators.

Mechanical exhaust ventilation was in considerable evidence in the secondary crusher building. Overall dust levels were significantly lower than those encountered in the primary crusher building. Nevertheless, average general air concentrations ranging from 180-1000 d/m/M3 (8.0 x 10^{-11} μc/ml) were detected at several conveyor transfer points as well as at the Cedar Rapids crusher, Symons crusher, and Ty-Rock sampling screen.

Yellow Cake Processing Areas

Forty-six workers were overexposed primarily from dust sources in yellow cake areas. One hundred and twenty-five other workers were overexposed indirectly in the same manner. General air concentrations were highly variable, ranging from 3-12,000 $d/m/M^3$ ($0.14-540 \times 10^{-11} \mu c/ml$) and averaging 1100 $d/m/M^3$ ($50 \times 10^{-11} \mu c/ml$).

Housekeeping procedures were not satisfactory. Spills were frequent and cleanup ineffective. Evidence of these conditions was obtained in the steam pan, drumming stations, and carbonate yellow cake filter areas which were major loci of air contamination. Maximum general air concentrations observed in these areas were 1100 $d/m/M^3$ ($52 \times 10^{-11} \mu c/ml$), 2200-2800 $d/m/M^3$ ($100-130 \times 10^{-11} \mu c/ml$) and 12,000 $d/m/M^3$ ($550 \times 10^{-11} \mu c/ml$) respectively.

Listed in Table V (page 10) in descending order of magnitude are results of breathing zone samples taken at operations performed in this area. Workers wore respirators while performing these operations and were afforded thereby a measure of protection against high airborne dust concentrations. Breathing zone concentrations at many operations listed in Table V were within range of general air concentrations in neighboring areas; this probably holds true for reported air concentrations of 1000 $d/m/M^3$ ($46 \times 10^{-11} \mu c/ml$) or less. Although it may be assumed that the latter operations did not contribute very much air contamination under these conditions, they should not be ignored since they may prove to be sources of radioactive dust later on.

It is clear, from an examination of Table V that several yellow cake processing operations may be incriminated as sources of radioactive dust. Shoveling yellow cake to buckets from pan, dumping into carbonate drum, and covering was a particularly offensive operation. The air concentration indicated by two samples taken during this operation was in the range of 7400-10,000 $d/m/M^3$ ($340-460 \mu c/ml$).

Existing multiple drum filling booths, although ventilated, were essentially inadequate as evidenced by high breathing zone and general air concentrations, reported previously, obtained therein. For example, breathing zone concentrations detected during beating and replacing of acid yellow cake drum averaged 9200 $d/m/M^3$ ($420 \times 10^{-11} \mu c/ml$).

TABLE IV A

GENERAL AIR CONCENTRATIONS IN SELECTED LOCATIONS

Location	No. of Samples	RESULTS d/m/M^3 Low	High	Ave.	μc/ml x 10^{-11} Avg.
Plant	146	1	12,000	420	19
Acid Mills	57	1	140	33	1.5
Acid Crushing Plant	13	1	100	35	1.6
Main floor and pit	9	5	95	32	1.5
2nd floor	2	1	100	151	6.9
3rd floor	2	29	53	41	1.9
Acid Grizzly Area	4	11	95	38	1.7
Acid Sample Tower	6	9	56	24	1.1
Main floor	3	17	56	31	1.4
2nd, 3rd and 4th floors	3	9	27	16	0.73
Acid Ore Bin Building	9	1	68	21	0.95
Conveyor area	4	9	68	36	1.6
1st floor	5	1	30	9	0.41
Carbonate Crushing Plants	23	160	7,700	1,500	71
Primary Crushing Plant					
Main floor	4	230	960	570	26
Basement	3	7,000	7,700	7,300	330
Secondary Crushing Plant					
Basement	3	400	1,300	680	31
Main floor	3	270	660	420	19
Screen floor	3	510	1,400	1,000	46
2nd floor	3	615	1,400	1,000	46
Inclined conveyor ramp	4	160	900	470	21
Carbonate Mill	20	14	300	79	3.6
Rod and ball mill area	5	14	67	50	2.3
Burt filters	4	45	74	58	2.6
Oliver filters	3	17	55	38	1.7
Leach tanks	4	79	300	220	10
Precipitation	2	19	21	20	0.91
Yellow Cake Area	18	3	12,000	1,100	51
Weigh Room	1	-	-	3	0.14
Furnace Area	1	-	-	44	2.0
Bucking House					
Bucking room	3	4	18	12	0.55
Heads pulverizing room	3	5	40	24	1.1
Blending room	3	5	25	14	0.64
Core room	2	2	3	3	0.14
Pilot Mill	7	<1	23	10	0.45
Grinding, leaching, sand-slime	4	1	14	6	0.27
RIP Make-up banks	1	-	-	23	1.0
Precipitation and elution make-up	1	-	-	6	0.27
Yellow cake packaging	1	-	-	23	1.0

Carbonate Grizzly Area	3	7,000	7,700	7,300	330
Sample Tower	4	14	150	73	3.3
Ground Floor	1	-	-	150	6.9
2nd, 3rd and 4th floors	3	14	84	47	2.1
Ore Bin Building	13	4	180	68	3.1
Tripper belts	5	89	290	160	7.3
First floor	6	4	38	16	0.73
Rest of building	2	9	10	10	0.45
Acid Leaching Building	19	7.6	80	28	1.3
Grinding	3	7.6	33	20	0.91
Leaching	8	10	35	25	1.1
Classification	8	19	80	36	1.6
Operation floor	4	30	40	34	1.5
Ground floor	4	19	80	39	1.8
RIP Building	9	1	139	59	2.7
Make-up	1	-	-	66	3.0
Banks	3	24	36	29	1.3
Clarification	3	1	90	37	1.7
Elution and precipitation	2	125	139	130	6.0

TABLE V

RESULTS FOR YELLOW CAKE AREA BREATHING ZONE SAMPLES

OPERATION	NO. OF SAMPLES	RESULTS d/m/M³ LOW	HIGH	AVERAGE	$10^{-11}\mu c/ml$ AVERAGE
Removing carbonate drum from carbonate filling station - shoveling yellow cake to buckets from pan and dumping in drum	1	-	-	10,000	460
Beating acid yellow cake drum and replacing	3	1300	15,000	9,200	420
Covering carbonate yellow cake drum	1	-	-	7,400	340
Cleaning acid yellow cake press	3	300	810	530	24
Cleaning carbonate clarification press	3	210	580	380	17
Cleaning acid yellow cake press floor	1	-	-	300	14
Raking yellow cake in steam pan	3	150	310	240	11
Cleaning carbonate yellow cake press	3	100	310	200	9.0
Cleaning carbonate yellow cake press floor	1	-	-	140	6.2
Sampling and covering acid yellow cake drum	3	50	280	130	5.9

Pilot Plant Area

The major source of contamination in this area was an operation involving cleaning of drier, removing of pan, and filling of drum. Results of three samples taken at this operation averaged 66,000 d/m/M³ (3000 x $10^{-11}\mu c/ml$) and ranged from 48,000-80,000 d/m/M³ (2200-3700 x $10^{-11}\mu c/ml$). This operation was entirely unventilated; smoke and dust were plainly visible during the sampling period. Operators wore respirators while performing these operations.

Silica Dust

Listed below is the most recent list of maximum allowable concentrations for silica dust as published by the American Conference of Governmental Industrial Hygienists.

DUST COUNT mppcf	PERCENT Free Silica
5	>50
20	5-50
50	>5

Results of petrographic analyses are shown in Table VI in Appendix F and indicated maximum particle sizes ranging from 75-150 microns and estimated weights of free silica of the order of 3-8%. Chemical analysis of a single sample of settled dust in the sandstone crusher area indicated 9.5% quartz as indicated in Table VII in Appendix F. The MAC for gross dust count is 20 mppcf at this silica content.

Samples for silica dust were taken in all areas where relatively high exposure to workers was anticipated, i.e., the sandstone crusher building, sandstone sample tower, sandstone fine ores bin, and sample preparation building. Results of analyses are given in Table VIII, Appendix F. Dust counts ranged from 1.9 million particles per cubic foot (mppcf) to 20.2 mppcf. At the locations and under the conditions sampled, it is clear that silica dust concentrations were essentially below the MAC.

Direct Radiation

The maximum permissible whole body exposure to gamma radiation is 5 rem/hr. Assuming the normal work week to be forty hours, an exposure to a uniform whole-body dose of 2.5 mr/hr of gamma radiation will result in a yearly cumulative whole-body dose corresponding to the maximum permissible amount.

Gamma radiation levels were determined in areas where relatively high exposure to workers was anticipated. Measurements ranged from 0.1 to 0.15 mr/hr. These are essentially insignificant when compared to the maximum permissible amount.

Beta radiation levels were not determined. In other mill surveys, significant beta dose rates have been detected along with gamma radiation but have not been found to be excessive. This problem is explored further in other reports in this series.

Radon

For purposes of regulations stipulated in 10 CFR Part 20, limits for radon prescribed therein will be considered to be met if measured radioactivity of one or more decay products (for example RaC^1) does not exceed that which would result from the occurence, at the time of sampling, of 1×10^{-7} microcuries, per milliliter of air, of Rn^{222} and each of its short-lived decay products, RaA, RaB, RaC, and RaC^1.

Radon concentrations were determined in areas where maximum exposure to workers was considered to be most likely. Measurements of airborne radioactivity of radon as determined from activity measurments of RaC^1 on dust filtered from air in core storage rooms was in the range of $0.5\text{-}1 \times 10^{-9}$ $\mu c/ml$. These are insignificant when compared to the maximum permissible amount.

APPENDIX A

RECOMMENDATIONS

Carbonate Crushing Area

Dust control facilities were essentially minimal in the primary crusher building. The airborne hazard resulting therefrom was undoubtedly augmented by the low moisture content of processed ores. Steps should be taken to minimize these failings.

