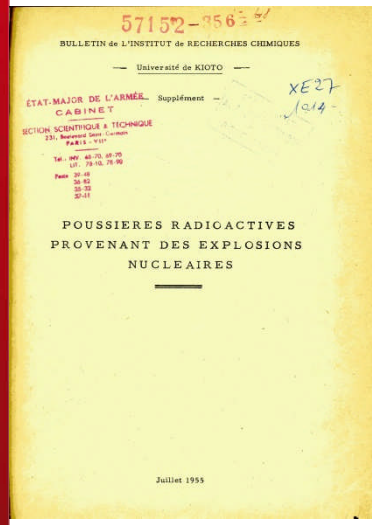
FROM RESEARCH TO INDUSTRY

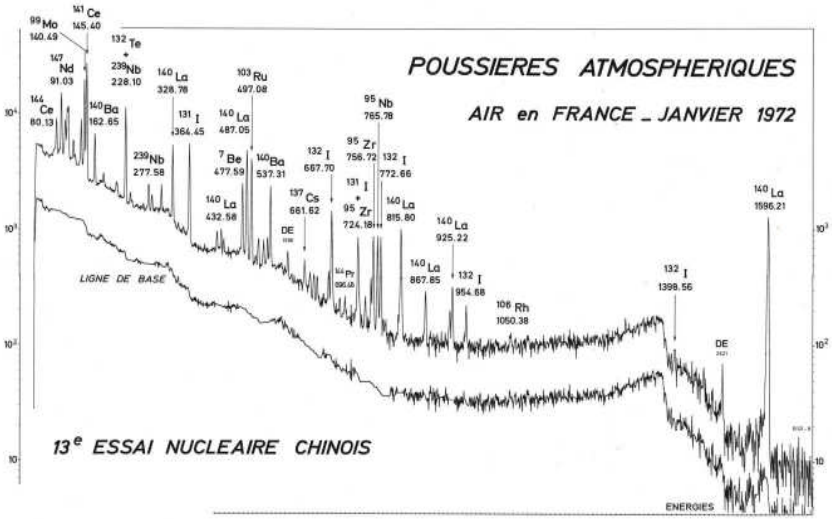
SURVEILLANCE DE L'ENVIRONNEMENT AUX ÉCHELLES MONDIALE, RÉGIONALE ET LOCALE TOUR D'HORIZON HISTORIQUE - DE 1895 AUX ANNÉES 1960 -


BULLETIN de L'INSTITUT de RECHERCHES CHIMIQUES

— Université de KIOTO —

POUSSIERES RADIOACTIVES
PROVENANT DES EXPLOSIONS
NUCLEAIRES

Juillet 1955

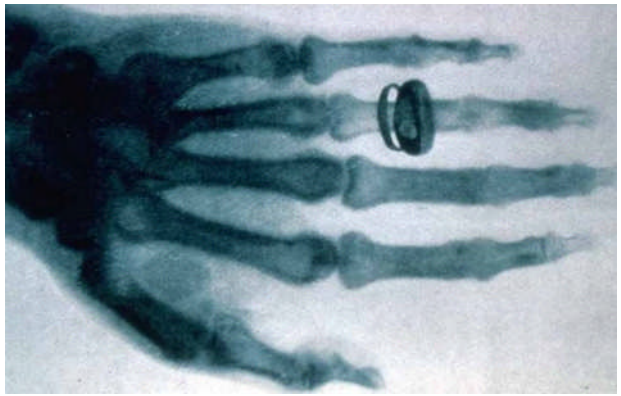


SFRP-Paris | 5 novembre 2015

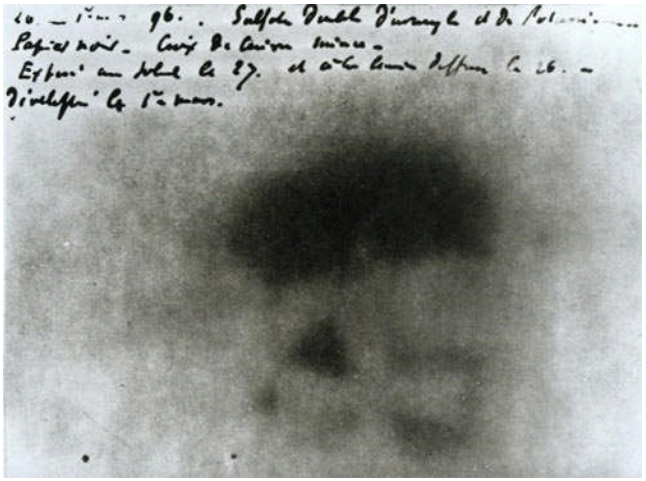
M. Dominique CALMET
CEA/MR/DPSN

www.cea.fr

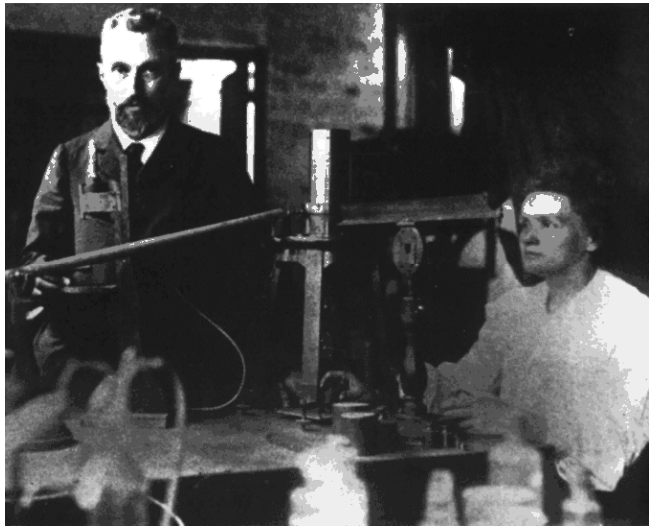
AIRE DES PIONNIERS: LES DÉCOUVERTES



Rayons X,
Röntgen, 8.11.1895



Radioactivité: Becquerel,
26.03.1896



Polonium et radium, Pierre
et Marie Curie, 1898

Observations des premiers effets dus aux irradiations aigues

AIRE DES PIONNIERS: PREMIÈRES APPLICATIONS

Radiographie des poumons, Béclère, 1897

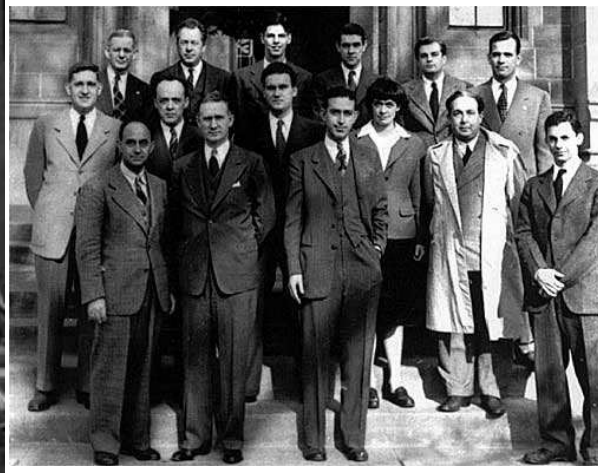
Véhicule équipé radiologie, 1913

1922 : Une centaine de radiologues décédés
1925 : *Congrès international de radiologie* décide de quantifier la *radioexposition* via le *Comité des unités de mesure des rayonnements*
1928 : Commission internationale de protection contre les rayons X et le radium

DU RISQUE PROFESSIONNEL AU RISQUE COLLECTIF

Création d'isotopes radioactifs artificiellement, Irène et Frédéric Joliot-Curie,1933

Découverte de la fission, Lise Meitner et Otto Hahn, 1938

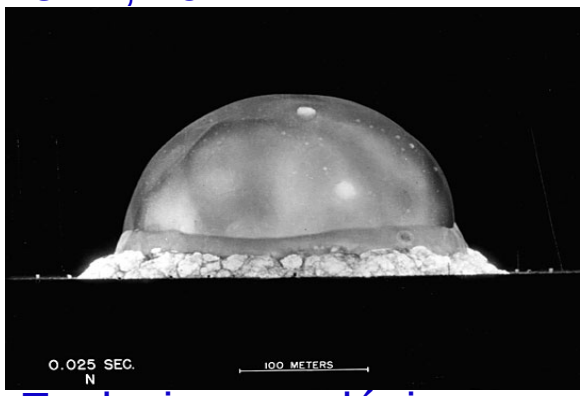


Chicago Pile-1
Fermi, 1942

1934: Notion de seuil de tolérance

1941: dose maximale permissible

D'une question d'hygiène professionnelle les effets des rayonnements ionisants deviennent une question de risque collectif



Explosions nucléaires
Essai Trinity, 1945

SURVEILLANCE RADIOLOGIQUE DE L'ENVIRONNEMENT

Juillet 1949 : *Projet GABRIEL puis SUNSHINE (1953).*

***Objectif**: "**Evaluer les dangers radiologiques des retombées** de débris d'explosions d'armes nucléaires en cas de guerre… soit des **retombées locales** ou par accumulation des retombées provenant d'explosions **à plus longues distances** de nombreuses armes nucléaires…"*

***Moyens**: « **Programme(s) surveillance** planétaire à l'aide de **prélèvements d'échantillons** et de leur **analyses radiochimiques** qui fourniront les données nécessaires à l'étude des mécanismes… »*

***Mécanismes étudiés**:*

«Conditions expliquant la formation des retombées : Altitude de l'explosion, puissance

Conditions météorologiques expliquant les transports des débris, influence de la pluie

O…

Com…

I…

La connaissance des termes sources et la surveillance de la radioactivité de l'environnement et des aliments apparaissent comme inséparables de la protection de la santé humaine

Incorporation et métabolisme des produits de fission par l'homme et les animaux

Effets sur l'homme des expositions externe et interne aux radiations »

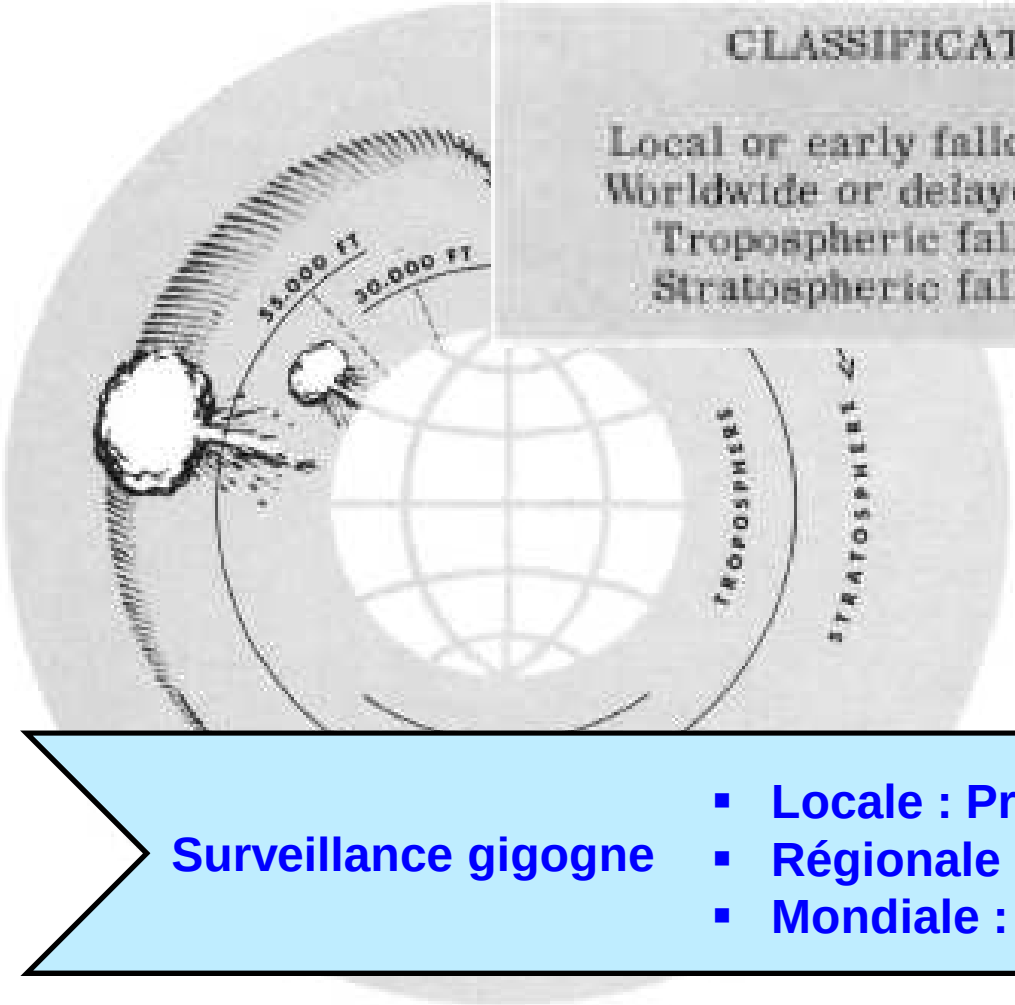
USA : PROGRAMMES DE SURVEILLANCE RADIOLOGIQUE

Table 6. Major global fallout monitoring programs.

