PRNC003

PRNC-3

Health Physics

ENVIRONMENTAL SURVEY

PROCEDURES MANUAL

By J. A.Ferrer Monge

Puerto Rico Nuclear Center

Operated By

University of Puerto Rico

For

U.S. Atomic Energy Commission

Mayagiez, P.R.

? JULY 1,1960.

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RIC = 3,

(HEALTH PHYSICS)

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U.S. ATOMIC ENEKGY coMMTSsTOR

Mayaguez, P. Re

uly 1,?3960

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ACK#OusEDGEnEH?

Tho writer expresses his appreciation te Hire Pedro

cous, lir. Pernande Valiveilio ahd Misa Hiriem H. Vesa

of tie Health Puysics Section for their help in the

preparation of the anual.

Is is a pleasure to apecteliy acknovldge the

assistance of Dr. Join i. Garley und hie stett at

ie ew York Heutu and Sefuty Laboravary wio read the

uanuocript, commented and nado valueble suggestions.

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INTRODUCTION

?This manual has been prepared for the purpose of establishing standard procedures to be folloved, by the Puerto Rico Nuclear Center Health Paysics Section, for uso in training personnel and trainees in the Health Physics prograns and to supply technical information to all persons interested in the field of environmental eurveiliance.

AREA oP sruDY

?the area to be surveyed 1s located between latitute

100 to, 18°25" (North) and longitude 66°57'30" to 67°27°30" (West) with an area of approximately 352 square miles. ?This is mostly mountainous rogion being an exten~ sion of the Cordillera Central and includes several

water sheds, the min ones being the Culebrinas, Grende @e Afiaaco, Yague, Ro Cafins, Gunnajibo and Rosario Rivers. ?he lowlands are? located in Cabo Rojo, Lajas, Mayaguez, ?AMingco and Aguadi lia.

Figure 1 presents a map of the island of Puerto Rico indicating the area of study, the cities and toms ?within thet area as vell as other large towns (15,000 or nore inhabitants) outside the area.

Figure 2 presents a mp of the area of study and is based on the U.8. Geological Survey topographical maps and incluées?o plan of the city of Mayaguez indicating the site of the PRNC and permanent stations where special samples Will be collected.

To factitate the identification of the samples ?the whole area has been divided into 3 Each one represents 6.1 square miles (2.45 x 2.45).

With PRNC ns center, a number of circles with radii

of 2.5, 5.0, 7.5, 10.0 and 12.5 miles respectively

des been drown to relate activity measured to distance

if this vere necessary.

---Page Break---

ACTIVITY 70 BE MEASURED

?The radiological survey involves the measurements of gross alpha

and deta-guma activity.

IDEWEEFICATION OF SAMPLES

?Table 1 presents the code to be used in the identification of samples.

Samples vill have an identification musher ar follows: RS-1-A-39(EL)W or

RS-I-J-354 where:

RS -_?Rattological survey Program

I+ fret Radtolog:cal Survey to be carried out

A= area in the mp ?mere the suxple vas collected

35 ~~ sample number independently of the area where it was

collected

(21) = tmitcates that the comple vee collected in a permanent

station

Wo = Andteates vater sample. (A - air, 9 - sediment, M- milk,

8 = soil, V - vegetation, W - vater)

ERReSDUE

T+ Goliection and Identiticstion of sespIns

A ott

Four so} samples (from etatsoar Wi, 55, Bh and 86) wi

collected per month. ?AAdtioncl on

E

g

Gimmeter hand auger. ?The cample vill be divided into 2 portions.

?he 2" top soil will be pieced in « plyethelene plastic bag

Anclading « tag with the folloving information:

1. Radiological suey

2. Sample o.

3. Date

?This mmber shall correspond with thet in Form 631. The

remining 4" of soil vill be placed in enother bag including

BL. Next, Form 65la Fieli Dute sheet, shall be completed.