1. a. Dry ores should be wet down either at the ore dump location or at some other place prior to entering the mill proper. Caution must be exercised, however, in regard to freezing of wetted materials in cold weather. Such procedures as draining lines after each day's use, adding an antifreeze material, etc, must be considered.

   b. The grizzly and jaw crusher beneath it in the primary crusher building should be enclosed and ventilated. Recommended exhaust rate for the grizzly is 200 cfm per square foot of hood opening but not less than 50 cfm per square foot of screen area. The crusher should be ventilated at a rate of at least 200 fpm through all openings in the enclosure.

2. An inspection port ventilated at a rate of 150-200 ft/min should be provided at the primary crusher.

3. Adequate ventilation should be provided in the secondary crusher building at all transfer points and at the Cedar Rapids crusher, Symons crusher, and Ty-Rock sampling screen. Minimum velocities of 150-200 fpm through openings should be maintained at all these points.

4. A regular schedule of housecleaning using non-dust producing clean-up methods should be instituted. Use of brooms and/or compressed air should be avoided. Industrial vacuum cleaners are to be preferred although wet cleaning may be more practical in certain areas. When the latter method is employed, high pressure nozzles should not be used with hose lines.

5. Until dust loadings are diminished to safe working levels in carbonate crushing areas, mill operators and any other personnel entering mill areas, while crushing and sizing are in progress, should wear respirators.

Yellow Cake Processing Area

6. Existing multiple drum filling ventilated booths are essentially inadequate. Individual ventilated enclosures for each drum are preferred. Enclosures should be ventilated individually at a minimum rate of 150 ft/min at tops of open drums.

Provision should be made for rapping, sampling, weighing, and covering drum within enclosure at each drum filling unit. Automatic vibrators or other analogous device should be installed on each drum feed hopper to insure continuous flow of material to drum.

If a single sampling station for all drum filling units is preferred, provision should be made for enclosing and ventilating the station and drum conveyor systems leading thereto. Minimum velocities of 150 ft/min through openings should be maintained.

7. Shoveling yellow cake to buckets from pan, dumping into carbonate drum, and covering, should be accomplished in ventilated booth. Ventilation at a minimum rate of 150 ft/min through opening would be required.

8. Exhaust ventilation should be provided for steam pan. Minimum air requirement would be 150 ft/min across face of hood.

9. A regular schedule of housekeeping using non-dust producing cleanup methods should be instituted. Details suggested in recommendation number four are applicable here.

10. Until proper controls are provided, all yellow cake workers and any other personnel entering yellow cake areas, while operations are in progress, should wear respirators.

Pilot Plant Area

11. Provide ventilated enclosure for drum filling operation. Minimum air requirement would be 150 ft/min at top of open drum.

APPENDIX B

MAXIMUM ALLOWABLE CONCENTRATIONS FOR ALPHA EMITTING DUSTS

In order to evaluate the degree of over-exposure of the personnel working in the uranium industry, it is necessary to apply the values which are stated in 10 CFR Part 20. Appendix B of this part lists the maximum permissible concentration in air for most of the materials of interest to this industry. Where a single element or isotope is involved the interpretation of the table presented in Appendix B is reasonably straightforward. For example, the maximum permissible concentration for natural uranium in the insoluble from, a value is given of 5×10^{-11} uc/ml.

Paragraph 20.5C further defines this value in terms of alpha disintegrations per ~~minute~~ with the statement that "the number of microcuries shall be determined by dividing the total disintegration rate in d/m from the mixture by $2.2 \times 10^{+6}$ d/m/uc." It can therefore be readily seen that a value of 112 alpha d/m/M^3 is the maximum permissible uranium concentration in the atmosphere, and all values may be compared directly to this.

Where a complex mixture of isotopes is encountered, it is necessary either that this mixture be broken down and, each element analyzed separately or that some composite value of permissible concentration in air be chosen. Any value which is finally derived must be properly weighted for the respective insults which each isotope presents to the body.

Precisely this latter situation exists in the handling of uranium ore.

Analyses which have been made in connection with this and other surveys indicate that by and large an air sample which is taken in those areas where uranium ore is handled is in isotopic equilibrium. In some cases small quantities of thorium and its daughter products also exist. Certain analyses which have been performed to date show some unexplained short lived decay. This tends to over-emphasize the original count by as much as a factor of 2. However, inasmuch as neglecting this results in a conservative estimate of exposure, this phenomenon will be overlooked until it can be accurately explained.

The equilibrium uranium decay series contains 8 successive alpha emitting substances. The first 4 of these materials are: U-238, U-234, Thorium 230, and Radium 226. According to the report of the National Committee on Radiation Protection NBS Handbook 52, the organ to which the uranium and the thorium are of primary interest is the lung, while the organ to which the radium is of interest is the bone. Calculations which have resulted in the permissible level of each of these materials assume a maximum permissible radiation dose to the critical organ of not more than 300 mrem/wk. Inasmuch as the uranium and the radium seek different body organs, the permissible concentrations of these materials cannot be considered to be additive. It must be assumed that each stands on its own and that the one delivering the greatest dose should govern.

It is very important, also, that any permissible level which is finally derived must be evaluated in terms of alpha d/m on the total sample rather than from a complex chemical analysis of the fractions followed by analysis of each component. Such chemistry is much too tedious and complex to be considered as a routine field technic. This will be possible if it can be demonstrated that the ore material is consistent in its equilibrium ratio.

When one measures the activity from ore material, it appears from the data which have been gathered in this survey that 25% of the total alpha activity is contributed by uranium 238 plus uranium 234; 12½% is contributed by Thorium 230, and 12½% is contributed by radium. This corresponds to true equilibrium, within the limits of the analytical method. If this is the case, as we believe it is, in order that there be not more than 5×10^{-11} uc of uranium plus thorium in a sample (37.5% of all the alphas), the total alpha count should not exceed $\frac{5}{0.375} \times 10^{-11}$ or 13.3×10^{-11} uc.

In order that there be not more than 2.4×10^{-11} uc of radium, the sample must contain not more than $\frac{2.4}{0.125} \times 10^{-11}$ or 19 uc.

In connection with this it is noted that page 14 of Handbook 52 states: "In the case of radium .....uc.....values are based on the disintegration rate of the parent isotope only." This would indicate that although the value as listed states radium 226 plus one-half the daughters, the energy contribution of the daughters is added to that of the parent material in the calculation but should not be assessed in sample evaluation.

Inasmuch as the effective dose of the uranium contribution is significantly higher than that of the radium contribution, it is recommended that the effective uranium dose govern. This would permit the following values to be used in assessing the internal hazard from the various materials in the ore processing plants:

1. Material which is substantially all ore - 13.3 uc/ml (300 $d/m/M^3$)

2. Where the material is uranium or of any unknown equilibrium ratio a value of 5×10^{-11} uc/ml should be used (100 $d/m/M^3$)

It should be pointed out that as the ore progresses through processing, the decay products are selectively removed along with the inert materials. Therefore, the alpha component from uranium becomes proportionately greater in the air dust. Whereas in normal ore, radium is approximately 12.5% of the total activity and uranium approximately 25%, the concentrate dust contains 99% of uranium and 1% of radium.

One might assume a transition in the relative isotope fractions as the material progresses through concentration, but although this phenomenon has not been fully investigated, it appears that substantially all of the air contamination in the intermediate areas is due to concentrate dust against which the uranium MAC is strictly applicable.