Program	Dates	Measurement	No. of sites	Sampling frequency
HASL gummed-film	1951–1958	Beta activity	~60–200	Daily
HASL precipitation	1954–[a]	^{89}Sr, ^{90}Sr	~150	Weekly
United Kingdom precipitation	1956–[a]	^{90}Sr	29	3 mo
AEC/USDA soil	1953–1967	^{90}Sr	~50–100	~Biannual
NRL/HASL surface air	1957–[a]	Total beta activity, selected nuclides	21–33	Daily, weekly composites
AEC high altitude	1956–1983	Total beta activity, selected nuclides	6–27 km at several latitudes	~Weekly
WMO precipitation	1961–1964	^{3}H	102	Monthly

[a] Sampling networks still in operation.

SURVEILLANCE RADIOLOGIQUE : OBJECTIFS



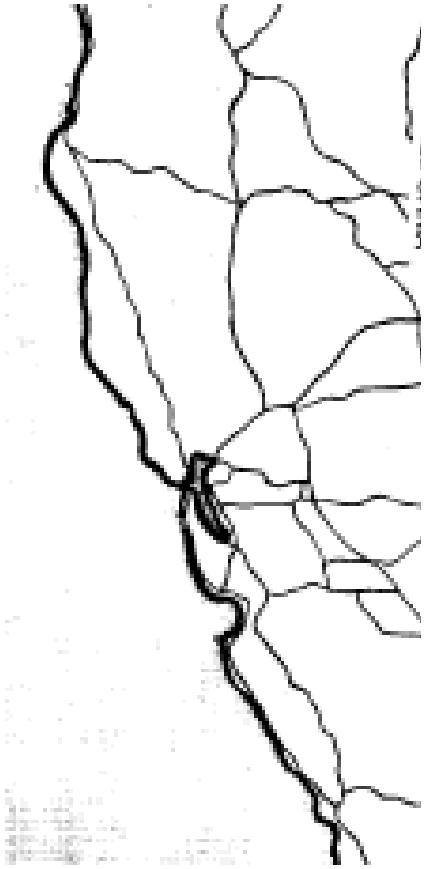
CLASSIFICATION	TIME REQUIRED
Local or early fallout	Minutes to 1 day
Worldwide or delayed fallout:	
Tropospheric fallout	1 day to 1 month
Stratospheric fallout	Up to 5 years or more

Surveillance gigogne

- **Locale : Proximité site d'expérimentation**
- **Régionale : Territoires voisins**
- **Mondiale : Couverture de la planète**

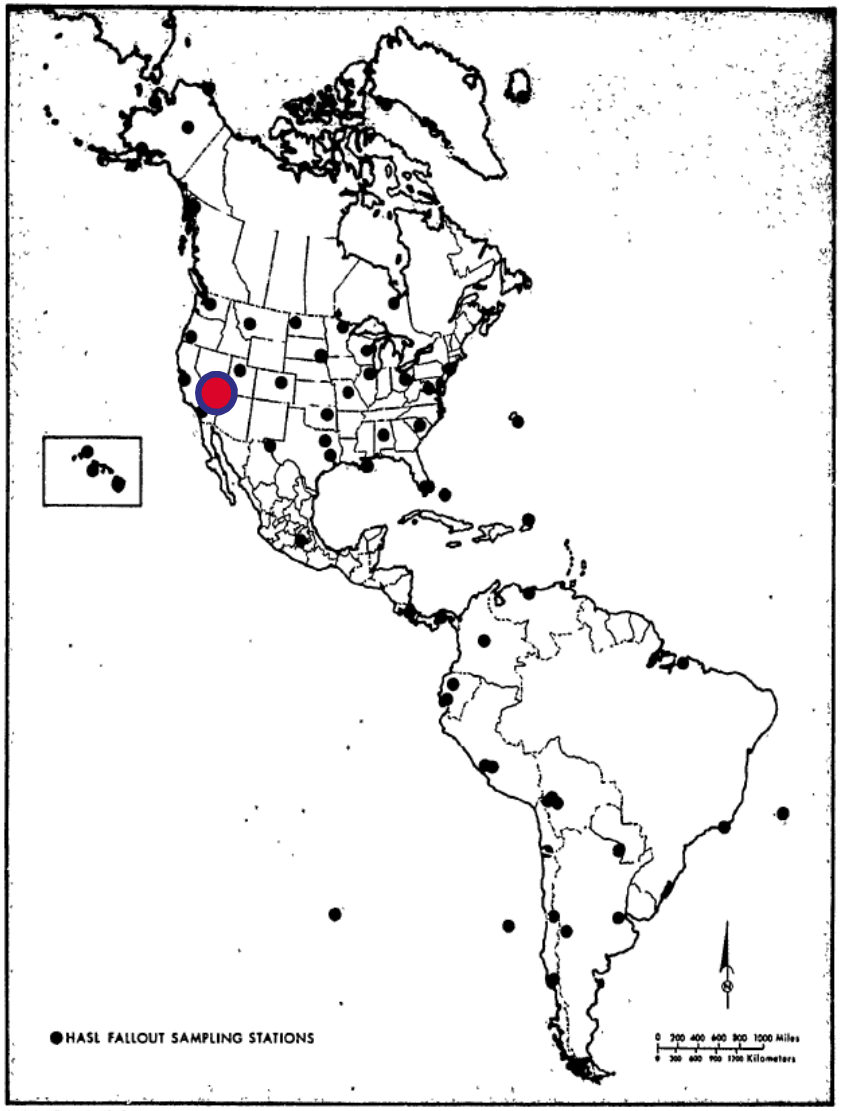
Figure 1 *The arrows in the diagram should be interpreted as representing the ultimate movement of debris that occurs only after constant mixing by random eddies, and not as simple one-way circulation.*

SURVEILLANCE RADIOLOGIQUE SPATIALE



SOURCE: Radiation Data and Reports (Dece

FIGURE A-2 AIR SURVEILLANCE N



SOURCE: Radiation Data and Reports.

SA-2981-3

FIGURE A-7 HASL FALLOUT SAMPLING STATIONS IN THE WESTERN HEMISPHERE

SURVEILLANCE RADIOLOGIQUE : RÉSEAU DE STATIONS

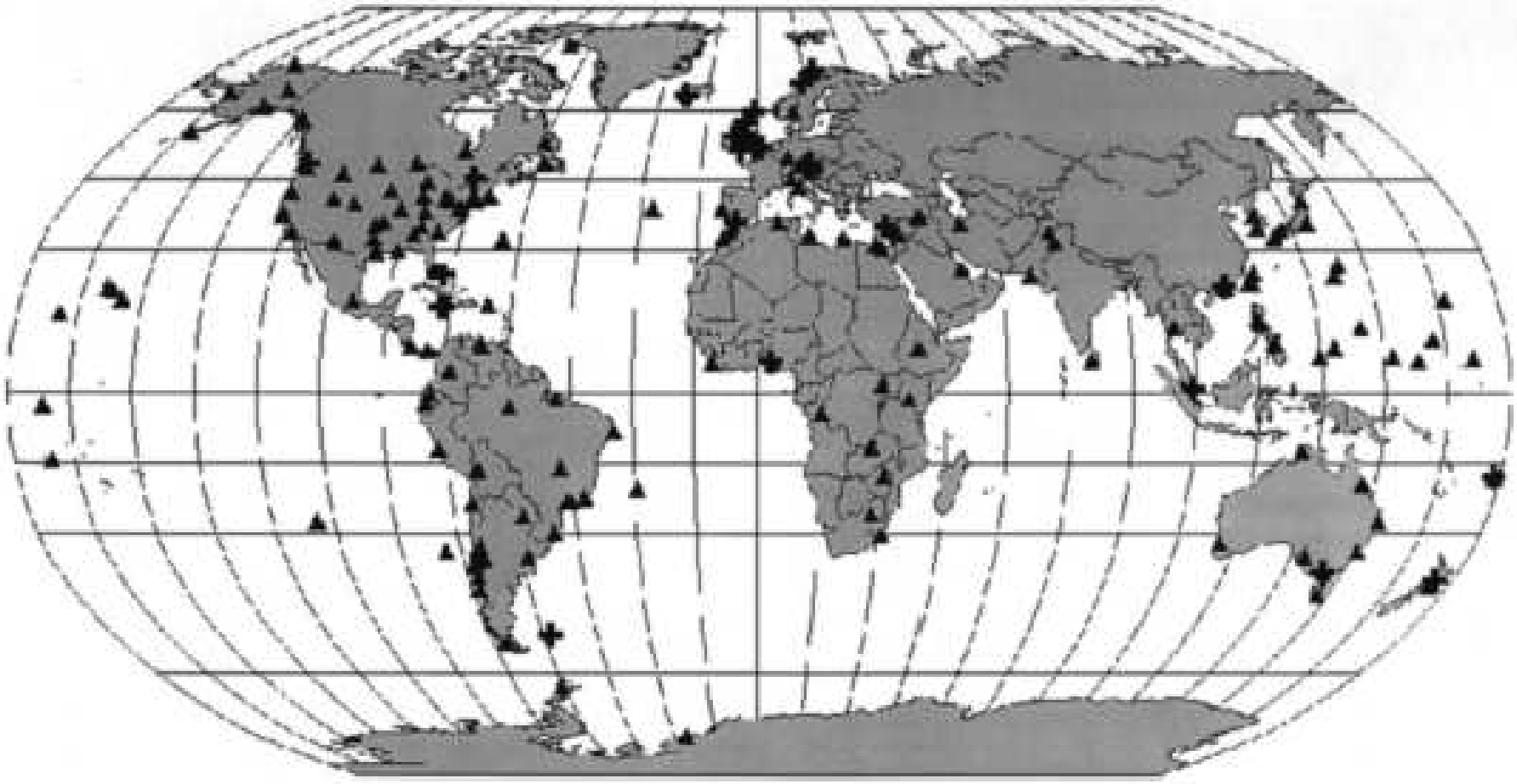


Fig. 5. HASL (triangles) and United Kingdom (crosses) precipitation sampling sites in 1962.