?the laboratory the: ~:~"; bags will 3s scaled enclosing the

?one within the inrger. The sample ie now ready for

aH

i

2

---Page Break---

Water

Drinking Water

?One sample will be collected every tvo weeks from station (1) at the mouth of the Yaguez River and one per nonth at station (E2), five miles up stream of the Yaguer River. One semple vill be collected veekly at station (E5), Qiebrada de Gro, and one per month at station (EM), a dan and (BS), an artesian vell. A veekly sample vill be collected from statinn (35), at PRC.

?Additional samples vill be collected whenever necessary ?from permanent stations or elsewhere.

?ALL water samples shall be collected in duplicate using polyeticlene one liter bottles properly identified (Form fo. 331). Complete Torn 6518.

(a) surface water

Bottles will be filled either by imersion in water or using another container to transfer the Liquid to the dottles.

(>) Underground Water

Sane as 1(a)

?Rain Vater

one sample will be collected each veek from the

jluvioneter installed in the vicinity of PRIC, station

(BT) and one per month from the one at the city airport,

station (BS). All the vater accumlated in the pluvioneters

@uring the veek vill be collected.

?The bottles will be sealed, the samples identified and

forns 651 and 651a completed.

Ate

Bach veek one air sample vill be taken from 2 stations

(3) and (85) and one sample four times per year from three

other stations. Samples are to be collected in Whatman filter

paper No. 1, approximately 4? in danster using @ High-Volume

air sampler during 24 hour

After removing the filter paper from the sampler it shall.

?be enclosed in an envelope with the following informatica:

---Page Break---

rR

Tocation : area or station where the sample was

collected

Date + tndicate the time at which collection

started and the tine at which sampling vas

finished.

ofa + indicate the ft/min, at the hegining and

fend of gampling as indicated by the instru-

nent. (See Manual of Instrument Used in

= Portable Air Sampler)

Signature : signature of the person who tock the sample.

mak

?Mo one iter samples vill be collected per semester.
Samples shall be collected in polyethelens bottles sealed
end identified.

Forn 651 and 61a shall be completed.

Vegetation

One sample per quarter vill be collected from ¢ stations
(1), (#5) and (86). Each sample shall consist of epproxinately
500 grams and it vill be encloted ine cardboard box or plastic
?bag Properly identified.

FA11 Forns 651 and 631a.

Sedtitent

Que sample shall be collected per senester from three
stations (Ei), (83) and (B4). The vet voisht of each sample
shall be no less than 20 granc. Sample vill be collected
in polyethelene bottles from the middle of the stream or at
a point 4 to 6 feet from the chore. The bottles vill be
?sealed and properly identiriea.

Complete Forms 652 and 6518.

SAMPLE COLLECTION PEROT

Whenever samples are to be collected in privete property, the

collector shall fi11 Form 631b.

---Page Break---

x certity

that the folloving Listed seaples are in storage,

have been physically snepected, sealed end in good

?conditions on this day of 9

Taian of storciecper

?Tiatare fitness

SAMPLE PREPARATION

2. Samples lov in 0.M. content are dried in an oven at 103°C.

2. Semple is pulverized and sieved in a No. 60 sieve (250 microns).

3. Approximately 200 ng. of the sample are spread uniformly in e

2 diameter, 1/8" decp, veighed stainless steel planchet. If

necessary vater my be added to forma thin paste, then

@ried under an infrared lap.

4. Determine sample weight.

Samples high in O.H. ?content are dried at 1054C and then aated

at

From here on follow the same procedure outlined above.

Water

Insoluble Solias*

2. Filter 1 Liter of water using \hatmn filter paper No. 42

(asnless) approxinately 5.5 cm in dianeter, previously

Weighed, in 4 1500 ml beaker.

2 Dry the filter paper containing the insoluble solide in an

?oven at 105°C. and veight it.

?Transfer to a planchet (some type as used for soil samples).

Saturate paper vith etnyl alcohol and burn using a Meeker

burner.