APPENDIX C

SANDSTONE
ACID

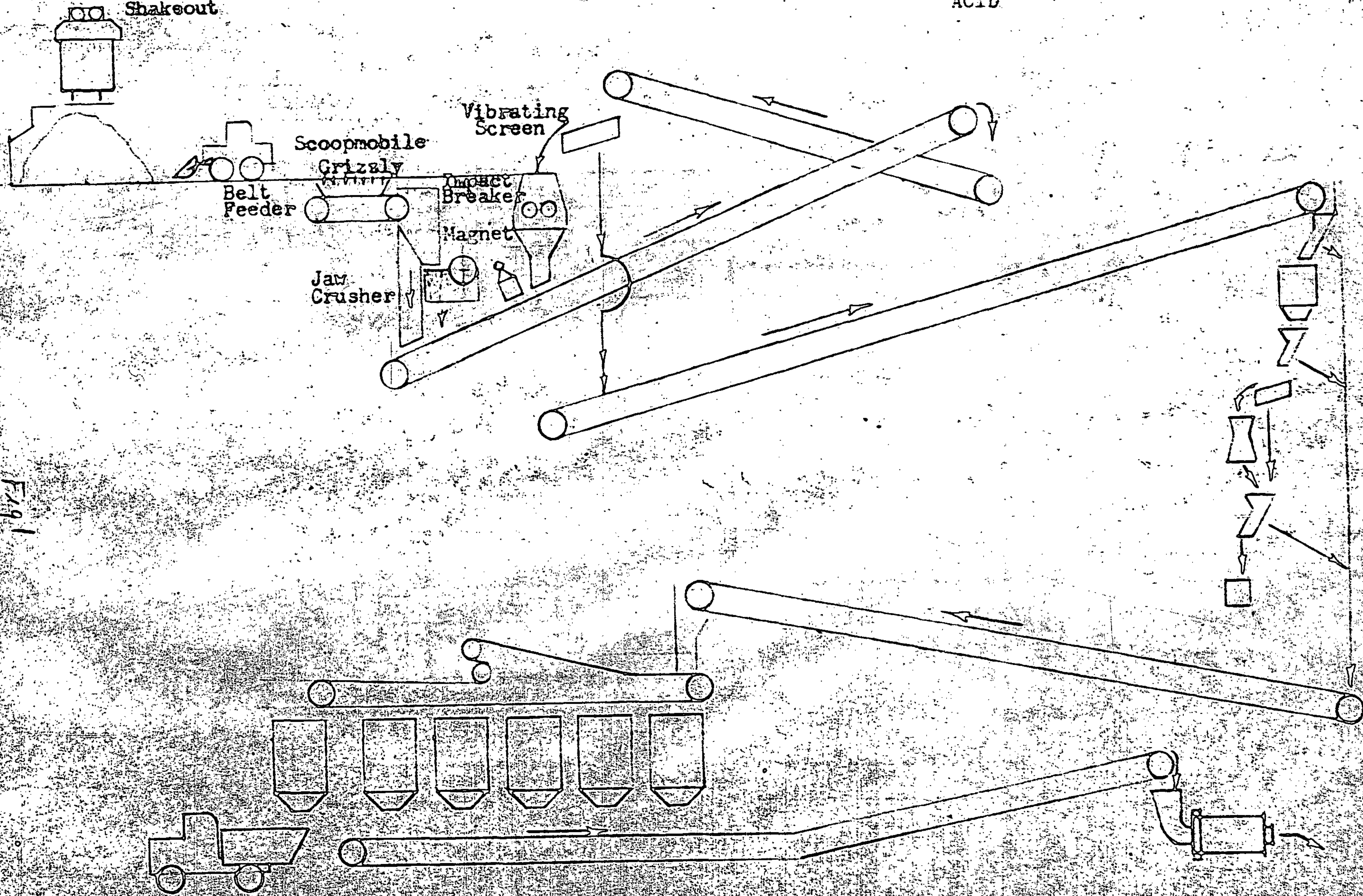

Fig. 1

ACID MILL

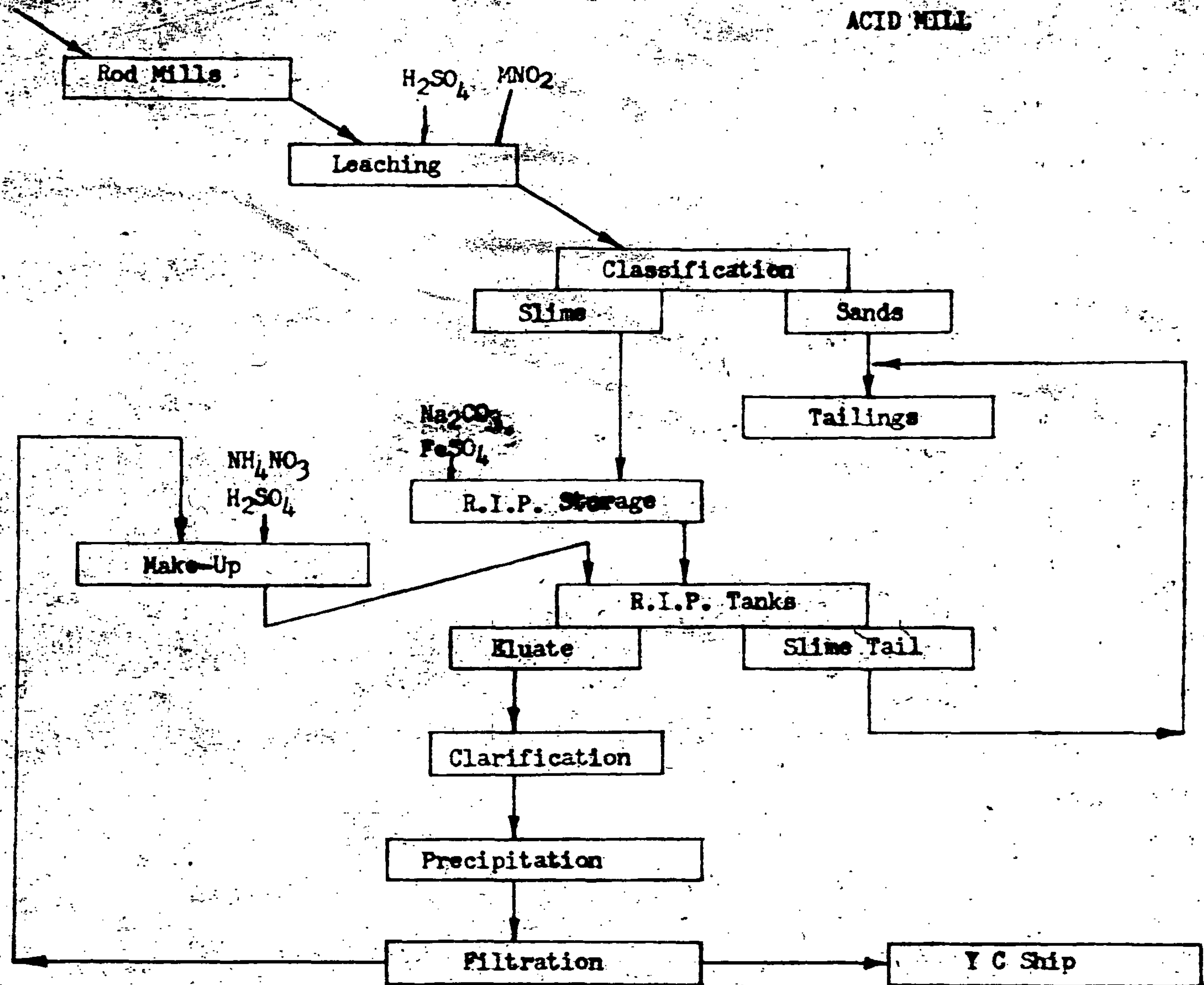

Fig 2

CA..NATE CR..HI..