SURVEILLANCE RADIOLOGIQUE : RÉSEAU DE STATIONS

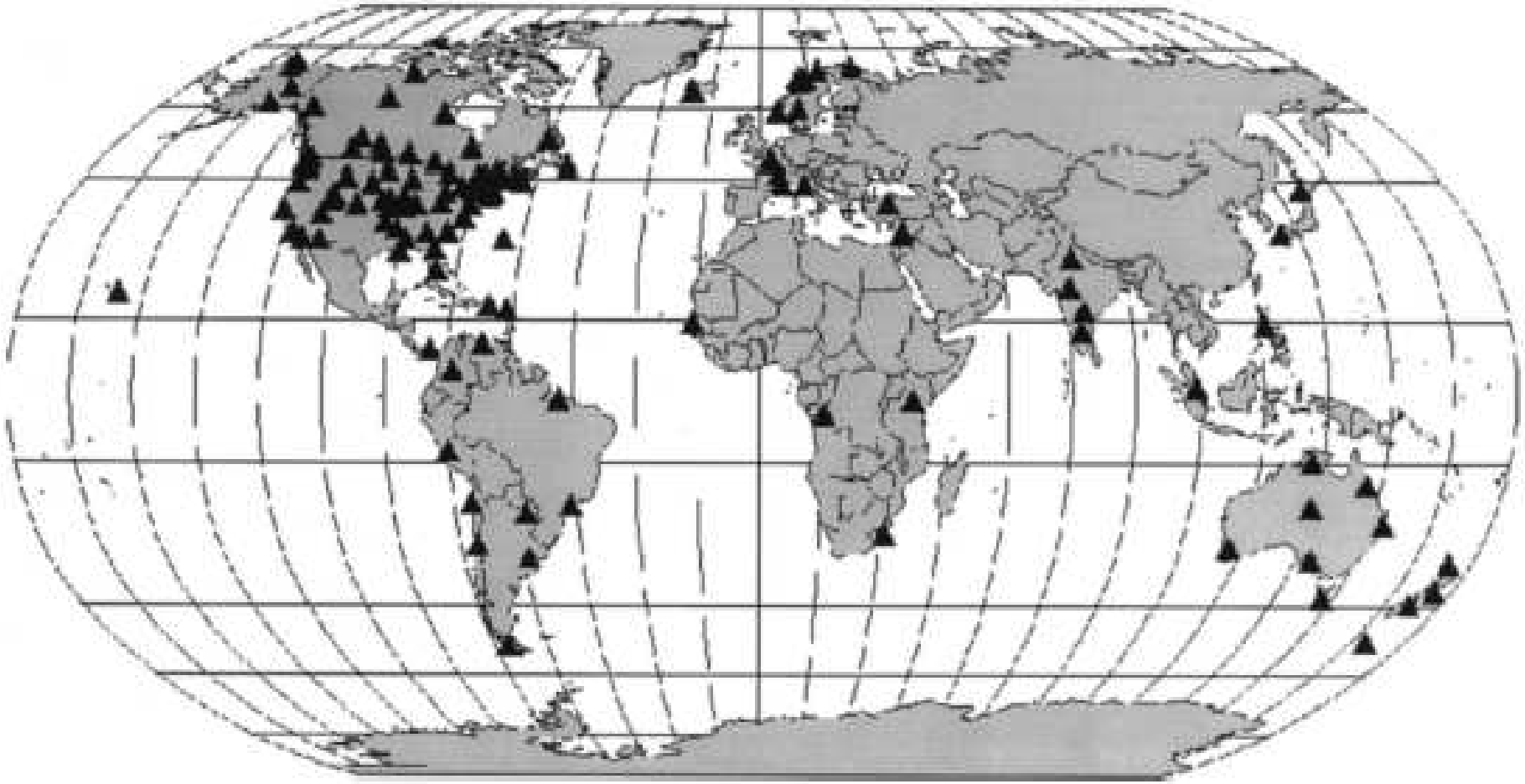
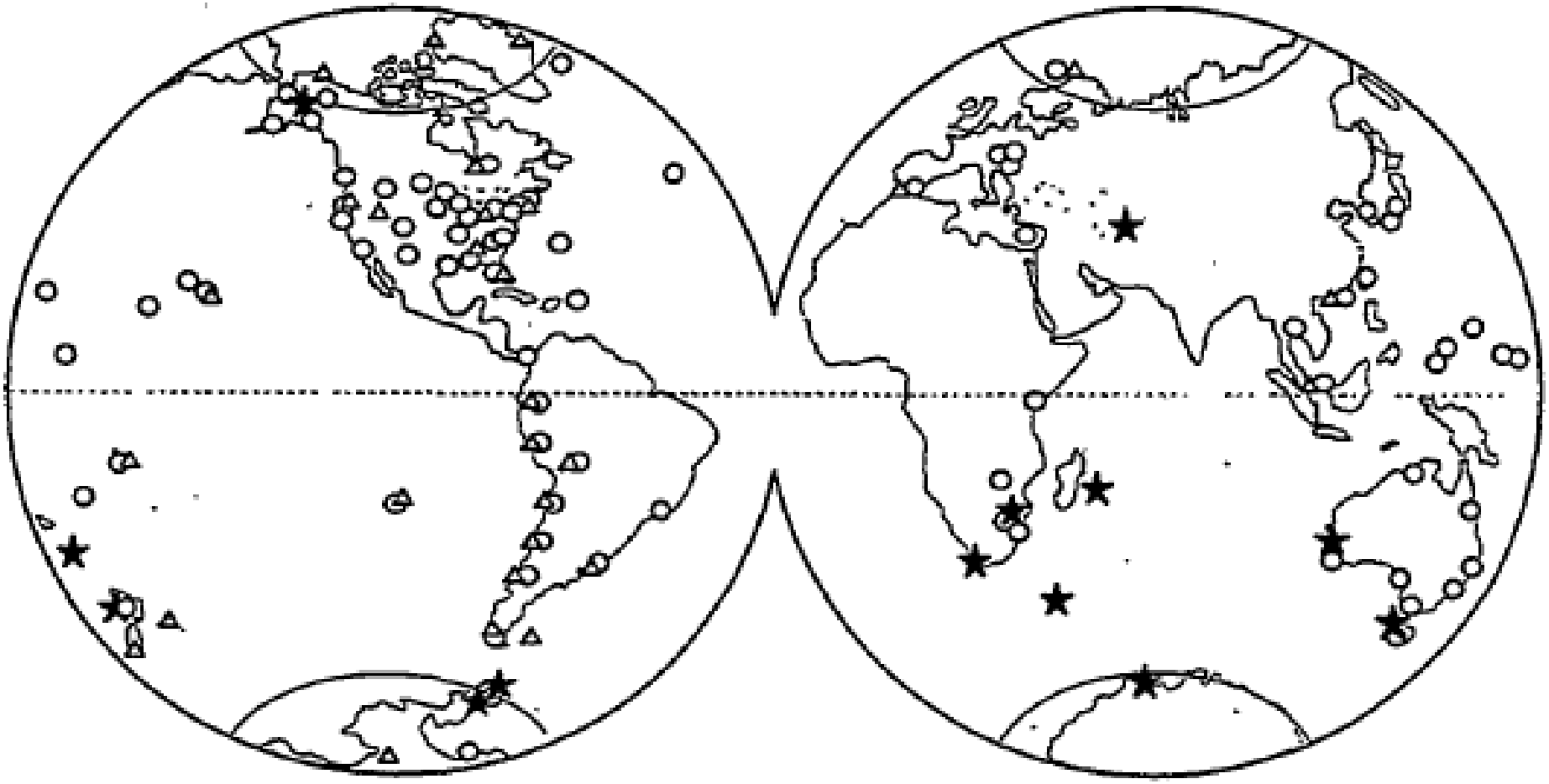


Fig. 6. Soil sampling sites from 1963–1965.

SURVEILLANCE RADIOLOGIQUE : RÉSEAU DE STATIONS



EML's global sampling network.

△ Surface Air Stations ○ Total Deposition Stations

★ Remote Atmospheric Measurements Stations

Source : EML-571

SURVEILLANCE RADIOLOGIQUE : GAMMA AMBIANT

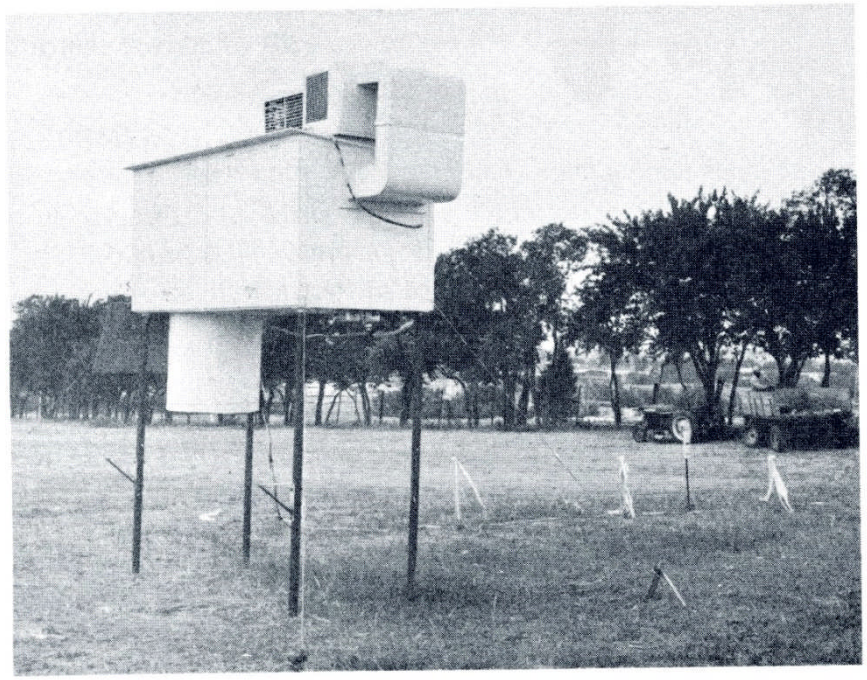


Fig. 1—Field instrumentation for total-absorption gamma-ray spe trometer.

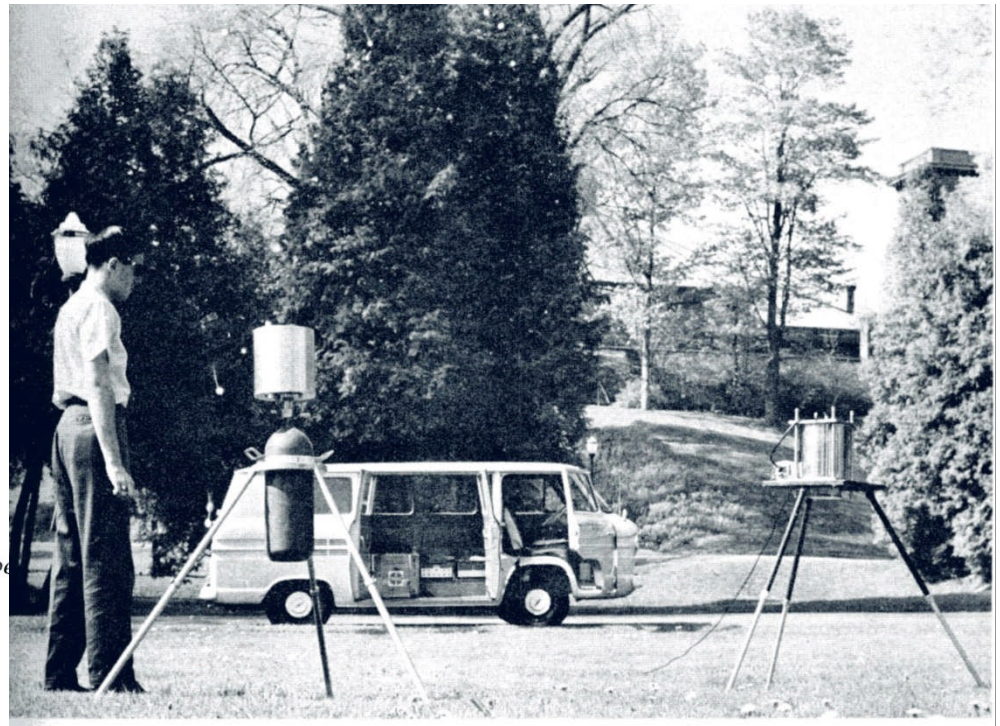
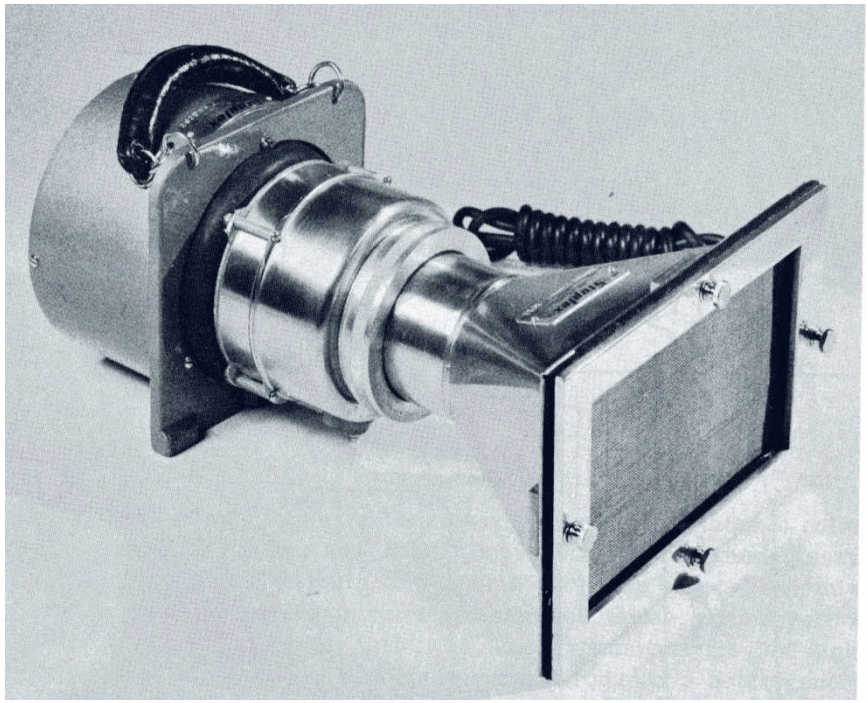


Fig. 1—HASL pressurized ionization chamber and spectrometer set up for a typical measurement. Saratoga Springs, N. Y., 1963.