?Ten to tventy seconds ie usually enough.

ry

wi

*# In cave of rain vater thie my be lege then 1 liter.

---Page Break---

°

Soluble Solids

1. Bvaporate the filtrate in the beaker to a volume of about 10 ml. and transfer quantitatively to a previously weighed Planchet containing several Grops of 2 nitric acid. Wash desker with @H nitric and transfer to planchet.

2 Dry an an oven at 103°C or under an infrared lamp.

3. Determine weight of soluble solids.

air

Air samples do not xequire any preperation. Tue filter paper ie removed from the air sampler and counted directly (See /ir~ Counting & Accuracy).

Sediment,

1. Decant and rexove excess water.

2. Granefer to a weigied plancaet an amount.of sediment auch

that when dry it is approximately 200 ng.

3+ Bvaporate to aryne:

A. Determine weight of sedimnt.

mae

2. Shake sample vell. Pour 20 cc in a 100 aly beaker.

2 Ada approximately 5 ml. of concentrated MO; (e- gr- 1-42).

West 1 nour or longer until seri separates complevely

from the sollé portion.

3. Garefully place the beaker in e hot plate and ovuporate slowly

almost to dryness (80"- 95°C).

4. Ruve tie beaker from the hot plate and add 10 mi. concentrated

> last until the solids are dissolved.

3: Bvaporate to dryness. Cool for 5 minutes

6 Repeat a second and third digestion adding each tine 5 als of HNO; and evaporating to dryness.

7. Ada? ml. concentrated ii0, and 2 to > arope of a 30% solution of Hep.

8. Remofe-beidity ty adding carefuniy aistslied water dom the sides of the beaker and evaporating to dryness. fepest thie top tice.

9 Add about 10 ul. of distiliea water and transfer carefully to @ previously weighed planchet.

30, Evaporate to dryness and count.

---Page Break---

activity of a sample by direct counting unless the enitter 1e knovn, Feference standards are used to counteract this difficulty.

AL Alpha Standards

2. Soil and Sediment

Ralverise a quantity of quartz and pass through @

0. 60 sieve.

D. Add to a known veight of quarts a mow amount of

uranyl nitrate in solution.

Mix thoroughly and evaporate to dryness.

@. Transfer 50, 100, 150, 200, 300, 500, 750, 1000 mgs.

approximate of the mixture of quart and Ureny)
Nitrate to previously weighed planchete and count.
Find the efficiency of the inetrument by dividing
?the counting rate of the sample by the desintegration
rate obtained by the amount of Uranyl Ritrate present.

f, Plot @ curve of per cent efficiency versus weight

of sample. (Graph 1).

Water

8 Byaporate enough water to obtain weights of 25, 50,

. 5, 100 ngs. of soluble golids.

* b. Transfer these solids to previously veighed planchets.

© A@d @ volume of uranyl nitrate solution having an

activity of approximately 1000 desintegrations per

mimite to each sample.

4. Dry under on infrared lamp and weigh the planchet to

find the weight of the samples.

e+ Count the sample and find the efficiency of the

instrument in each case by dividing the counting rate

Obbained by the desintegration rate of the sample.

f. Plot @ graph of percent efficiency of the instrument

versus weight of sample (Graph 2):

B. Bota Standards

1. soit

@ Rulyerdze the HEL in mortar and pase st through

a %. 60 sieve.

? b. Transrer 50,"100, 150, 200, 300, 00, 500, 750 end

2000 mgs. of 1C1 to previopsly weighed planchets

c+ Find the counting rate for each sample.

4 Determine the efficiency of the instrument by Aividing

the counting rate by the desintegretion rate of the

80 inotope present in each sample. of KCl.

e Plot a OF percent efficiency versus wetght of

: sempie (Graph 5).

Water

?s+ Prepare @ saturated solution of KCL.

9

---Page Break---

a

fe: Plot @ curve of percent efficiency of the instrument,

versus weight of sample (Graph 4).