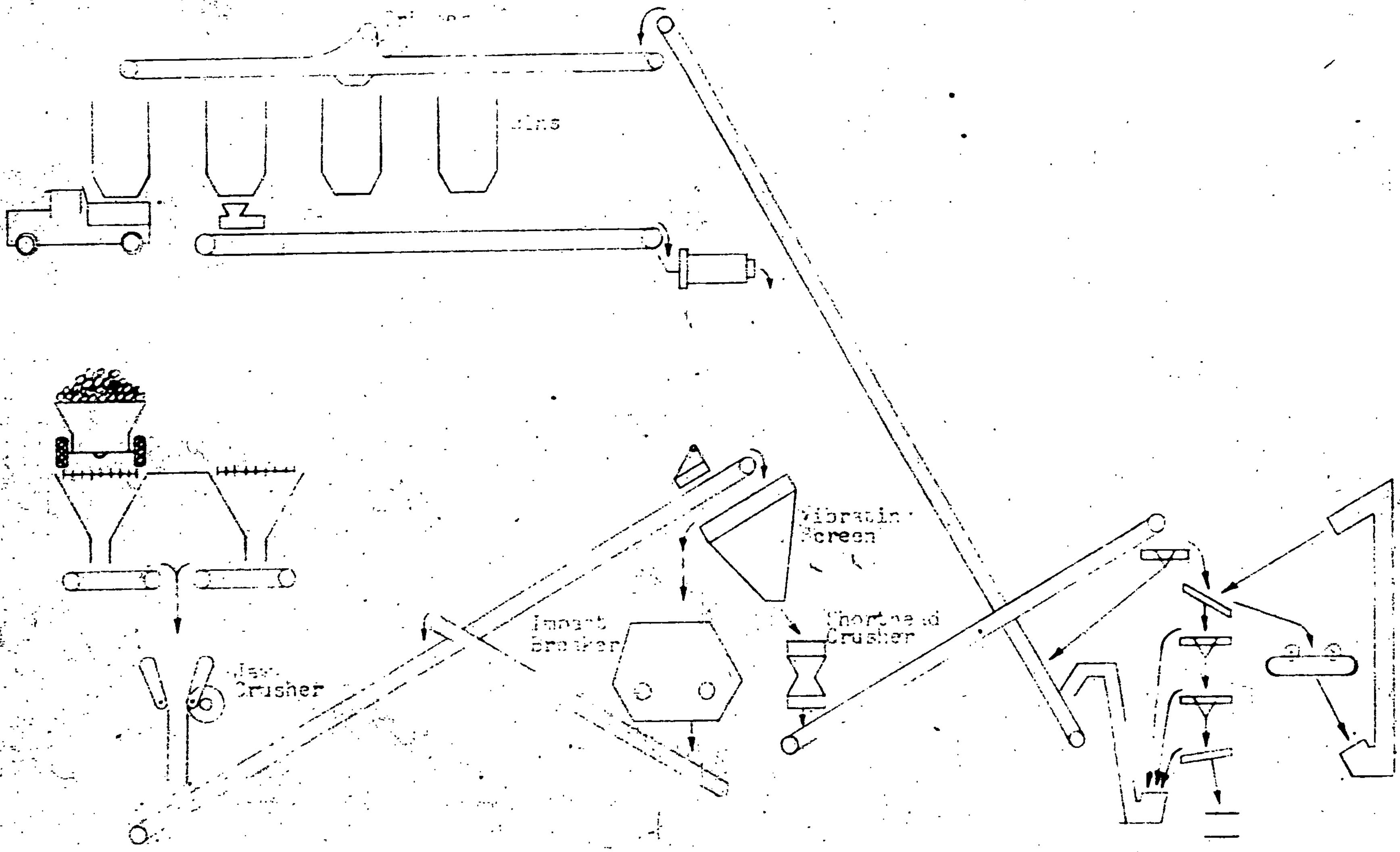

Fig 3

CARBONATE MILL

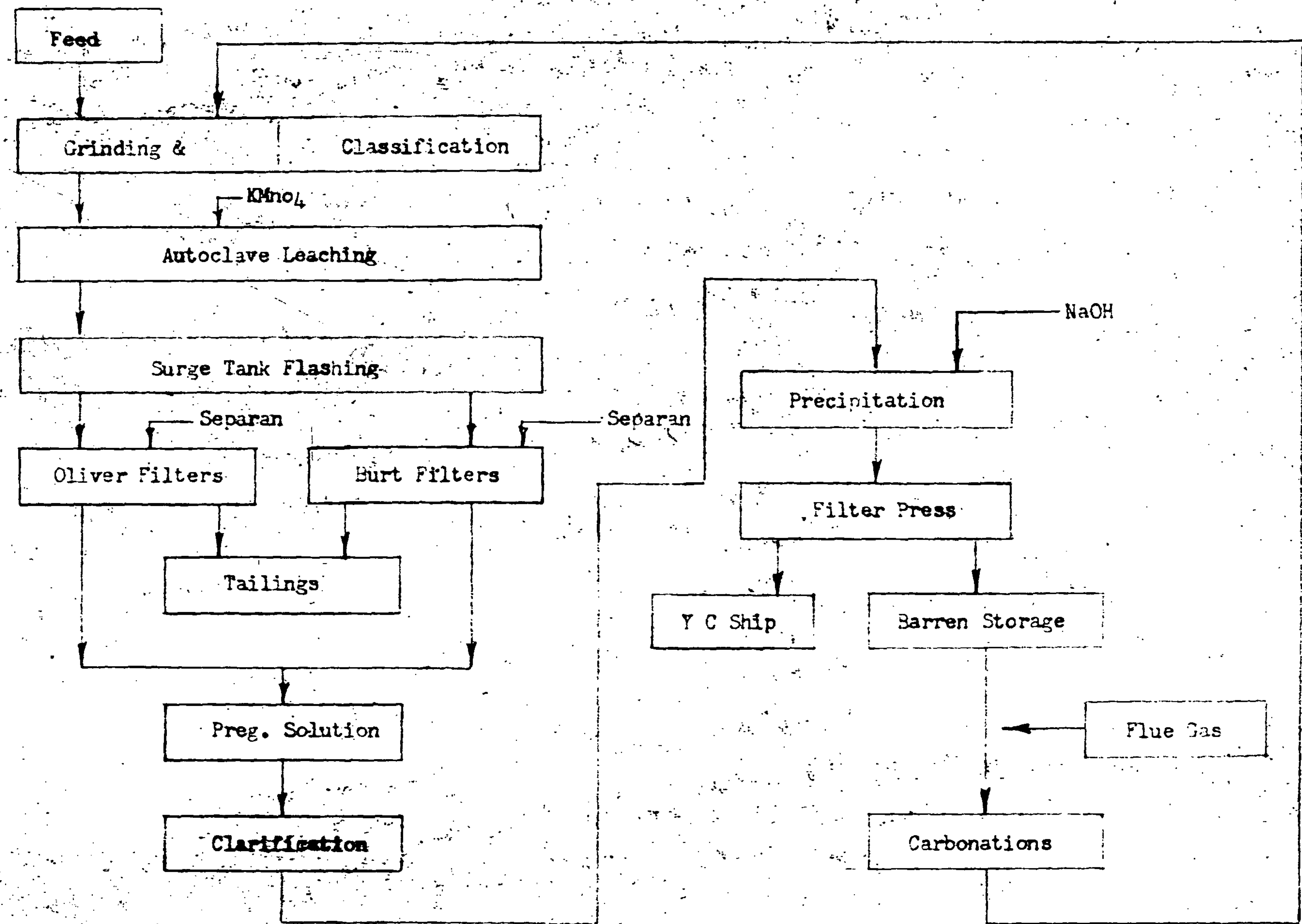

Fig 4

APPENDIX D

TABLE II

URANIUM-RADIUM RATIOS

LOCATION	URANIUM~μg/M³ No.	Low	High	Avg.	RADIUM~μμg/M³ No.	Low	High	Avg.	$\frac{gRa}{gU} \times 10^{-9}$ Ratio
LIMESTONE AREAS									
At Grizzly-swamping and cleanup	1	-	-	98	1	-	-	15	150
At Grizzly-during dumping of Haystock ore	1	-	-	240	1	-	-	630	260
Primary Crusher-ground floor level	2	26	93	60	2	4.7	250	130	220
Crusher-first floor	1	-	-	390	1	-	-	120	320
Primary Crusher-first sub level	2	75	1100	590	2	10	211	110	160
Under first floor	1	-	-	1400	1	-	-	18	13
Primary Crusher-discharge onto belt	1	-	-	4700	1	-	-	970	210
Secondary Crusher-first deck	1	-	-	370	1	-	-	140	370
Secondary Crusher-first floor at Symons Crusher	1	-	-	180	1	-	-	2.2	12
Secondery Crusher-third deck	1	-	-	14	1	-	-	31	2200
Sample Tower-first deck	1	-	-	48	1	-	-	16	330
Sample Tower-third deck	2	100	330	220	2	35	37	36	230
Top of Storage Bins	1	-	-	48	1	-	-	3.5	73
AVERAGE VALUE									320
SANDSTONE AREAS									
Crusher-first floor	3	24	96	48	3	2.4	65.0	33	25.0
Crusher-vibrating screen area	3	18	52	31	3	2.1	5.3	3.6	41
Crusher-area of head pulley	3	13	31	20	3	2.2	11	5.9	310
Sample Tower-first deck	3	24	75	45	3	0.5	7.4	3.2	81
Sample Tower-second deck	1	-	-	17	1	-	-	5.7	340
Sample Tower-third deck	3	46	80	58	3	0.4	6.3	2.7	56
Sample Tower-fourth deck	1	-	-	39	1	-	-	1.4	36
Fine Ores Bin-top level	2	14	65	40	2	1.6	4.8	3.2	180
Fine Ores Bin-bottom level	1	-	-	21	1	-	-	0.5	24
Feed to Rod Mill	1	-	-	17	1	-	-	0.2	12
AVERAGE VALUE									100

For ore in equilibrium, the value of the ratio $\frac{gRa}{gU}$ is approximately 330×10^{-9}. The preceding data would seem to indicate that radium and uranium are in the correct proportions in limestone ore handling areas but not in areas where sandstone ore is processed.

TABLE III

RATIO OF ANALYTICAL VALUES TO RADIOMETRIC COUNT

LOCATION	TOTAL COUNT d/m/M^3	URANIUM $\mu g/M^3$	RATIO $\frac{\mu g}{d/m}$
Limestone Areas			
Crusher-first floor	960	390	0.41
Crusher-under first floor	7700	1400	0.18
Secondary Crusher-top of conveyor #1	1400	190	0.14
Secondary Crusher-first floor at Symons	660	180	0.28
Sample Mill-first floor	150	27	0.18
Sample Mill-fourth deck	84	11	0.14
Storage Bin-top	290	48	0.16
Storage Bin-top	180	28	0.16
AVERAGE VALUES			0.21
Sandstone Areas			
Crushing Plant-second deck	100	16	0.15
Crushing Plant-at primary crusher	95	15	0.16
Sample Mill-third deck	27	5.1	0.19
Sample Mill-first deck	21	2.0	0.10
Storage Bin-main belt	68	11	0.16
Storage Bin-chute discharge	44	12	0.27
AVERAGE VALUES			0.17

For ore in equilibrium, the ratio $\frac{\mu g\ U}{d/m}$ is approximately 0.18. The preceding data tends to indicate uranium is essentially in correct proportion to total activity in all ore handling areas.

APPENDIX E

TABLE IV

TOTAL ALPHA EXPOSURE (DAILY AVERAGE) EXPRESSED AS DAILY AVERAGE GROSS ALPHA COUNT

JOB DESCRIPTION	NO. OF EMPLOYEES	DAILY AVERAGE EXPOSURE $d/m/M^3$	10^{-11} $\mu c/ml$
General Crushing Plant	6	980	45
General Crusher Foreman	1	2000	90
Crusher Foreman	1	730	33
Crushing Plant Shift Bosses	4	800	36
Acid Crushing Plant	17	35	1.6
Primary and Secondary Crusher Operator	3	38	1.7
Sample Tower Operator	3	23	1.0
A-Bins Tripper Operator	3	23	1.0
Grizzly Laborer	3	37	1.7
Relief Operator	1	33	1.5
Sample Tower Men	4	48	2.2
Carbonate Crushing Plant	12	1900	88
Primary Crusher Operator	2	2600	120
Secondary Crusher Operator	2	670	31
Sample Tower Operator	2	99	4.5
C-Bin Tripper and Shuttle Operator	2	84	3.8
Grizzly Laborer	2	7300	330
Relief Operator	1	720	33
Clean-up Laborer	1	640	29
Acid Leaching	37	26	1.2
Acid Mill Superintendent	1	24	1.1
Foreman	4	26	1.2
Grinding Operators	7	20	0.9
Leaching Operators	11	25	1.1
Classifier Operator	11	34	1.5
Swamper	3	19	0.9
Ion Exchange Building	44	58	2.6
Assistant Mill Superintendent	1	59	2.7
Mill Foremen	4	64	2.9
RIP Makeup Operator	4	66	3.0
Electrician and Precipitation Operator	3	130	6.0
RIP Makeup Sub Operator	4	82	3.7
RIP Bank Operators	14	29	1.3
Floor Labor	4	59	2.7
Swamper	3	59	2.7
Clarification Pressman	7	64	2.9

TABLE IV (cont'd)

Carbonate Mill	46	120	5.4
Assistant Mill Superintendent and Foreman	2	590	27
Shift Foreman	3	130	5.8
Relief Shift Foreman	1	630	29
Precipitation Operator	4	230	10
Burt Filter Operators	8	58	2.6
Grinding Operator	4	54	2.5
Grinding Sup Operator	4	38	1.7
Leach Operator	3	160	7.2
Oliver Filter Operators	6	38	1.7
Swamper and Bull Gang	11	79	3.6
Yellow Cake	36	1000	47
Shift Foreman	3	1100	51
Relief Shift Foreman	1	630	29
Sample Room Operator	3	330	15
Acid Dryer and Drum Beater	8	1300	58.0
Acid Dryer Helper	4	1000	47
Carbonate Dryer Operator	3	1000	46.0
Acid Yellow Cake Press Laborer	7	1100	50
Carbonate Press Laborer	5	1000	47
Floor Man	2	880	40
Bucking House	18	23	1.0
Lead Man	2	12	0.5
Pulpmen	4	45	2.0
Coffee Mill Men	3	14	0.6
Core Splitters	2	3	0.1
Mihe Sample Bucking Room	7	24	1.1
Metallurgical	41	90	4.1
Chief Metallurgists	1	120	5.5
Assistant Chief Metallurgist	1	220	9.8
Pilot Mill Foremen	1	14	0.6
Shift Foreman	4	110	4.8
Pilot Mill Supervisors	3	10	0.5
Pilot Mill Grades 3-5-6-7	21	120	5.2
Metallurgical Grades 3-5-6	10	48	2.2
Mechanical	194	260	12
Machine Shop Welder	1	770	35
Plant Repair; Carpenter Shop (Painter); Electrical; Plant Engineer Surveyors; Lube Department Foreman; Lubrication Men; Yard Department-Repairmen and Laborers; Water Department-Water Tenders; Equipment Operator and Truck Driver	109	420	20

TABLE IV (cont'd)

Acid Plant and Power House Plant Engineer and Draftsman Yard Department (Janitors) Water Department (Water Tender's Helper) Office Personnel Chemical Laboratory Clerks	74	7	0.3
Lubrication Department	10	310	14.0
Carbonate Wet Mill	3	79	3.6
Acid Mill-Grinding and Leaching Building	2	30	1.4
Acid Mill-Ion Exchange Building	2	58	2.6
Yellow Cake Section	1	1100	51.
Carbonate Mil-Crushing Section	1	1500	68
Acid Mill-Crushing Plant	1	35	1.6
TOTAL	451		
AVERAGE		290	13

APPENDIX F

TABLE VI

RESULTS OF PETROGRAPHIC ANALYSIS (AIRBORNE DUST)

SAMPLE DESCRIPTION	MAXIMUM SIZE MICRONS	% <10µ COUNT	% FREE SILICA COUNT BELOW 10µ	ESTIMATED WEIGHT % FREE SiO_2	REMARKS
GA - Sandstone crusher area	75	90	2	5	Chiefly carbonate, opaque particles, silicates and quartz. There is a substantial amount of organic fiber - presumably from a filter.
GA - Bucking room	75	95+	tr	3	
GA - Sandstone crushing plant, first floor	150	90	2	8	Sample contains less carbonate, more silica than the above samples.
GA - Sandstone, sample mill in sampler's cage	100	95	1	6	Similar to sample above but with less silicate.