SURVEILLANCE RADIOLOGIQUE : AÉROSOLS



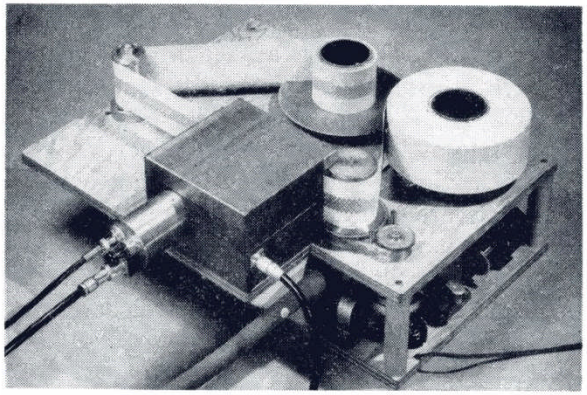
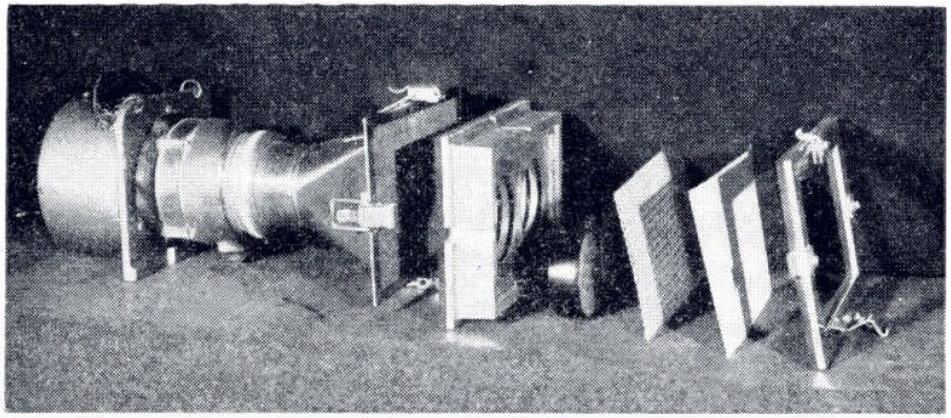
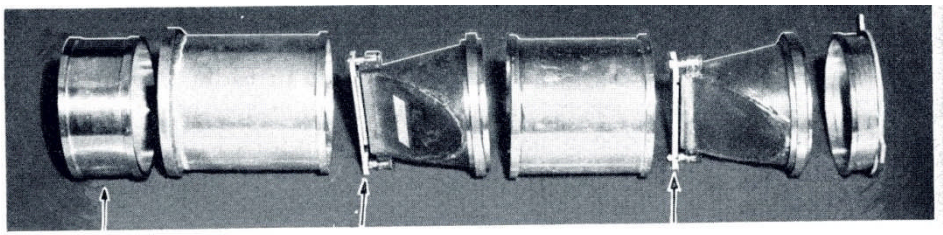


FIG. 16-11. A continuous air sampler that filters the dust on moving tapes which are automatically counted after permitting time for decay of the natural radioactivity. (*Brookhaven National Laboratory.*)





FILTER (FOR <0.02-μ-RADIUS PARTICLES)

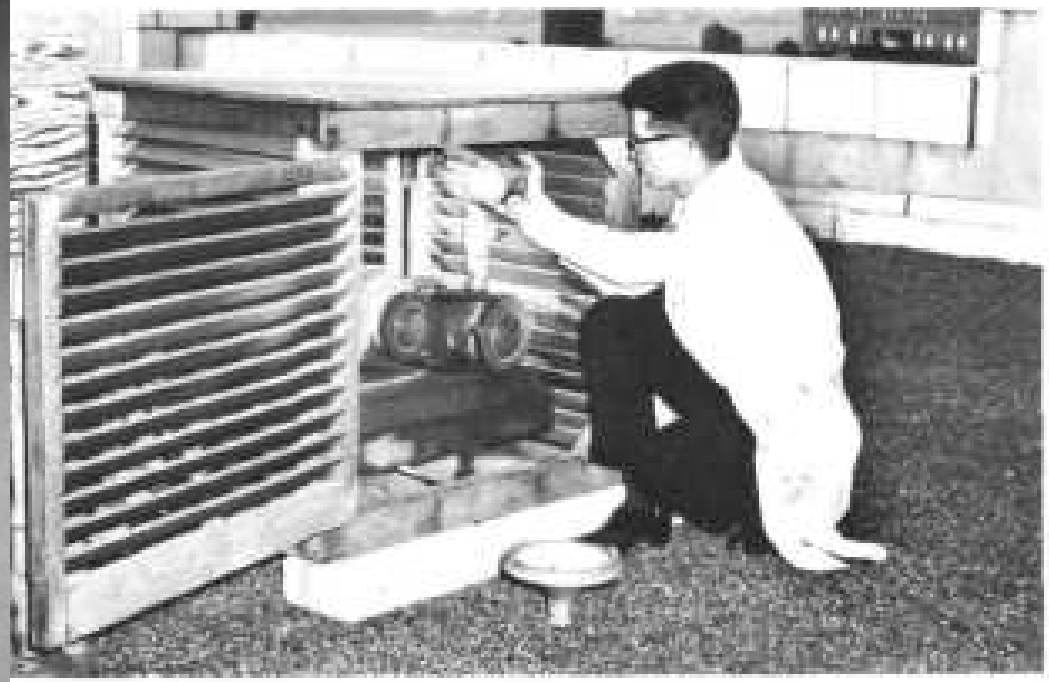
STAGE 2 (FOR 0.02 TO 0.15-μ-RADIUS PARTICLES)

STAGE 1 (FOR >0.15-μ-RADIUS PARTICLES)

Fig. 1—Exploded view of a single impactor–filter sampler.

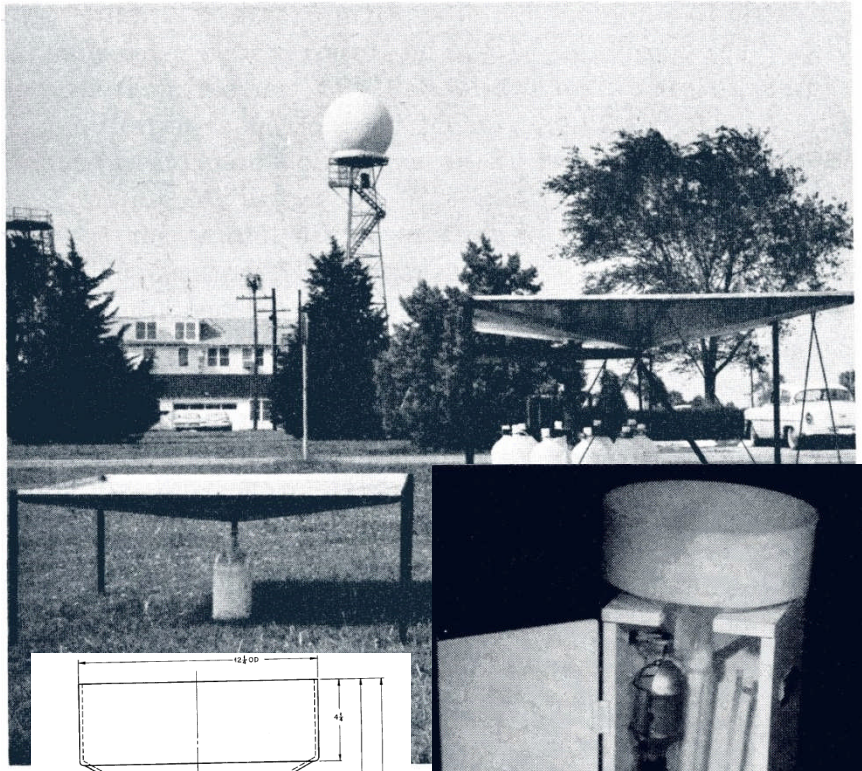
SURVEILLANCE RADIOLOGIQUE : AÉROSOLS

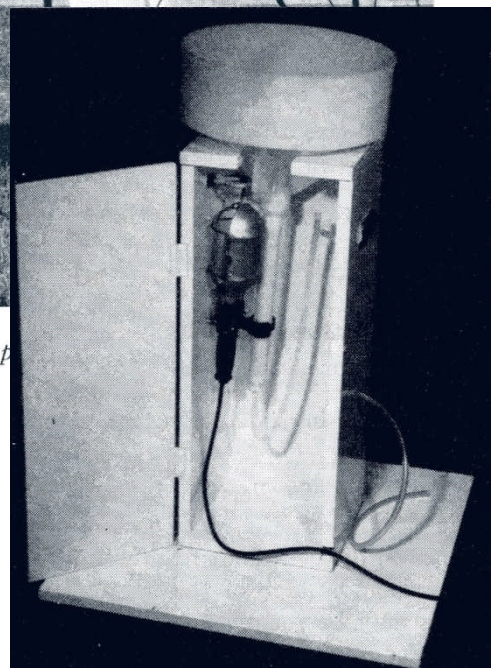
This high-altitude balloon is being prepared for launching at Goodfellow Air Force Base in Texas. The balloon carries air-filtering devices to collect atmospheric particulate samples, which are analyzed for various radionuclides. This information is useful in interpreting movement of radioactive debris from its point of injection into the atmosphere to its deposition on the earth's surface.



ion-product concentrations in ground-level air are measured stations at the same longitude, at intervals from Greenland ie southern tip of South America. From these measurements nixing of fission debris in the atmosphere at different latitudes ndied. This photo shows a sampler on the roof of the AEC's th and Safety Laboratory in New York City. This sampler rs dust from 10,000 cubic meters of air each week.

SURVEILLANCE RADIOLOGIQUE : DÉPÔTS





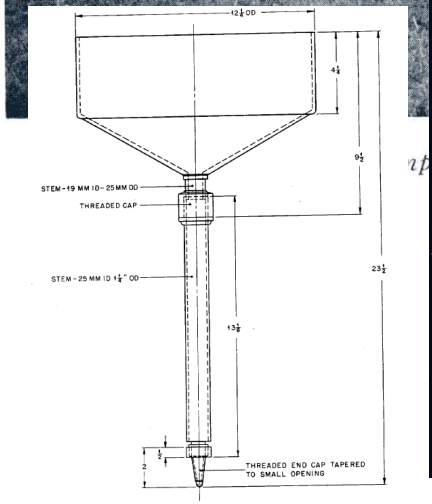


Fig. 1 — Ion-exchange fallout collector.

SURVEILLANCE RADIOLOGIQUE : ALIMENTS

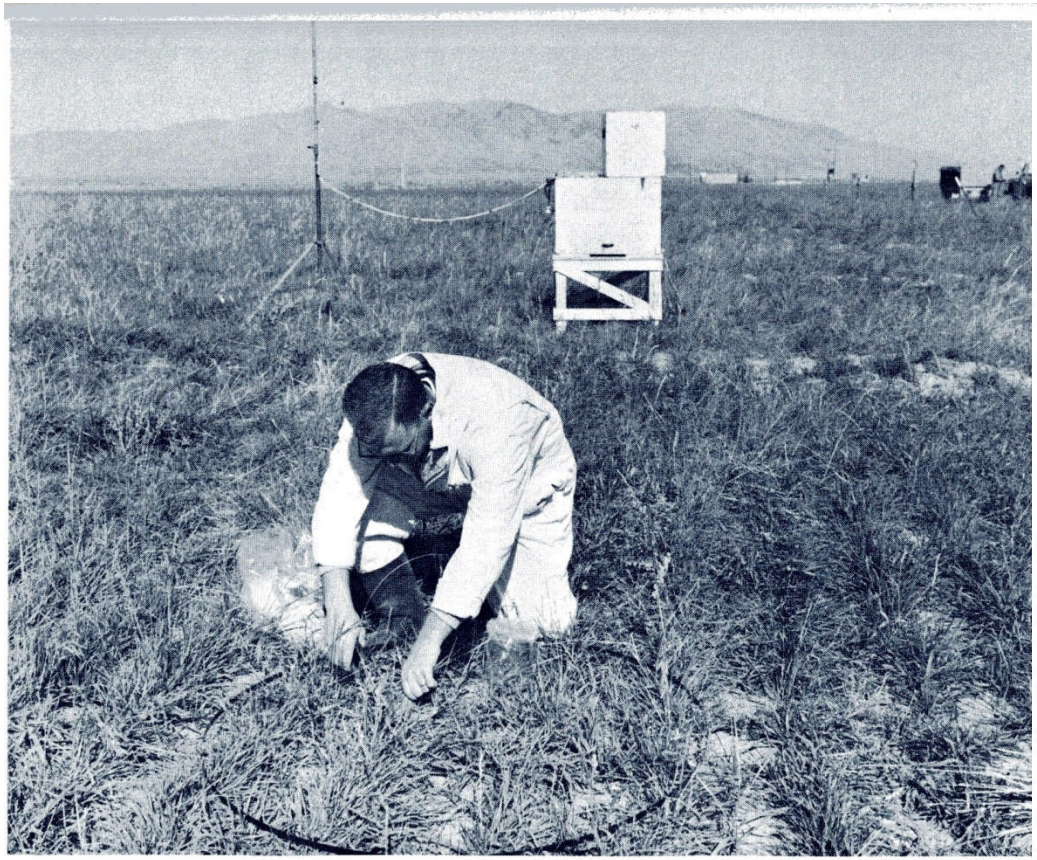
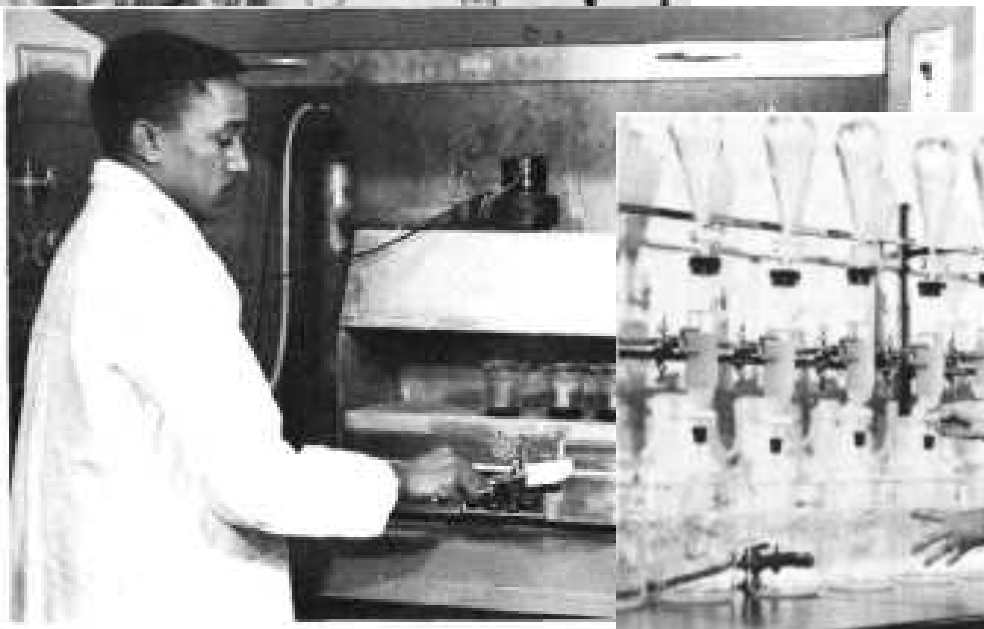