For air samples the portable air sampler is assumed to have a

collecting efficiency of 1 (1003) and the filter paper an absorption

efficiency of .7 for alphas (.3 or 30% 18 lost) und 1.0 for betas (no loss).

COMMING AD TITERPRETATION

I. Soll, Vegetation, Mitk, Sediment and Vater

A Aecuracy

Samples shall be counted for a period of time not less than

55 minut

?Thirty minutes counts for background shall be taken at least

? ?tice a day.

The counting rate of samples will be reported with a 0.9

statistical error. Tis error (E) is calculated frou:

E-x ?? +h

1.65

counting rate of sample (background included)

counting rate of background

tine in minutes the sample was counted

time in minutes the background vas counted

counting rate, M, will be given ag

(Ns - My) +E

A soi sample is counted for 55 minutes and the total

count obtained was 6916. The background obtained for

30 minutes vas 2550 counts. ?hat is the net counting

Fate of the sample?

---Page Break---

Mes Qe 25 of

aed = 85 cfm

ty = 95 min.

F

t= nin,

Te 0.9 statistical error is

zg

x (?h? + bv?

26 (igs Ee = 1.65 (2.29 + 2.05)2

1.55 (5.12)? = 1.65 (2.25)

Bo = 37 e/a

?he net counting rate of the samples is therefore:

Hoos Me-m + B= (15-05) 4 5.7

Kos We57 of

Waenever greater accuracy is desired the sample and background can be comted fora longer period of tine thus malting the 0.9 error eualler-?aie i true specially in cases vhore the counting rate of sample

(ig) is very close to background?s (Ii).

In such cases it is desirable to distribute the counting periods

Of sample and background in such a vey as to reduce the error to a minimm. hie cen be done applying the formla

(_te_yue

---Page Break---

Gince H, and Np have been previcusl~ Zatercined (ia the first run)

?laces counting tine of the comple end the counting tine

Of the background (ts) can be obtained.

?A. Counting and Accuracy

1. Count the sample until © minimn of 500 total courte 10

obtained or for 55 minutes, viichever ie shortert, thts

gives approximately Tf error at se 90h CL.

2 For ?mediate alpha or beta activity, cout caxple as

soon as renoved fron sexpler~

? 3. For alpha activity due. to long-lived retioteotopes take

?one count (Cy) at least four houra after collecting the

sample.

4. Bake « second count (C2) at least 20 hours after taking,

first count.

5. For beta activity due to long-lived reatoteotopes take

one count (Cy) after removing the filter froa the saxpler.

6. Tee count (Cp) ot least Geonty Rours after the

first count.

7. Between first ani eecond covstins return Ciiter peper to

its appropriate envelope.

8. Determine activity due to alpha and/or beta es instructed

in Porm PRNC-HP5(iS) 652.

9+ Save all smples until Fite) calculations and reports have

?been made.

REPORT oF

The final result of sample exelyses chall be reported in microcuries

per ce or ge whichever the case my be.

40 individual report shall be mie of exch explo ustag the folloving

?orm PRIC-HPS(75)632 - Data choet - cil, Yogetation, Ik, Seeinent

and vater.

Form PRNC-HPS(RS)632a - Data Crect - ur

caslyzas using Ferm (5)

fot] saxples im one

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-

;

(CALCULATIONS

?Some calculations and examples are given under Counting and Inter-

pretation. As reference cther calcu tions are presented herein.

I. Activity in Air Saxples

?he general equation to use is:

° ucfec = met cfe py

fox A Rerxtexk

= effictency of counter. This value is obtained from the

efficiency curves of the corresponding standards.

absorption of activity by the filter paper.

= O47 for alphas (

june 30$ activity is absorbed).

= 1.0 for betas (assume no absorption)

= | air row co/mimute.

= sampling tine interval in mimtes.

fe = filter paper efficiency for collecting particles in

the airs Aaoume fp = 1.