NOTE: Since the % free silica by count is lower in the <10µ range than the estimated weight % of free silica, one may infer that the opaque particles were essentially of fine size.

TABLE VII

CHEMICAL (SETTLED DUST)

LOCATION	% QUARTZ
Sandstone crusher - first floor	9.5%

TABLE VIII

ATMOSPHERIC DUST CONCENTRATIONS (SILICA)

LOCATION OR OPERATION	NO. OF SAMPLES	DUST COUNT-MPPCF LOW	HIGH	AVERAGE
Sandstone Crusher-first floor	3	1.9	20.2	9.9
Sandstone Crusher-vibrating screen area	3	3.0	5.0	4.0
Sandstone Crusher-third deck	1	-	-	3.8
Sandstone Crusher-area of head pulley	3	3.6	11.4	7.5
Sandstone Sample Tower-first deck	3	2.2	10.3	7.5
Sandstone Sample Tower-second deck	1	-	-	11.0
Sandstone Sample Tower-third deck	3	4.9	10.3	8.3
Sandstone Sample Tower-fourth deck	1	-	-	10.3
Sandstone Fine Ores Bin-top level	2	7.7	10.7	9.2
Sandstone Fine Ores Bin-bottom level	1	-	-	3.3
Sandstone Feed to Rod Mill	1	-	-	3.5
Sample Preparation Building-bucking room	1	-	-	1.9
Sample Preparation Building-Bucking room BZ - Roller man	1	-	-	2.6
Sample Preparation Building-BZ Coffe Mill Operator	1	-	-	4.5
Sample Preparation Building-bucking room (Drying Area)	1	-	-	4.6
Sample Preparation Building-pulp room	1	-	-	2.2
Sample Preparation Building-drying room	1	-	-	1.8
Front End Loader - BZ - in cab loading sandstone ore	1	-	-	5.9

APPENDIX G

.Y. FORM 144
11-9-52)

JOB ANALYSIS SHEET

GENERAL CRUSHING PLATN DEPT.

OPERATOR: GENERAL CRUSHER FOREMAN 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION ~~d/m~~ /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Crushing Plants			240	36	1	7700	3930	943000
GA Main Office			240	1	-	-	14	3360

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 947,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 1970 d/m /M³ = ~~19.7~~ 6.6 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
(1-9-52)

JOB ANALYSIS SHEET

GENERAL CRUSHING PLANT DEPT

OPERATOR: CRUSHER FOREMAN 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Truck Scale Room			60					
GA R.R. Scale			30					
GA R.R. Trestle & Pit-Alleys			60					
GA Acid Crushing Plant			180	14	1	102	35.3	6350
GA Carbonate Crushing Plant			150	23	160	7700	1546	232000

*Adjusted to two significant figures Σ T 330 Σ (T x C) 238,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 730 d/m /M³ = ~~7.3~~ 2.4 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
(11-4-52)

JOB ANALYSIS SHEET

GENERAL CRUSHING PLANT DEPT.

OPERATOR: ~~[illegible]~~ CRUSHING PLANT SHIFT BOSSES   1 MEN/SHIFT: 3 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Truck Scale Roome			60					
GA R.R. Trestle & Pit Alleys			60					
GA Acid Crushing Plant			180	13	1	102	35.3	6350
GA Carbonate Crushing Plant			180	23	160	7700	1546	279000

*Adjusted to two significant figures   Σ T 360   Σ (T x C) 285,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 795   d/m /M³ = 2.7 ~~8.0~~ TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(1-9-52)

JOB ANALYSIS SHEET

OPERATOR: ~~ACID CRUSHING PLANT DEPT.~~ PRIMARY & SECONDARY CRUSHER OPERATOR 1 MEN/SHIFT: 1 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M^3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Main Floor & Pit			300	9	5	95	32	9600
GA 2nd Floor			120	2	1	102	51	6120
GA 3rd Floor			60	2	29	53	41	2460

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 18200

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 37.8 d/m /M^3 = ~~0.4~~ 0.1 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
1-4-52)

JOB ANALYSIS SHEET

ACID CRUSHING PLANT DEPT.

OPERATOR: SAMPLE TOWER OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMP-LES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Main Floor			300	3	17	56	31	9300
GA 2nd, 3rd 4th Floors			130	3	9	27	16	1780

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 11,100

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 23

d/m/M³ = ~~0.2~~ 0.08 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
1-9-52)

JOB ANALYSIS SHEET

ACID CRUSHING PLANT DEPT.
A-BINS TRIPPER OPERATOR

OPERATOR: 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA A-Bins Conveyor Area			240	4	9	68	36	8640
GA 1st Floor			240	5	1	20	9	2160

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 10,800

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 22.5 d/m/M³ = ~~0.2~~ 0.08 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
(1-4-52)

JOB ANALYSIS SHEET

ACID CRUSHING PLANT DEPT.

OPERATOR: GRIZZLY LABORER 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION $d/m/M^3$ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA At Grizzly Area			240	4	11	95	38	9120
GA Main Floor			120	5	5	55	26	3120
GA 2nd & 3rd Floors			120	4	1	102	46	5520

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 17,800

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 37

d/m /M³ = ~~0.4~~ 0.1 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
1-4-52)

JOB ANALYSIS SHEET

ACID CRUSHING PLANT DEPT.
CRUSHING PLANT RELIEF

OPERATOR: ~~OPERATOR~~ 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M^3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
Daily Weighted Average Exposure for Primary and Secondary Crusher Operator			240				37.8	9100
Daily Weighted Average Exposure for Sample Tower Operators			80				23.0	1840
Daily Weighted Average Exposure for A-Bins Tripper Operator			80				22.5	1800
Daily Weighted Average Exposure for Grizzly Laborers			80				37	2960

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 15,700

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 32.6 d/m /M^3 = 0.1 ~~0.3~~ TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

OPERATOR: ACID CRUSHING PLANT SAMPLE TOWER LEAD MEN   1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Acid Sample Tower			240	6	9	56	23	5520
GA Carbonate Sample Tower			240	4	14	152	73	17600

*Adjusted to two significant figures   Σ T 480   Σ (T x C) 23,100

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 48.1   d/m/M³ = ~~0.5~~ 0.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

ACID CRUSHING PLANT DEPT.
OPERATOR: SAMPLE TOWER LEAD MAN RELIEF 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION ~~d/m~~/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Acid Sample Tower			240	6	9	56	23	5520
GA Carbonate Sample Tower			240	4	14	152	73	17600

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 23,100

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 48.1

d/m/M³ = ~~0.5~~ 0.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
(1-9-52)

JOB ANALYSIS SHEET

CARBONATE CRUSHING PLANT DEPT.

OPERATOR: PRIMARY CRUSHER OPERATOR   1 MEN/SHIFT: 2 SHIFTS/DAY: 2 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M^3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Primary Crusher - Main Floor			120	4	230	960	570	68400
GA Primary Crusher Basement			120	3	7000	7700	7300	876000
**BZ Pushing Ore through Grate atop Crusher			240	3	620	9000	1330	319000

**Filter respirator worn

*Adjusted to two significant figures

Σ T 480   Σ (T x C) 1,260,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 2640   d/m /M^3 = ~~26.4~~ 8.8 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
1-9-52)

JOB ANALYSIS SHEET

CARBONATE CRUSHING PLANT DEPT.

OPERATOR: SECONDARY CRUSHER OPERATOR 1 MEN/SHIFT: 2 SHIFTS/DAY: 2 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Secondary Crusher Basement			60	3	403	1255	680	4080
GA Main Floor			120	3	274	663	420	50400
GA Screen Floor			60	3	510	1400	1000	60000
GA 2nd Floor			180	3	615	1400	1000	180000
GA Inclined Conveyor Ramp			60	4	160	900	470	28200

*Adjusted to two significant figures

Σ T 480 Σ (T x C) 323,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 671 d/m/M3 = ~~6.7~~ 2.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(11-9-52)

JOB ANALYSIS SHEET

CARBONATE CRUSHING PLANT DEPT.
OPERATOR: SAMPLE TOWER OPERATOR 1 MEN/SHIFT: 2 SHIFTS/DAY: 2 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION c/m/M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Ground Floor			240	1	-	-	152	36500
GA 2nd, 3rd, 4th Floors			240	3	14	84	47	11300

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 47,800

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 99.3

d/M3 = ~~1.0~~ 0.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-9-52)

JOB ANALYSIS SHEET

CARBONATE CRUSHING PLANT DEPT.