Fig. 5—View of irrigated pasture showing grass type and density and grass sampling techniqu Barn and corrals in background.

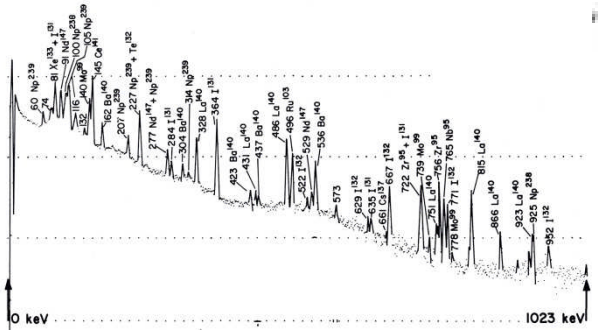
A local health worker picks up a gallon sample of raw milk in one of the farm areas monitored by the Public Health Service.

SURVEILLANCE RADIOLOGIQUE : MESURAGES

Measuring fallout con
collection stations aro
column (right) from r

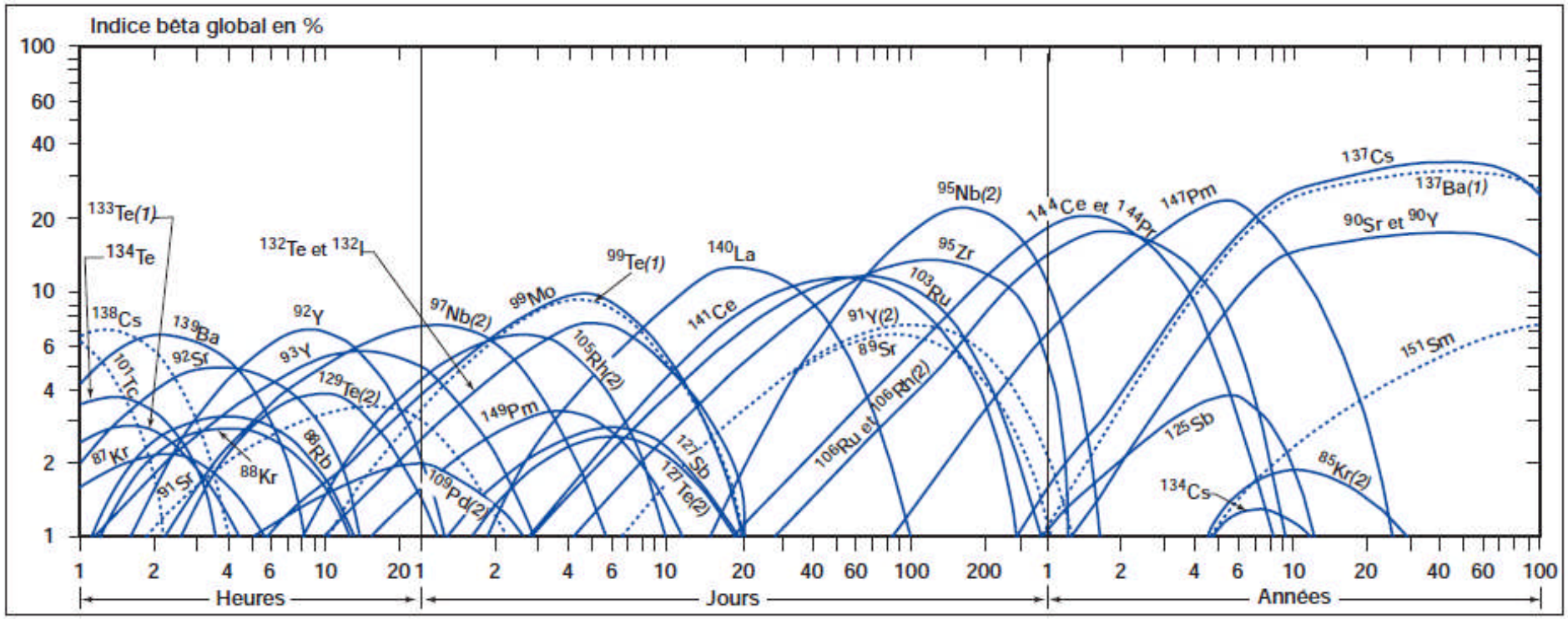


A chemist separates strontium-90 as a s
tion from a solution prepared from milk
rated prior to counting.



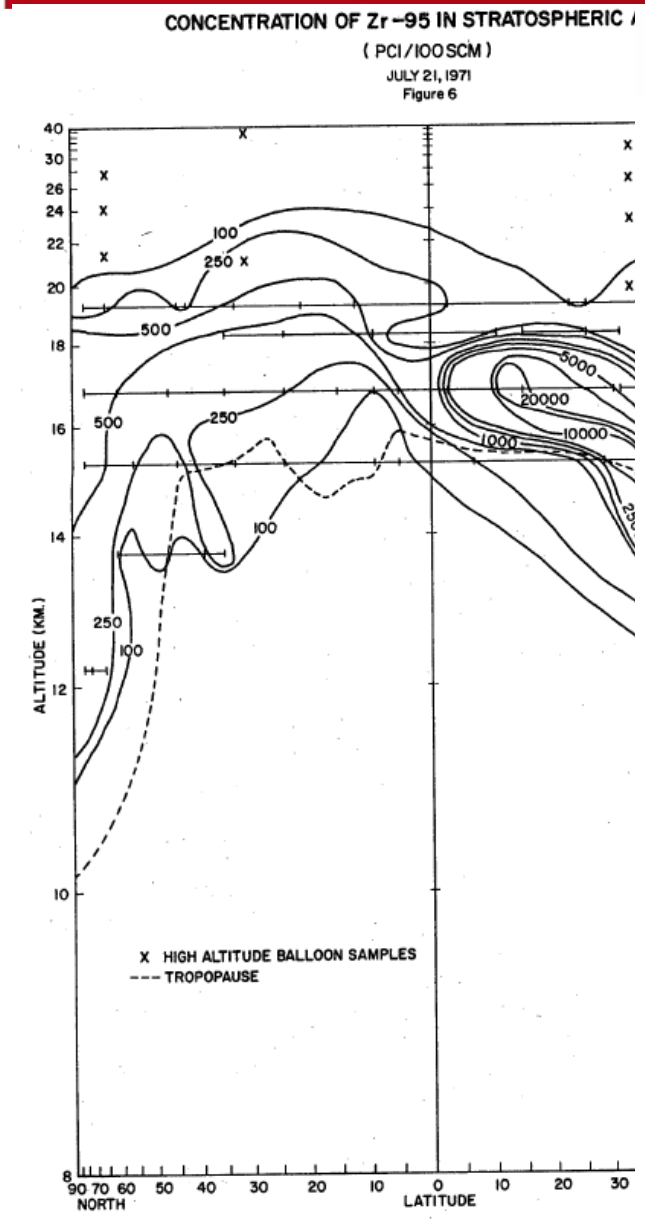
A technician conducts radiochemical analysis of milk samples at a laboratory in Montgomery, Alabama.

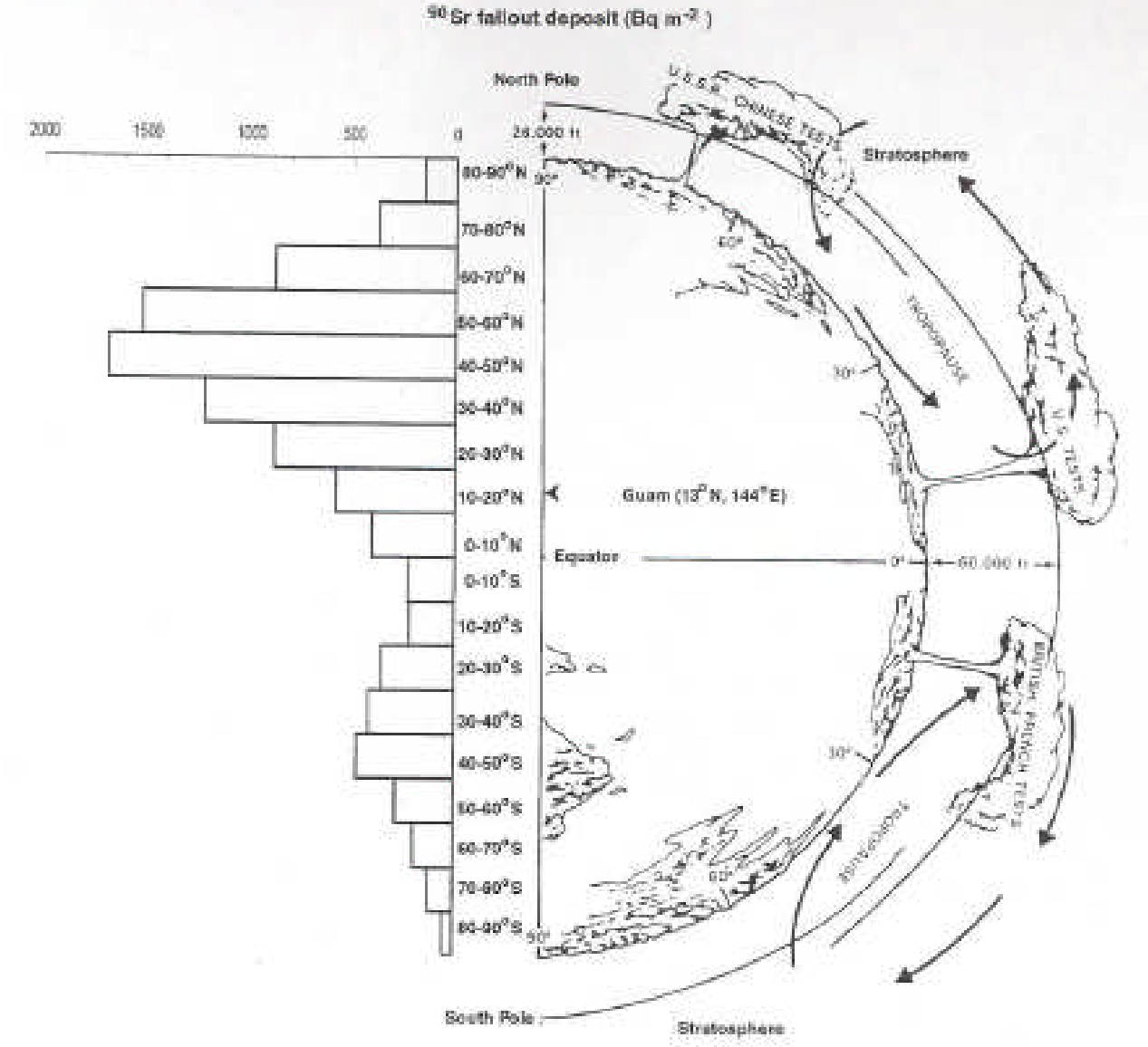
DESCRIPTION DU TERME SOURCE



Evolution au cours du temps de la contribution relative (%) à l'indice bêta global associé aux radionucléides émetteurs bêta-gamma présents dans le mélange initial non fractionné de produits de fission générés lors d'un essai thermonucléaire