K = a constant to convert a/a/ec to uc/ecs K = 2.22 x 10°4/mue

?Substituting in equation (1) for alphas

@ whee * a tet ae

Oe x OTR TRIXEX

?vaich can be simplified to

@)

uuc/ee = Bet o/m 5.4 x 10

ie Ag the equation in Form 652a for air samples.

For betas the equation is simtlar, but f, 1s assumed to be 0.5 and

A=, thus

---Page Break---

uc/ec = ?pet c/n x 0.9 x 10°6

O) wef =

This equation also appears in Form 6328. To determine activity in

?str due to long-lived radioisotopes the general equation to use 1a:

© wc 07: 0595lt2 = ty)

= 22% «

ow, 1 -OBHeg Gy fe

Cy, = counte-mimite due to long-lived radiotectopes

©, = counts/nimute 4 noure or more after collecting

?he sample

counte/nimite 24 hours after Cy

1) = correction factor due to desintegration

rate of Thoron, ,

tne lapse between ¢) ax cp (in hours).

2t (to - t,) Se Rept constant, for example 20 hours, equation (5)

can be mibstitubea by:

Cy

f= 6 (21)

a, - = Lb (co = -27 cy) of

u 0.73 @ *

once Cy, counts/aimite corrected has been determined for a and p

activity Value is substituted in equations (3) and (4) to calculate

?the alpha and beta activity in the sample co thats

Cp, x Selb x 10°S

(1) sefee atpha = ? He

(8) wofee beta» X09 210°

ae

TL. Activity in Goll, Water, Milk, Vegetation and Sediment Samples

A, Alphs activity of the samples vill be expressed in uc relative to

natural uranium.

?The activity in natural Uranium ie due to ite Lsotopes 238,

235 and 254 and it is determined as follows.

---Page Break---

3

Arora = EM

Where 14%; 1s the activity of each one of the isotopes

The activity due tu

= 4.88 x 10

where T 1/2 io the bait-1ite of V? or 4.49 x 107 years

¥ = maber of 7 atone per gx of Uranyl Bitrate

= SB 16.005 xo «19 x ot

*

2 0.993 40 the abundance of the 238 isotope

6.025 x 10°? 16 Avogadro's munber

302 fe the mse mumber of Uranyl Hitrate

A ot = 468 x 1078 x ag x 10

= 3810 a/sec/g of Uranyl Nitrate

Tre activity of

: = 3.08 x 1077 geo

a ZH + exw

where Tye = 7.13 x 10° years

t w= 00a x 6.02 xi. 6.60 x 1019 atoms of 0? per

ee gran of Uranyl Mitrate

Where 0.00715 18 the abundance of U° seotope

a: A= am = (5.08 x 10%) (8.60 x10) «260 a/s/en.

---Page Break---

he activity of v2" isotope 4s the same as the activity of the

072 vecaise they are in secular equilibrium ?the sovslcottny vor

_ Gran of Uranyl Bitrate ie therefore

Ayotar = 9810 + 5810 + 260

= 11900 a/aee

3 Beta, getivity of the samples will be expressed in uc relative

The activity in KCL due to x is determined as follovs:

& Percent of x9 in natural K = .O119$

be mate-tite of KYO (n 3/2) = 1.3 x 109 years

?Sherefore:

ds Rs

TYE 13 x 10 x 365 x 2h x 60

= 101 x 107 win.?

Molecular weight of KCl = 74.557

@- m= number of K"° atone/g of KCL

B= 20009 y 6.02 x 10°

Ts. 55T

N= 9.6 x10" 2° atons

eA = activity of MO in A/a

>

= ats 1.01 x 10° x 9.6.x 1017

= 970 a/a/g of Kor

?The basic equation to convert activity of sample in a/m to uc/ce

or uc/g te:

(9)