OPERATOR: C-BIN TRIPPER & SHUTTLE OPER. 1 MEN/SHIFT: 2 SHIFTS/DAY: 2 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Tripper Belts			240	5	89	291	155	37200
GA 1st Floor			120	6	4	38	16	1920
GA Rest of Building			120	2	9	10	10	1200

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 40,300

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 83.9 d/m/M³ = ~~0.8~~ 0.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
1-9-52)

JOB ANALYSIS SHEET

CARBONATE CRUSHING PLANT DEPT.
GRIZZLY LABORER

OPERATOR: ________ 1 MEN/SHIFT: 2 SHIFTS/DAY: 2 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMP. LES	CONCENTRATION d/m/M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA At Grizzlys			480	3	7000	7700	7300	3500000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 3,500,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 7290

d/m/M3 = ~~72.9~~ 24.1 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

CARBONATE CRUSHING PLANT DEPT.

OPERATOR: CRUSHING PLANT RELIEF OPERATOR 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION $d/m/M^3$ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
Daily Weighted Average Exposure for Primary Crusher Operator			80				2632	211000
Daily Weighted Average Exposure for Secondary Crusher Operator			80				671	53700
Daily Weighted Average Exposure for Sample Tower Operator			160				99.3	15900
Daily Weighted Average Exposure for C-Bin Tripper & Shuttle Operator			80				83.9	6710
Daily Weighted Average Exposures for Grizzly Laborer			80				728.8	58300

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 345,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 719 d/m/M³ = ~~7.2~~ 2.4 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-9-52)

JOB ANALYSIS SHEET

CARBONATE CRUSHING PLANT DEPT.

OPERATOR: CLEAN-UP LABORER G-PLANT 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³			AVG CON'C.* TIMES TOTAL TIME (TXC)
					LOW	HIGH	(C) AVG	
GA Secondary Crusher Basement			180	3	377	1255	680	122000
GA Main Floor			120	3	274	663	423	50800
GA Inclined Conveyor Ramp			90	4	191	900	470	42300
GA Screen Floor			60	3	510	1400	1000	60000
GA 2nd Floor			30	3	615	1400	1000	30000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 305,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 635 d/m/M³ = ~~6.4~~ 2.1 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
1-9-52)

JOB ANALYSIS SHEET

OPERATOR: ACID LEACHING DEPT. ASS'T. MILL SUPERINTENDENT   1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION $d/m/M^3$ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Acid Ore Bins			240	9	1	68	21	5040
GA Leaching Bldg			240	19	7.6	80	28	6720

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 11,800

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 24.4 $d/m/M^3$ = 0.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(1-9-52)

JOB ANALYSIS SHEET

ACID LEACHING DEPT.

OPERATOR: FOREMAN 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Acid Ore Bins			30	9	1	68	21	630
GA Grinding			90	3	7.6	33	20	1800
GA Leaching			120	8	10	35	25	3000
GA Classification			180	8	19	80	36	6480
GA Mill Office			60	3	3	14	10	600

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 12,500

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 26.0 d/m/M3 = 0.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
-9-52)

JOB ANALYSIS SHEET

OPERATOR: ACID LEACHING DEPT. GRINDING OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Acid Ore Bins			60	9	1	68	21	1260
GA Grinding Section			420	3	7.6	33	20	8400

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 9660

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 20

$d/m/M^3$ = 0.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

ACID LEACHING DEPT.

OPERATOR: GRINDING SUB-OPERATOR   1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Acid Ore Bins			120	9	1	68	21	2520
GA Grinding Section			360	3	7.6	33	20	7200

*Adjusted to two significant figures

Σ T 480 Σ (T x C) 9720

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 20   d/m /M³ = 0.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-9-52)

JOB ANALYSIS SHEET

OPERATOR: ACID LEACHING DEPT. LEACH OPERATOR

1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Leaching Section			480	8	10	35	25	12000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 12,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 25.0 d/m/M³ = 0.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(11-9-52)

JOB ANALYSIS SHEET

ACID LEACHING DEPARTMENT

OPERATOR: LEACH SUB-OPERATOR 2 MEN/SHIFT: 3 SHIFTS/DAY: 7 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Leaching Section			480	8	10	35	25	12000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 12,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 25.0

d/m /M³ = 0.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-9-52)

JOB ANALYSIS SHEET

ACID LEACHING DEPT.
OPERATOR: CLASSIFIER OPERATOR 2 MEN/SHIFT: 3 SHIFTS/DAY: 7 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMP. LES	CONCENTRATION d/m/M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Classifier Operating Floor			360	4	30	40	34	12240
GA Cyclone Operating Floor			120					

*Adjusted to two significant figures

Σ T 360

Σ (T x C) 12,200

$\frac{\Sigma (T \times C)}{\Sigma (T)}$ = 34.0 d/m /M3 = 0.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-9-52)

JOB ANALYSIS SHEET

ACID LEACHING DEPT.

OPERATOR: CLASSIFIER SUB-OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Classifier Operating Floor			300	4	30	40	34	10200
GA Cyclone Operating Floor			120					
GA Classifier Ground Floor			60	4	19	80	39	2340

*Adjusted to two significant figures

Σ T 360

Σ (T x C) 12,500

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 34.8 d/m/M³ = 0.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

ACID LEACHING DEPT.

OPERATOR: SWAMPER 1 MEN/SHIFT: 2 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Acid Leaching Building			240	19	7.6	80	28	6720
GA Acid Bin Building - 1st Floor			240	5	1	30	9	2160

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 8880

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 18.5 d/m /M³ = 0.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(11-9-52)

JOB ANALYSIS SHEET

OPERATOR: TON EXCHANGE BLDG DEPT. ASS'T. MILL SUPERINTENDENT 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA RIP Building			480	9	1	139	59	28300

*Adjusted to two significant figures Σ T 480 Σ (T x C) 28,300

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 59 d/m /M³ = 0.6 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-4-52)

JOB ANALYSIS SHEET

ION EXCHANGE BLDG. DEPT.

OPERATOR: MILL FOREMAN 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION ~~d/m~~ /M³ LOW	HIGH	(C) AVG	AVG CON'C. TIMES TOTAL TIME (TXC)
GA Control Office			60					
GA RIP Makeup			60	1	-	-	66	3960
GA RIP Banks			90	3	24	36	29	2610
GA RIP Pit			60					
GA Clarification			120	3	1	90	37	4440
GA Elution & Ppt'n			90	2	125	139	132	11900

*Adjusted to two significant figures

Σ T 360

Σ (T x C) 22,900

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 63.8 d/m/M³ = 0.6 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-4-52)

JOB ANALYSIS SHEET

ION EXCHANGE BLDG. DEPT.

OPERATOR: RIP MAKEUP OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA RIP Makeup			480	1	-	-	66	31700

*Adjusted to two significant figures Σ T 480 Σ (T x C) 31,700

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 66 d/m /M³ = 0.7 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
1-9-52)

JOB ANALYSIS SHEET

ION EXCHANGE BLDG DEPT.

OPERATOR: ELUTRON & PPTN. OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Elutron and Precipitation Floor			480	2	125	139	132	63360

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 63360

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 132 d/m /M³ = 1.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-9-52)

JOB ANALYSIS SHEET

OPERATOR: ION EXCHANGE BLDG. DEPT. RIP MAKE-UP SUB-OPERATOR   1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA RIP Makeup			360	1	-	-	66	23800
GA Elution & Precipitation			120	2	125	139	132	15800

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 39,600

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 82 d/m/M³ = 0.8 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-9-52)

JOB ANALYSIS SHEET

ION EXCHANGE BLD. DEPT.

OPERATOR: RIP BANK OPERATOR 2 MEN/SHIFT: 3 SHIFTS/DAY: 7 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C TIMES TOTAL TIME (TXC)
GA RIP Bank Section			480	3	24	36	29	13900

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 13900

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 29

d/M = 0.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-9-52)

JOB ANALYSIS SHEET

ION EXCHANGE BLDG. DEPT.

OPERATOR: RIP BANK SUB OPERATOR 2 MEN/SHIFT: 3 SHIFTS/DAY: 7 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA RIP Banks Section			480	3	24	36	29	13900

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 13,900

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 29 d/m /M³ = 0.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(1-9-52)

JOB ANALYSIS SHEET

ION EXCHANGE BLDG. DEPT.

OPERATOR: FLOOR LABOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M^3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Ion Exchange Bldg.			480	9	1	139	59	28300

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 28,300

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 59 d/m/M^3 = 0.6 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-4-52)

JOB ANALYSIS SHEET

ION EXCHANGE BLDG. DEPT.

OPERATOR: SWAMPER 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA RIP Banks, Precipitation Tank Area, Clarification Area			420	8	1	139	58	24400
GA RIP Makeup Area			60	1	-	-	66	3960

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 28,300

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 59 d/m/M³ = 0.6 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-9-52)

JOB ANALYSIS SHEET

ION EXCHANGE BUILDING DEPT.

OPERATOR: CLARIFICATION PRESSMAN 2 MEN/SHIFT: 3 SHIFTS/DAY: 7 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
**BZ Cleaning clarification press	160	1	160	4	68	138	94	15000
GA Clarification Section			200	3	1	90	37	7400
GA Rest of Building			120	6	24	139	70	8400

*Adjusted to two significant figures

**Filter respirator worn.

Σ T 480

Σ (T x C) 30,800

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 64 d/m /M³ = 0.6 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
1-4-52)

JOB ANALYSIS SHEET

CARBONATE MILL DEPT.

OPERATOR: ASS'T MILL SUP'T 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Carbonate Mill			240	20	14	302	79	19000
GA Yellow Cake Section			240	18	3	12000	1100	264000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 283,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 588 d/m /M3 = 5.9 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-4-52)

JOB ANALYSIS SHEET

OPERATOR: CARBONATE MILL DEPT. GENERAL MILL FOREMAN   1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M^3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Carbonate Mill			240	20	14	302	79	19000
GA Yellow Cake Section			240	18	3	12000	1100	264000

*Adjusted to two significant figures   Σ T 480   Σ (T x C) 283,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 588   d/m /M^3 = 5.9 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-9-52)

JOB ANALYSIS SHEET

CARBONATE MILL DEPT.
OPERATOR: CARBONATE MILL SHIFT FOREMAN   1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M3 LOW	HIGH	(C) AVG	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Rod and Bell Mill Area			90	5	14	67	50	4500
GA Bust Filters			90	4	45	74	58	5220
GA Oliver Filters			90	3	17	55	217	3420
GA Leach Tanks			60	4	79	302	20	13000
GA Precipitation			60	2	19	21	1100	1200
GA Yellow Cake Section			30	18	3	12000	7	33000
GA Mill Office			60	3	3	14		420

*Adjusted to two significant figures Σ T 480 Σ (T x C) 60,900

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 127 d/m /M3 = 1.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-4-52)

JOB ANALYSIS SHEET

CARBONATE MILL DEPT.