DISPERSION ATMOSPHERIQUE





DÉPÔTS SECS ET HUMIDES

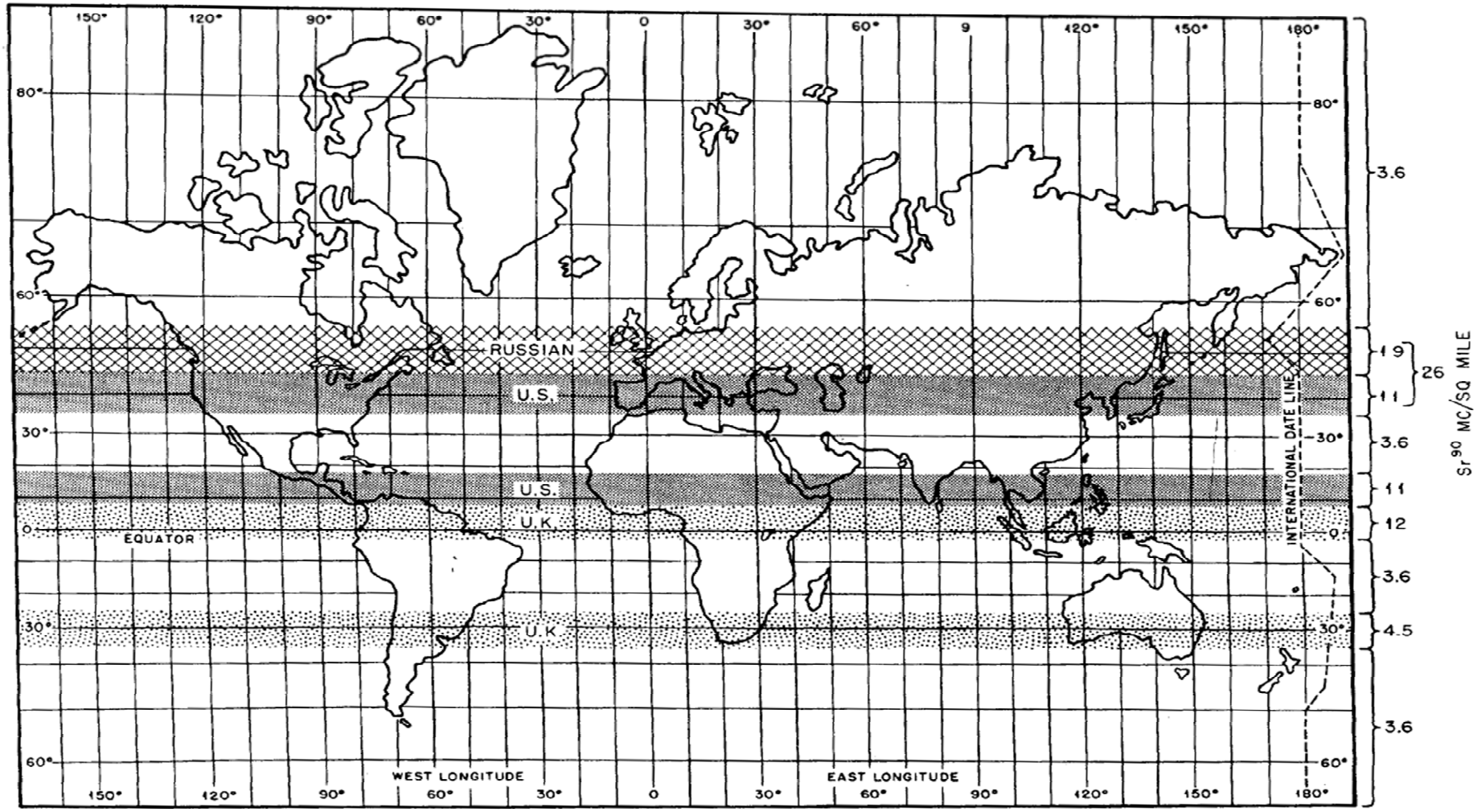


Fig. 4 — World fallout map (at end of 1957).

Source: HASL-42

TRANSFERTS À L'HOMME VIA LA CHAINE ALIMENTAIRE

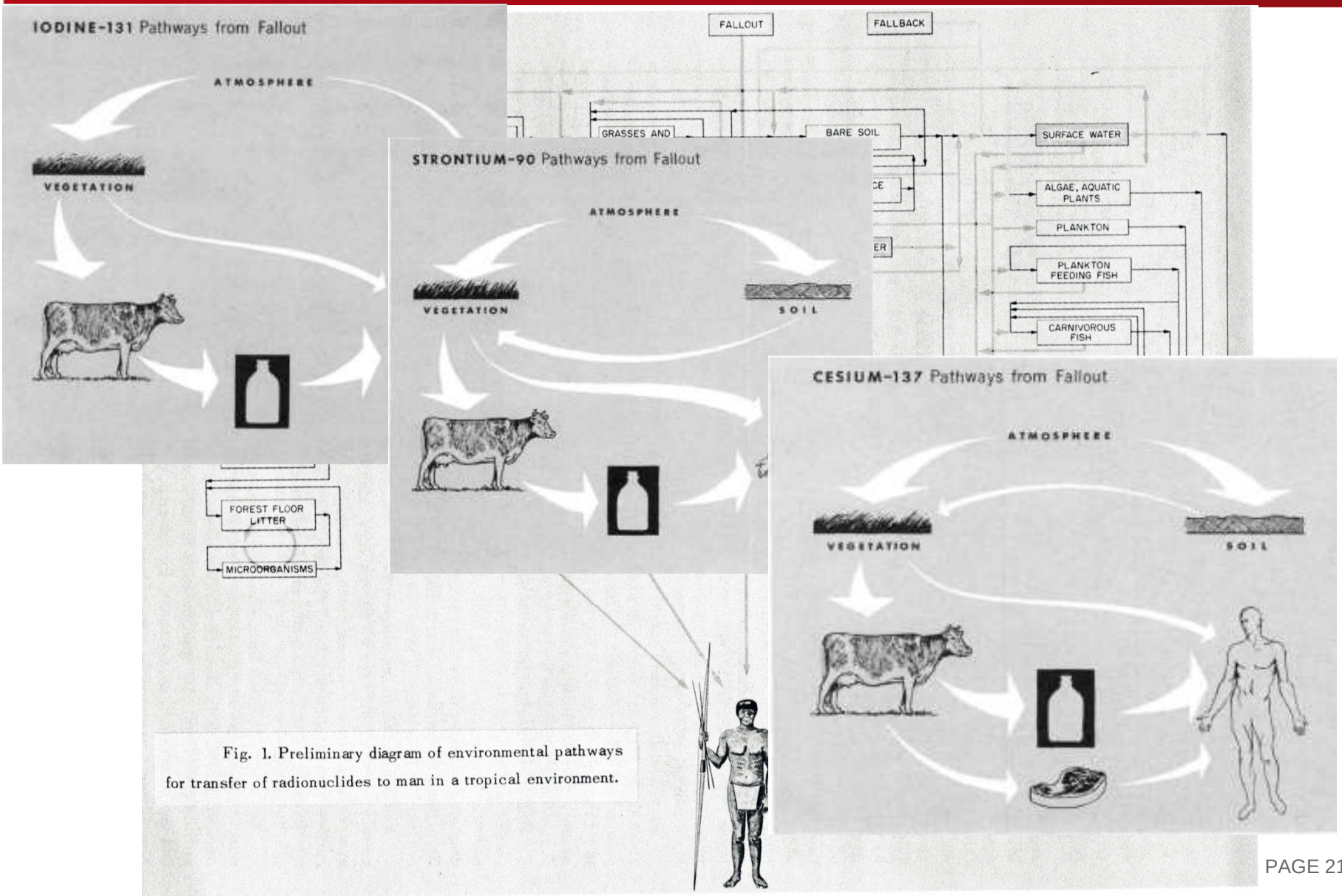


Fig. 1. Preliminary diagram of environmental pathways for transfer of radionuclides to man in a tropical environment.

TRANSFERTS À L'HOMME VIA LA CHAINE ALIMENTAIRE

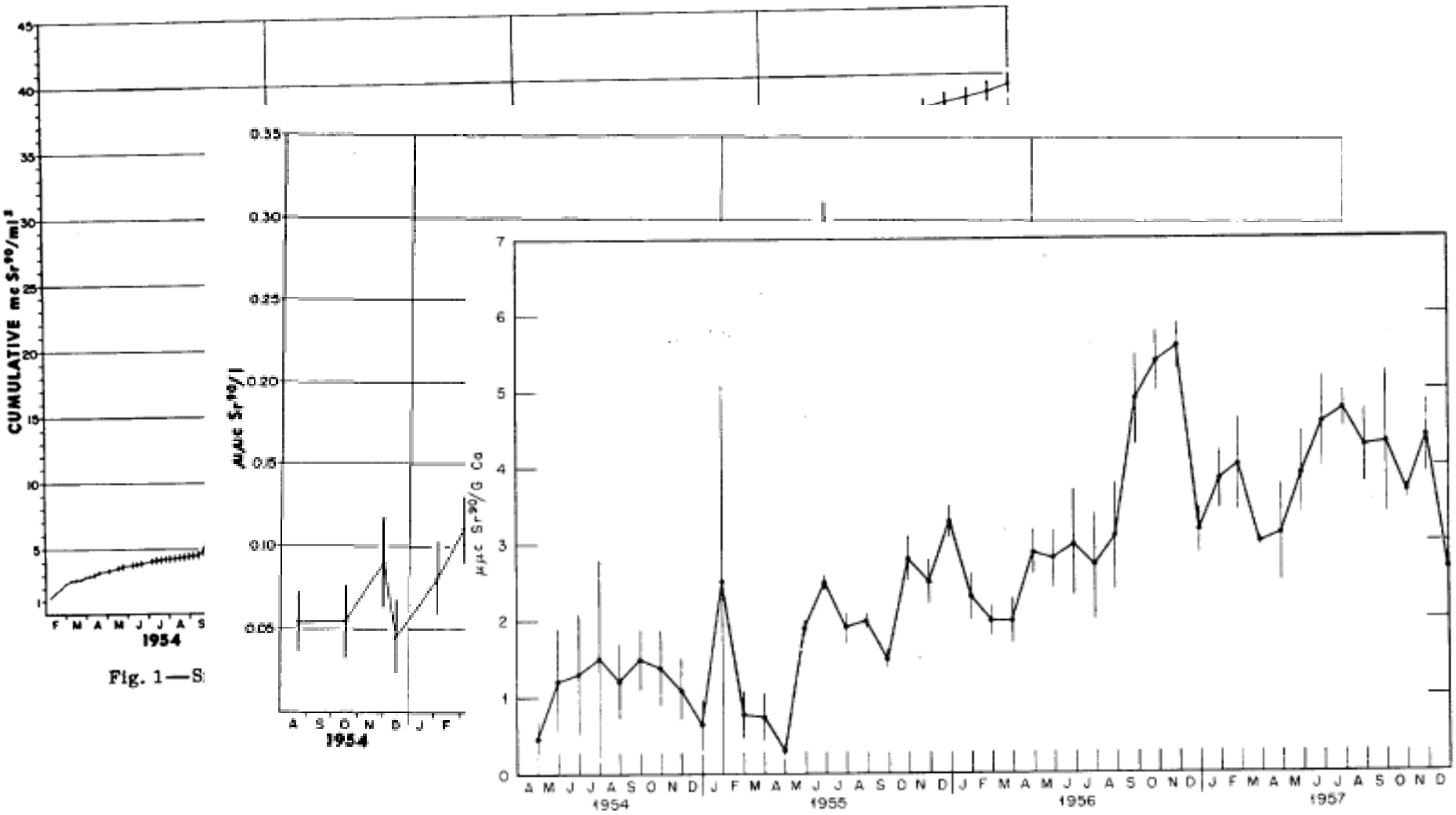


Fig. 1—S

Fig. 10—Monthly Sr^{90} levels in Perry, N. Y., powdered milk.