>

wo/es or g = ?Bet c/a

ox tgxk

fe effictency factor

fg = sample veight in co or g

K = constant to convert @/a to ue K = 2.22 x 108

u

---Page Break---

cg

---Page Break---

vas NVagaElyuvo

J9VSSVd VNOW

NV390 SDILNVILV

OOld OLYANd JO GNVIS! SHL 40 dVW

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Free, From "to

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ao or 30° w

a oe or a0

qo oe 30" o

ao er og oe 30"

a0 6 ot so er ot

or er aw 61" 32 30°

or or 30" aw

or os or 30"

or 02 30° oF

or 61" 09 oe 30°

or 6 ot 30° Gr ot

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o or 30" ww

os oe or 30"

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o oo Ce

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coe 2 wx ce 30° oe

mm 2 ee oo ww 30"

mm 2 wow oo

co 2 30° a rd

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OPERATED BY THR UNIVERSITY OF PUERTO RICO

FOR Tif UNITED STATES ATOMIC ENERGY COMMISSION

OBO AU00 WWOLEAR CRTER RIVERO DAL SURRY

SASPLE TOMITZATION

Sample Noy Book Wo,___ Page Wos,_Rof'. Map

Samplo Location= Latitude ____? Longitude

Tho undorsigned cortisios that this sample wes taken in nosordance with the

sempling specifications of the approved survey dato,

on this aay

of wee

a

?Signatare of Calloctar

Form PRIC- HPS (RS) 631

PUERTO RICO NUCLEAR CENTER

OPERATED BY THE UNIVERSITY GF PUERTO RICO

FOR THE UNITED STATES ATOMIC BIERGY COMMISSION

FUBRTO RIOD NUCLEAR CENTER DIVIROWONTAL SURVEY

SAMPLE IDENTIFICATION

Sample No. Book Noe Poge Rot. Map,

Semple Location-Jatitude- * _* Longitude st

?Tho undersigned cortifies that this sample was token in accordance with the

sompling specifications of the approved survey dato,

on tht

day of 29.

a «ee a

Form PitiG= HPS (BS) 631

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?PUSRTO RICO MUCLEAR CENTER

OPERATED 8Y TE UNIVERSITY OF PUERTO RICO

?FOR THE UNITED STATES ATOATC BVEGOY COMMISSION

BURR Ride WOMiAR GOITER BWEIROINEAL site

FIELD DATA SHEET

?Area Designation Data Shoot Wo. Wosthor Dota

Book Nos Boole Pago ?Tomporature___Wind.

tent, Marddity. Date

Procipitstion,

SSeS

Sample No. Dato Tino Type _Latitudo Longitude Ronarks

ee

SSS

Sea

eS

ee

?Wlecwgde tena

L Sortify that I have collected,

matkod end sealed the chor somos tn accorsouo with .-

othods and procures Sn tho P.RliCy Rodtdorleal Suray

mplisg qocitications dted

?2a bo complotod af the Laboratory

L cortity that the deta on this shoot

corresponds to that on tho sample tumod ovor to wo by

on this day of

19___ and thot I havo inspoctod tho samples ond found thes:

?to bo in good conditions, socled and logally LaboLled.

---Page Break---

PUERTO RICO NUCIEAR CENTER

(OPERATED BY SHE UNIVERSITY OF FUERIO RICO

?FOR SE UNITED STATES ADOC ENERGY coMESSTON

REMOVAL OF SAMPLE FROM STORAGE

1 cortity that I have

received Sample To. from on this

? ?vf ____, 9___sm order to

+ (Purpose of Removal).

tin of apie ?

Bigatare

Tate oF ites

---Page Break---

SAMPLE DATA SHEET

TYPE:

Sample no, ate and Time of Col;

feo; Sample Volume oF Weight

Survey Remarks:?_____ Laboratory Remarks ~

= BUA Aliquots ml. or gm.

{de Time | metoment [fea [ons | 2% | Sento T cm [BS | nwt om

Totar

instrument | Rea. | Lights | counts

tt, Factor:

net c/m

FRAX 222 X10"

Acti 2 9m,

ee

octal Analyses:

?Signature

Form PRNC ~ HPSIRS) 632

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