OPERATOR: CARBONATE MILL SHIFT FOREMAN RELIEF   1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C TIMES TOTAL TIM (TXC)
GA Rod and Ball Mill Area			45	5	14	67	50	2250
GA Burt Filters			45	4	45	74	58	2610
GA Oliver Filters			45	3	17	55	38	1710
GA Leach Tanks			30	4	79	302	217	6510
GA Precipitation			30	2	19	21	38	1140
GA Yellow Cake Section			255	18	3	12000	1125	286000
GA Mill Office			30	3	3	14	10	300

*Adjusted to two significant figures Σ T 480 Σ (T x C) 301,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 625 d/m /M³ = 6.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(11-4-52)

JOB ANALYSIS SHEET

CARBONATE MILL DEPT.

OPERATOR: PRECIPITATION OPERATOR   1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Precipitation Area			120	2	19	21	132	15800
GA Yellow Cake Area			60	18	3	12000	1125	67500
GA Carbonate Area			300	18	14	302	87	26,100

*Adjusted to two significant figures Σ T 480 Σ (T x C) 109,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 228 d/m /M³ = 2.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.T. FORM 144
11-4-52)

JOB ANALYSIS SHEET

CARBONATE MILL DEPT.
BURT FILTER OPERATOR

OPERATOR: ____________ 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMP-LES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Burt Filter Area			480	4	45	74	58	27800

**Adjusted to two significant figures*

Σ T 480

Σ (T x C) 27,800

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 58 d/m/M³ = 0.6 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-9-52)

JOB ANALYSIS SHEET

CARBONATE MILL DEPARTMENT

OPERATOR: BURT FILTER SUB OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M^3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Burt Filter Area			480	4	45	74	58	27800

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 27,840

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 58 d/m /M^3 = 0.6 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

I.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

OPERATOR: CARBONATE MILL DEPT. GRINDING SUB OPERATOR   1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION $d/m/M^3$ LOW	HIGH	(C) AVG.	AVG CON'C TIMES TOTAL TIM (TXC)
GA Carbonate Rod and Ball Mill Area			240	5	14	67	50	12000
GA Carbonate Ore Bin Area			240	13	4	179	68	16300

*Adjusted to two significant figures   Σ T 480   Σ (T x C) 18,300

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 38 $d/m/M^3$ = 0.4 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
(1-4-52)

JOB ANALYSIS SHEET

OPERATOR: CARBONATE MILL DEPT. LEACH OPERATOR   1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA-Leach Tank Areas			480	6	23	302	157	75400

*Adjusted to two significant figures   Σ T 480   Σ (T x C) 75,400

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 157 d/m/M³ = 1.6 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

CARBONATE MILL DEPT.
OPERATOR: OLIVER FILTER OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Oliver Filter Area			480	3	17	55	38	18200

*Adjusted to two significant figures   Σ T 480   Σ (T x C) 18,200

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 38 d/m/M³ = 0.4 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

(I.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

CARBONATE MILL DEPT.
OPERATOR: OLIVER FILTER SUB-OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Oliver Filter Area			480	3	17	55	38	18200

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 18,200

$\frac{\Sigma (T \times C)}{\Sigma (T)}$ = 38 d/m /M³ = 0.4 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.I.Y. FORM 144
(11-9-52)

JOB ANALYSIS SHEET

OPERATOR: CARBONATE MILL DEPT. SWAMPER   1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Carbonate Mill Areas			480	20	14	302	79	37900

*Adjusted to two significant figures   Σ T 480   Σ (T x C) 37,900

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 79 d/m /M³ = 0.8 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

CARBONATE MILL DEPT.

OPERATOR: BALL GANG   8 MEN/SHIFT: 1 SHIFTS/DAY: 8 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Carbonate Mill Areas			480	20	14	302	79	37,900

*Adjusted to two significant figures

Σ T 480 Σ (T x C) 37,900

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 79 d/m /M³ = 0.8 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

OPERATOR: YELLOW CAKE DEPT. SHIFT FOREMAN 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION $d/m/M^3$ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Yellow Cake Area			480	18	3	12000	1125	54000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 54,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 1125

$d/m/M^3$ = ~~1.1~~ 3.8 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

I.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

YELLOW CAKE DEPT.
OPERATOR: RELIEF SHIFT FORMEAN 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Yellow Cake Area			255	18	3	12000	1125	287000
GA Rod and Ball Mill Area			45	5	14	67	50	2250
GA Burt Filters			45	4	45	74	58	2610
GA Oliver Filters			45	3	17	55	38	1710
GA Leach Tanks			30	4	79	302	217	6510
GA Precipitation			30	2	19	21	20	600
GA Mill Office			30	3	3	14	10	300

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 301,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 628 d/m /M³ = 6.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

OPERATOR: YELLOW CAKE DEPT. SAMPEE ROOM OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION $d/m/M^3$ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
**BZ Sampling and covering laud yellow cake drum	2.8	18	50	3	50	275	129	6500
GA Weigh Room			240	1	-	-	3	720
GA Furnace Area			60	1	-	-	44	2640
GA Yellow Cake Area			130	17	53	12000	1125	146000

*Adjusted to two significant figures

**Filter Respirator worn.

Σ T 480

Σ (T x C) 156,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 325 $d/m/M^3$ = 3.3 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

YELLOW CAKE DEPT.

OPERATOR: ~~ACID DRYER OPERATOR~~ 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M^3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
**BZ Beating acid yellow cake drum and replacing	1	18 x ½	9	3	1300	15000	9150	82400
GA Yellow cake area			471	18	3	12000	1125	530000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 612,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 1270 d/m/M^3 = 12.7 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

N.Y. FORM 144
(11-4-52)

JOB ANALYSIS SHEET

YELLOW CAKE DEPT.
OPERATOR: ACID DRYER HELPER 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG	AVG CON'C. TIMES TOTAL TIME (TXC)
**BZ Sampling drums	2.8	18	50	3	50	275	129	6500
GA Yellow Cake area			430	18	3	12000	1125	484000

** Filter resp. worn

*Adjusted to two significant figures Σ T 480 Σ (T x C) 490,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = ~~1020~~ d/m/M³ = 10.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(1-9-52)

JOB ANALYSIS SHEET

OPERATOR: YELLOW CAKE DEPT. CARBONATE DRYER OPERATOR 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG	AVG CON'C.* TIMES TOTAL TIME (TXC)
**BZ Removing carbonate drum from carbonate filling station - shovelling yellow cake to buckets from pan and dumping in drum	5.5	1	5.5	1	-	-	10000	55000
**BZ Covering yellow cake drum	1.25	3	3.75	1	-	-	7400	27800
GA Yellow cake area			350.75	18	3	12000	1125	395000
GA Burt filter area			120	4	45	74	58	6960

*Adjusted to two significant figures

**Filter respirator worn.

Σ T 480 Σ (T x C) 485,000

$\frac{\Sigma (T \times C)}{\Sigma (T)}$ = 1010 d/m/M³ = 10.1 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
1-9-52)

JOB ANALYSIS SHEET

OPERATOR: YELLOW CAKE DEPT. ~~ACID YELLOW CAKE PRESS~~ LABOR   2 MEN/SHIFT: 3 SHIFTS/DAY: 7 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
**BZ Cleaning acid yellow cake press	35	1	35	3	296	810	525	18400
**BZ Cleaning press floor	5	1x½	2.5	1	-	-	301	7530
GA Yellow cake area			442.5	18	3	12000	1125	498000

*Adjusted to two significant figures Σ T 480 Σ (T x C) 524,000

**Filter respirator worn.

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 1090 d/m/M³ = 10.9 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(1-9-52)

JOB ANALYSIS SHEET

OPERATOR: YELLOW CAKE DEPT. ACID DRUM BEATER

1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
**BZ Beating acid yellow cake drum and replacing	1	18x½	9	3	1300	15000	9150	82000
GA Yellow cake area			471	18	3	12000	1125	530000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 612,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 1270 d/m /M^3 = 12.7 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(1-4-52)

JOB ANALYSIS SHEET

OPERATOR: YELLOW CAKE DEPT. CARBONATE PRESS LABOR 5 MEN/SHIFT: 1 SHIFTS/DAY: 5 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C TIMES TOTAL TIME (TXC)
**BZ Cleaning carbonate yellow cake press	37	2x2/5	30	3	102	312	197	5910
**BZ Cleaning yellow cake press floor	5	2x1/5	2	1	-	-	137	274
**BZ Cleaning carbonate clarification press	20.5	2x2/7	12	3	205	576	382	4580
**BZ Dumping carbonate clarification press cake into sump	6	2x1/7	1.7	3	65	180	111	190
GA Yellow cake area			434.3	18	3	12000	1125	490000

*Adjusted to two significant figures ΣT 480 $\Sigma (T \times C)$ 501,00

**Filter respirator worn.

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 1040 d/m/M³ = 10.4 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-4-52)

JOB ANALYSIS SHEET

YELLOW CAKE DEPT.

OPERATOR: FLOOR MAN 2 MEN/SHIFT: 1 SHIFTS/DAY: 2 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
**BZ Cleaning carbonate clarification press	20.5	2x2/7	12	3	205	576	382	4600
**BZ Dumping carbonate clarification press cake into sump	6	2x1/7	1.7	3	65	180	111	190
**BZ Raking yellow cake in ~~press~~ pan			120	3	146	309	242	29000
GA Yellow cake area			346.3	18	3	12000	1125	390000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 424,000

**Filter respirator worn.

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 882 d/m /M³ = 8.9 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

BUCKING HOUSE DEPT.

OPERATOR: ~~LEADMEN~~ 1 MEN/SHIFT: 2 SHIFTS/DAY: 2 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG C TI TOTAL (T
GA Bucking room			480	3	4	18	12	5760

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 57

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 12

d/m/M³ = ~~0.1~~ 0.04 TIMES THE MAXIMUM ALLOWABLE CONCEN TRATION.