Source: HASL-42

TRANSFERTS À L'HOMME VIA LA CHAINE ALIMENTAIRE

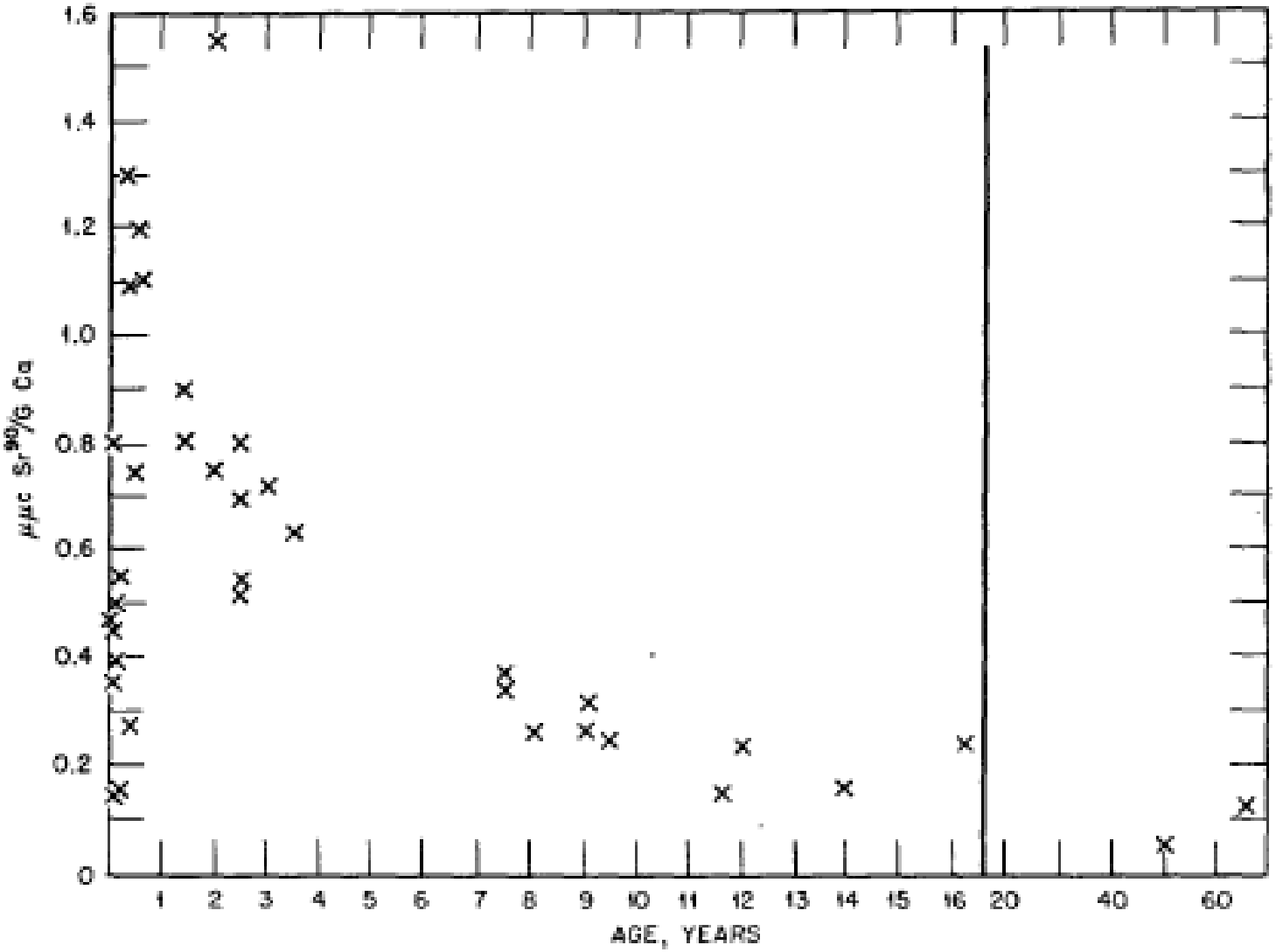


Fig. 7—Sr^{90} in human bone in 1956.

Source: HASL-257

TRANSFERTS À L'HOMME VIA LA CHAINE ALIMENTAIRE

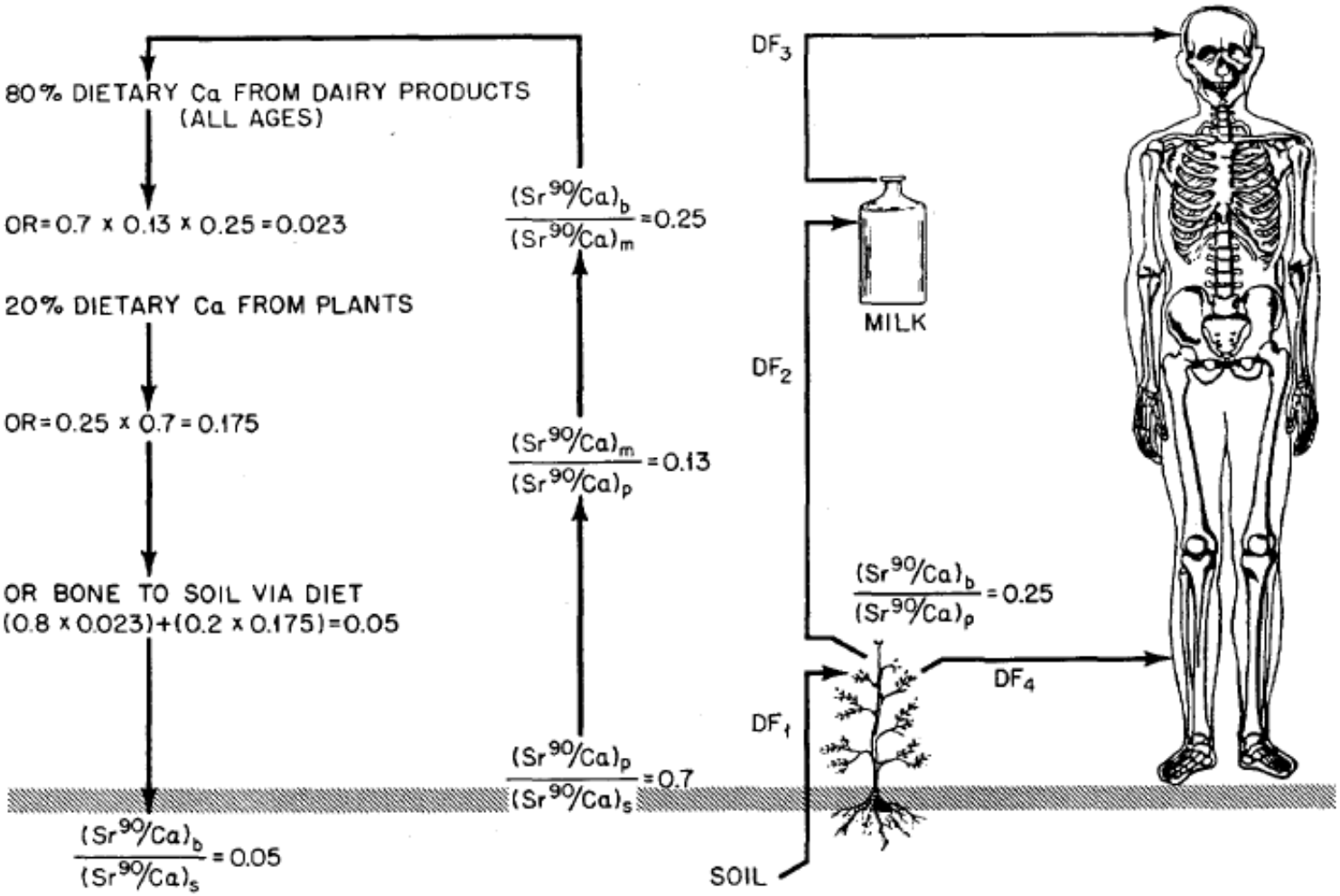
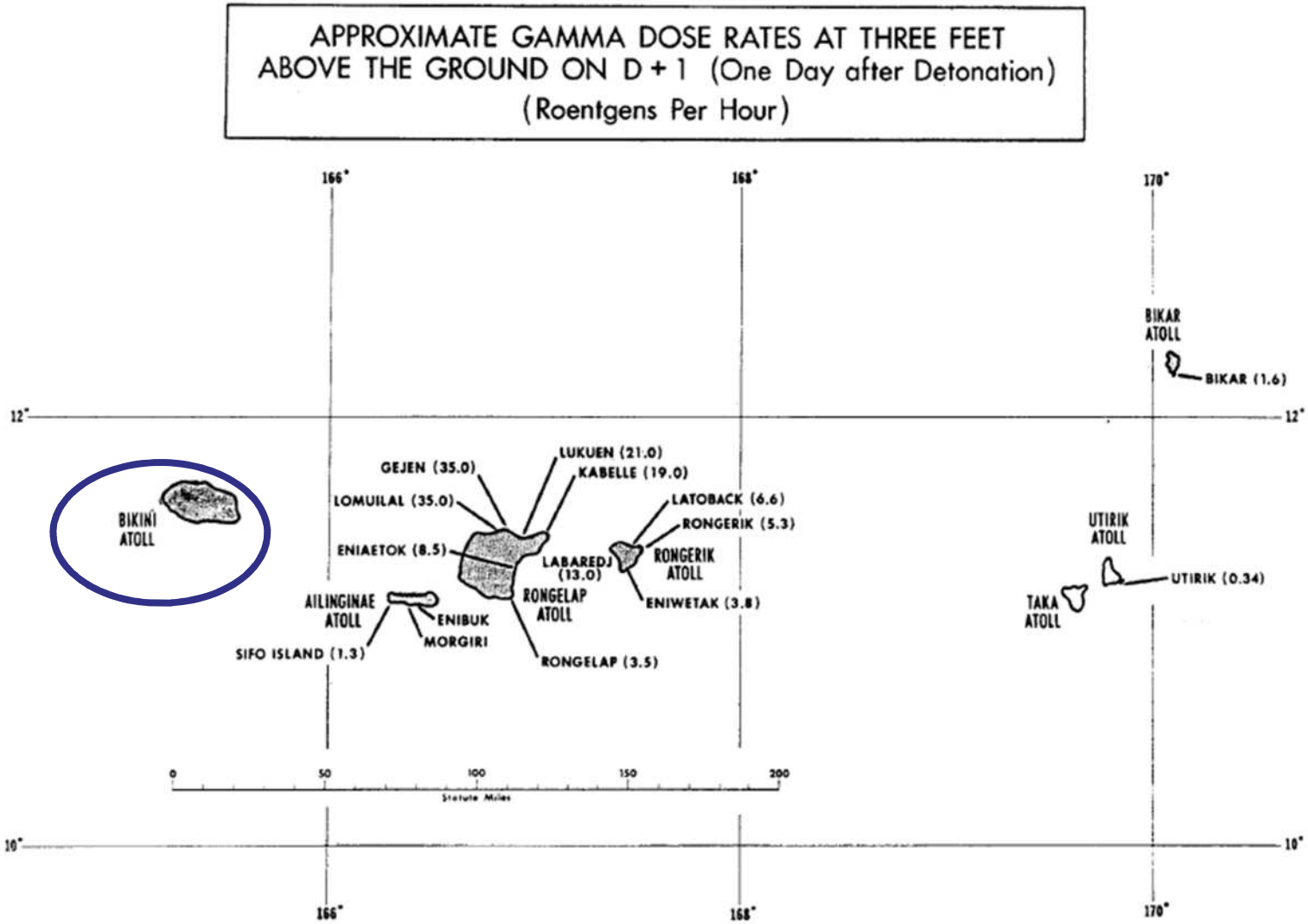
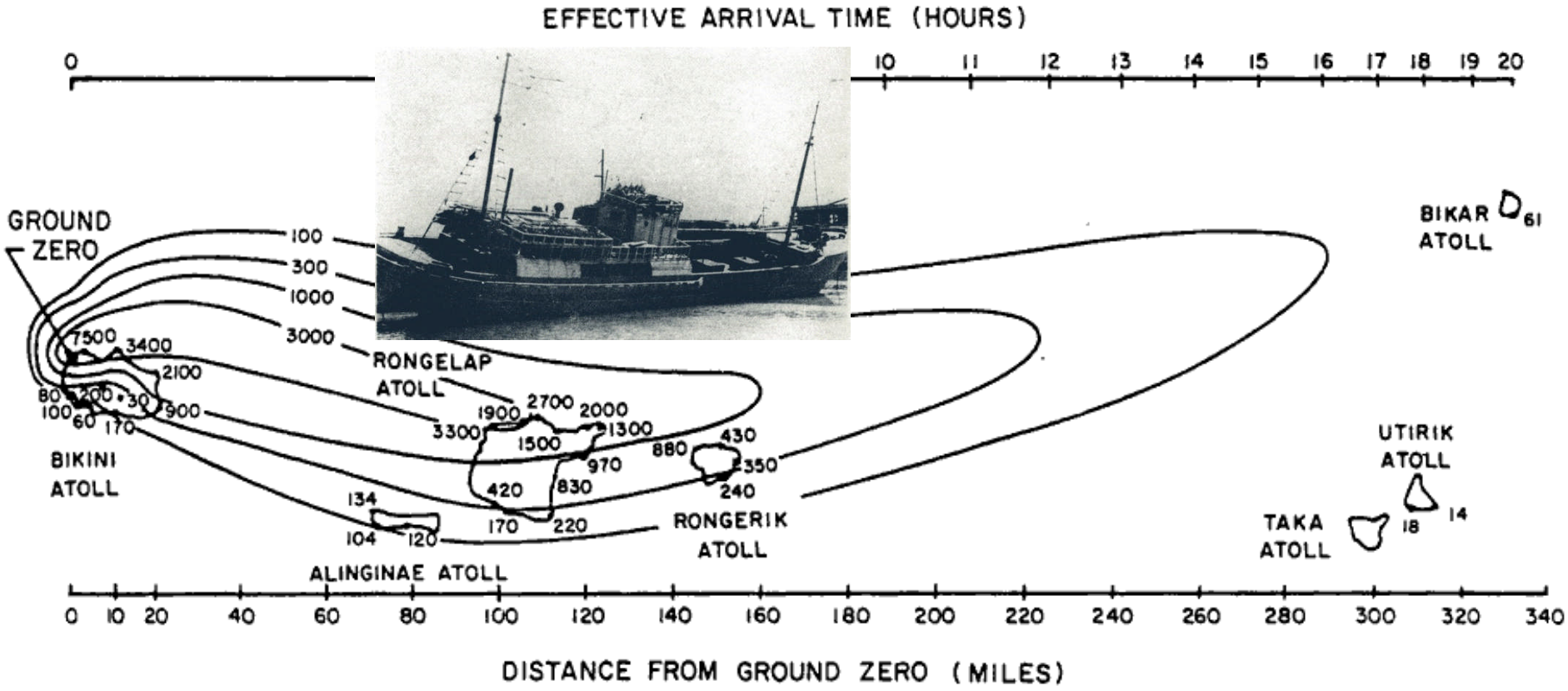