Y. FORM 144
1-9-52)

JOB ANALYSIS SHEET

BUCKING HOUSE DEPT.

OPERATOR: PULPMEN   1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
**BZ Pulverizing tailings and cleanup	2.5	6	15	3	2	55	38	570
**BZ Screening tailings	1.5	6	9	3	20	29	24	216
**BZ Rolling tailings and air cleaning	1.5	6	9	3	<1	137	53	477
GA Tails Pulverizing Room			81	2	22	32	27	2190
**BZ Taking material out of blender and splitting	3	6	18	1	-	-	148	2660
**BZ Grinding riffle fines in BICO pulverizer	5	6	30	1	-	-	6	180
**BZ Rolling fines from BICO pulverizer	3.5	6	21	1	-	-	25	525
**BZ Screening fines	4	6	24	1	-	-	3	72
**BZ Pulverizing Screener fines	2.5	6	15	1	-	-	6	90
**BZ Rescreening and blowing off roller	2	6	12	1	-	-	220	2640
**BZ Riffling and rolling 4 times	15	6	90	1	-	-	53	4770
**BZ Cleaning equipment with an air jet	7.5	6	45	1	-	-	120	5400
GA Heads pulverizing room			81	3	5	40	24	1940

*Adjusted to two significant figures
**Filter respirator worn.

Σ T 480

Σ (T x C) 17,100

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 45 d/m/M3 = ~~0.5~~ 0.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(1-4-52)

JOB ANALYSIS SHEET

OPERATOR: COFFEE MILL MEN 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
BZ Cleaning and reassembling coffee mill	11	6	66	1	-	-	22	1450
BZ Dumping 5 cans into coffee mill and transferring to blender	7	6	42	2	20	10	5	210
BZ Emptying blender into 7 cans	3	6	18	2	20	27	24	432
BZ Splitting 7 cans from blender	8	6	48	2	3	4	4	192
BZ Dumping 3 cans sandstone from splitter to blender	.75	6	4	1	=	-	20	80
BZ Filling 3 pans from can and putting into drier	3	6	18	2	14	17	16	288
BZ Dumping 1½ cans rejects into paper bags	.75	6	4	1	-	-	80	320
BZ Cleanup of splitter, blender, sweep floor	6	6	36	1	-	-	16	576
GA Blending room			244	3	5	25	14	3420

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 6970

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 14

d/m/M^3 = ~~0.1~~ 0.05 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 1440

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 3

d/m/M^3 = ~~0.03~~ 0.01

TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
1-4-52)

JOB ANALYSIS SHEET

BUCKING HOUSE DEPT.

OPERATOR: MINE SAMPLE BUCKING ROOM 3 MEN/SHIFT: 2 SHIFTS/DAY: 7 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG	AVG CON'C.* TIMES TOTAL TIME (TXC)
**BZ Pulverizing core Samples - putting in envelope	1.5	1/3x30	10	3	0	440	260	2600
**BZ Rolling core sample and cleanup	1.5	1/3x30	10	3	0	370	129	1290
**BZ Pulverizing sludge in Braun pulverizer	5.0	1/3x30	10	3	47	317	146	1460
**BZ Rolling and riffling sludge	4	1/3x30	10	3	3	25	14	140
**BZ Air blasting Braun pulverizer	2	1/3x30	10	3	33	117	81	810
GA Bucking room			430	3	4	18	12	5160

** Filter resp. worn

*Adjusted to two significant figures

ΣT 480 $\Sigma (T \times C)$ 11,500

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 24 d/m/M³ = 0.08 (~~0.2~~) TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

(1-9-52)

JOB ANALYSIS SHEET

OPERATOR: METALLURGICAL DEPT. CHIEF METALLURGIST   1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Main office			300	3	3	14	10	3000
GA Pilot mill			60	7	<1	23	10	600
GA Plant			120	146	1	12000	423	50400

**Adjusted to two significant figures*

Σ T 480

Σ (T x C) 54,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 122 d/m/M³ = 1.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
(1-4-52)

JOB ANALYSIS SHEET

METALLURGICAL DEPT.

OPERATOR: ASS'T. CHIEF METALLURGIST 1 MEN/SHIFT: 1 SHIFTS/DAY: 1 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Main Office			60	3	3	14	10	600
GA Pilot mill			60	7	1	23	10	600
GA Plant			120	146	1	12000	324	50400

*Adjusted to two significant figures

Σ T 240

Σ (T x C) 51,600

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 215 d/m/M³ = 2.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

OPERATOR: ___

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M^3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Main Office			60	3	3	14	7	420
GA Pilot Mill			120	7	1	23	10	1200
GA Acid Mills			60	57	1	139	33.2	1990

*Adjusted to two significant figures

Σ T 240

Σ (T x C) 3400

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 14.1

d/m/M^3 = 0.1 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Y. FORM 144
1-4-52)

JOB ANALYSIS SHEET

METALLURGICAL DEPT.

OPERATOR: SHIFT FOREMAN 1 MEN/SHIFT: 3 SHIFTS/DAY: 4 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Pilot Mill			120	7	1	23	10	1200
GA Sample Towers			120	10	9	152	44	5280
GA Plant			60	146	1	12000	423	25400

*Adjusted to two significant figures Σ T 300 Σ (T x C) 32,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 106 d/m /M³ = 1.1 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

JOB ANALYSIS SHEET

METALLURGICAL DEPT.

OPERATOR: ~~PILOT MILL SUPERVISORS~~ 1 MEN/SHIFT: 3 SHIFTS/DAY: 3 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMP. LES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CON'C TIMES TOTAL TI (TXC)
GA Pilot Mill			360	7	1	23	10	3600

*Adjusted to two significant figures

Σ T 360

Σ (T x C) 3600

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 10 d/m /M³ = 0.1 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

METALLURGICAL DEPT.
OPERATOR: PILOT MILL GRADE 7,5,6,7   7 MEN/SHIFT: 3 SHIFTS/DAY: 21 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M3 LOW	HIGH	(C) AVG.	AVG CON'C TIMES TOTAL TI (TXC)
**BZ Cleaning, drier, removing, 1 pan and filling drum	1.75	1/7x9/3	.75	3	48000	80400	65440	49100
GA Grinding, leaching, sand-slime			150	4	1	14	6	900
GA RIP Make-up Banks			180	1		23	23	4150
GA Precipitation and Elution Make-up			134.25	1		6	6	805
GA Yellow Cake Packaging			15	1		23	23	345

** Filter resp. worn
*Adjusted to two significant figures

Σ T 480 Σ (T x C) 55,300

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 115   d/m /M3 = 1.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

(1-4-52)

JOB ANALYSIS SHEET

METALLURGICAL DEPT.

OPERATOR: MET LAB GRADES 3, 5, 6   3 MEN/SHIFT: 3 SHIFTS/DAY: 10 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m /M³ LOW	HIGH	(C) AVG.	AVG CONC TIMES TOTAL T (TXC)
GA Carbonate Sampling Plant			180	4	14	156	73.5	13200
GA Acid Sampling Plant			180	6	9	56	23	4140

*Adjusted to two significant figures Σ T 360 Σ (T x C) 17,340

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 48   d/m /M³ = ~~0.5~~ 0.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

Plant			240	25	160	7700	1500	360000
GA Acid Crushing Plant			240	12	1	102	35	8400

*Adjusted to two significant figures Σ T 480 Σ (T x C) 368,400

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 768 d/m /M³ = 2.5 ~~7.7~~ TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

(4-4-52)

JOB ANALYSIS SHEET

OPERATOR: [illegible] SHOP PAINTER (4 men)
ELECTRICAL DEPT. (15 men)
PLANT ENGNG. SURVEYORS (2 men)
LUBRICATION MEN (4 men)
YARD DEPT. REPAIRMEN & LABORERS (22 men)
EQUIP. OPR. & TRUCK DRIVERS (8 men)
WATER DEPT. - WATER TENDERS

MEN/SHIFT: 3 SHIFTS/DAY: 109 MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG.	AVG CON' TIMES TOTAL TI (TXC)
GA Plant			480	146	1	12000	423	203000

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 203,000

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 423 d/m/M³ = 4.2 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

YARD DEPT. JANITORS (3 men)
WATER DEPT.-WATER TENDER'S HELPER (1 men)
OPERATOR: ~~OFFICE PERSONNEL (46 men)~~ MEN/SHIFT: 3 SHIFTS/DAY: ~~74~~ MEN/DAY
CHEM. LAB CLERKS (2 men)

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M^3 LOW	HIGH	(C) AVG.	AVG CON'C.* TIMES TOTAL TIME (TXC)
GA Power House and/or Offices			480	3	3	14	7	3360

*Adjusted to two significant figures

Σ T 480

Σ (T x C) 3360

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 7 d/m /M^3 = 0.07 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.

.Y. FORM 144
11-9-52)

JOB ANALYSIS SHEET

OPERATOR: ~~LUBRICATION DEPT.~~ ~~10~~ MEN/SHIFT: ~~1~~ SHIFTS/DAY: ~~10~~ MEN/DAY

OPERATION OR OPERATING AREA	TIME PER OPERA. (MIN)	OPERA. PER SHIFT	TIME PER SHIFT (MIN) (T)	NO. OF SAMPLES	CONCENTRATION d/m/M³ LOW	HIGH	(C) AVG	AVG CON TIME: TOTAL T (TXC)
GA Carbonate Wet Mill (3 men)			480	20	14	302	79	37900
GA Acid Mill - Grinding & Leaching Building (2 men)			480	30	1	139	30	14400
GA Acid Mill - Ion Exchange Building (2 men)			480	9	1	139	58	27800
GA Yellow Cake Section (1 man)			480	18	3	12000	1125	540000
GA Carbonate Mill Crushing Plant (1 man)			480	23	160	7700	1500	720000
GA Acid Mill Crushing Plant (1 man)			480	12	1	102	35	16800

*Adjusted to two significant figures

Σ T 480

Σ (T x C)

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ = 307 d/m/M³ = 3.1 TIMES THE MAXIMUM ALLOWABLE CONCENTRATION.