Fig. 3—Ecological discrimination against Sr^{90} with respect to calcium (United States).

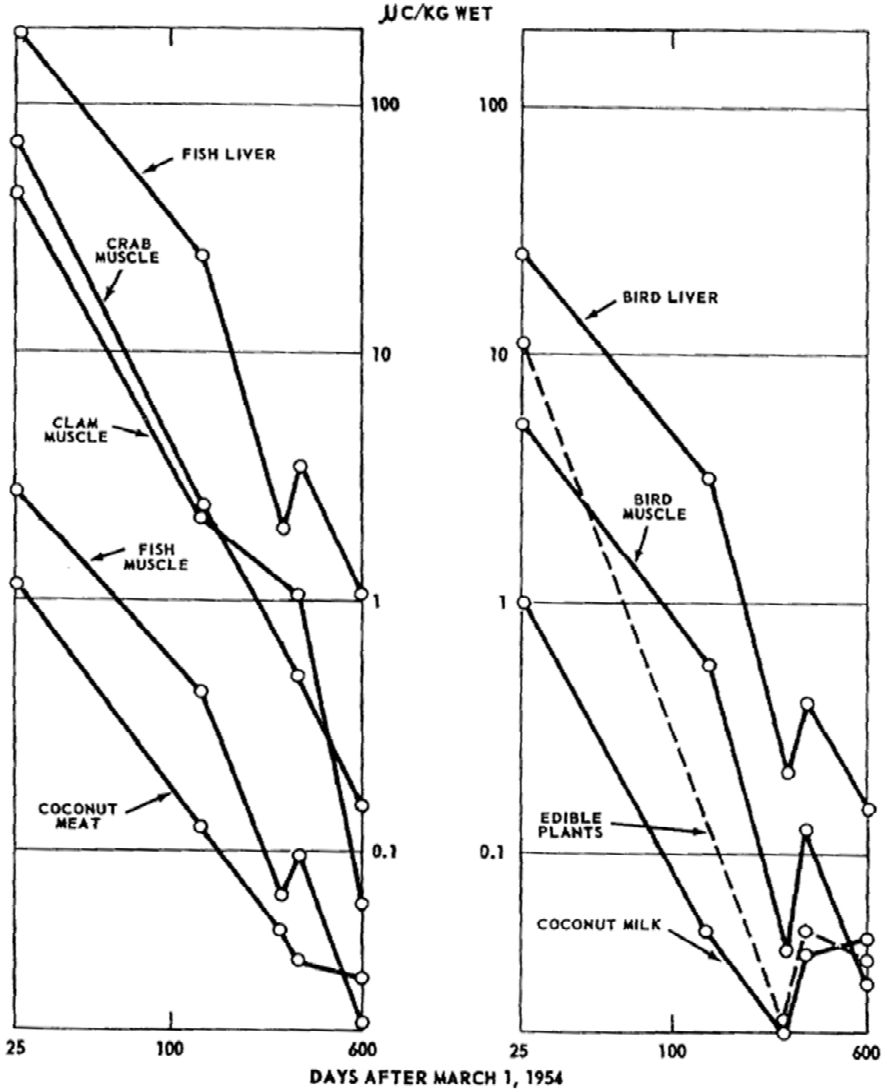
SURVEILLANCE DOSIMETRIQUE LOCALE



SURVEILLANCE DOSIMÉTRIQUE LOCALE



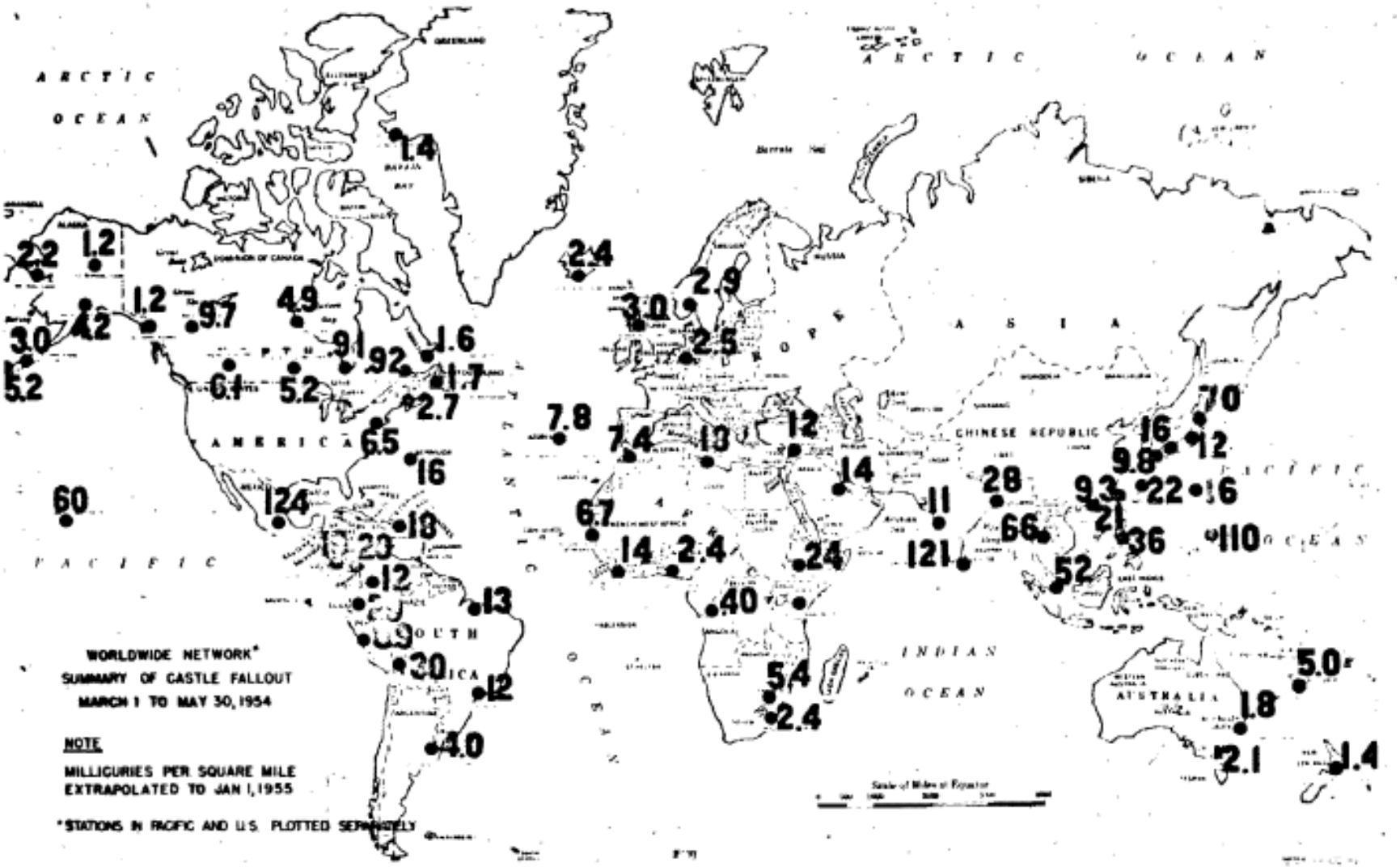
SURVEILLANCE DES ALIMENTS



RATE OF DECLINE OF RADIOACTIVITY IN FOOD ITEMS FROM COLLECTIONS AT RONGELAP ATOLL BETWEEN MARCH 26, 1954 AND OCTOBER 22-23, 1955. (AFL)

Officials of the Tokyo Metropolitan Government measure the levels of radiation of tuna offered for sale at Tsukiji fish market in Tokyo in 1954

SURVEILLANCE MONDIALE DES DÉPÔTS



DISPERSION MONDIALE DES POUSSIÈRES

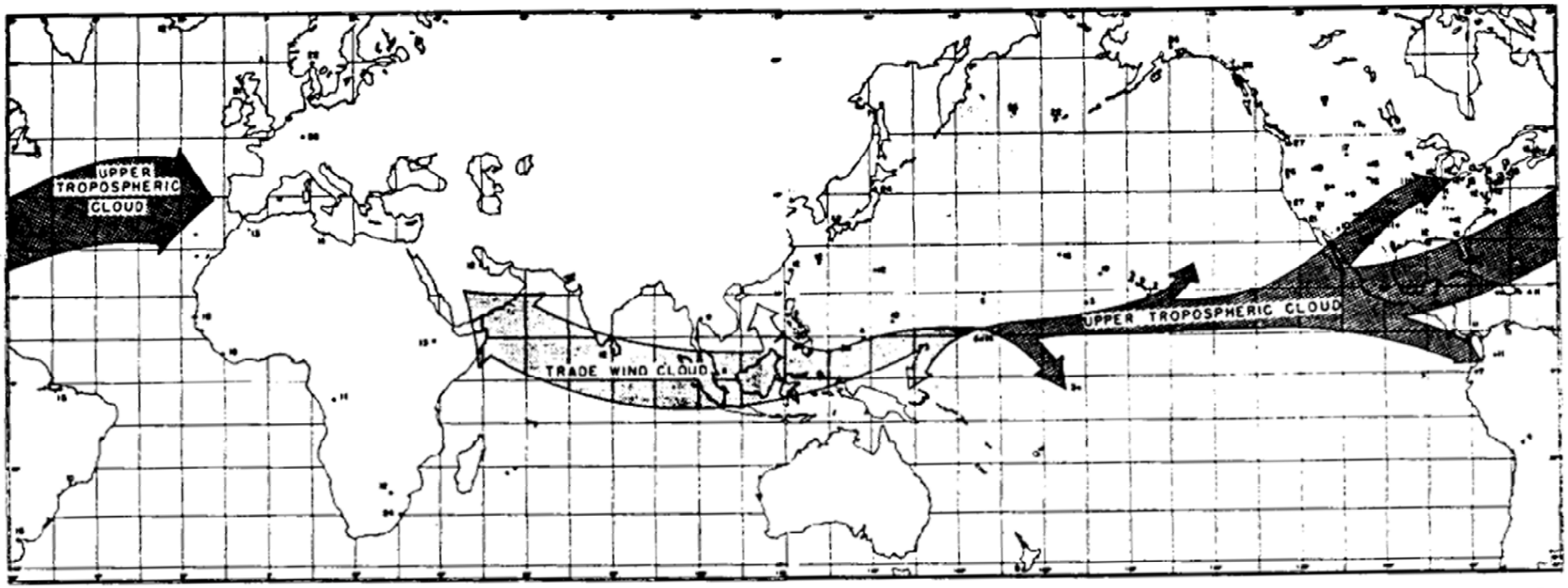


Fig. 3. Early history of the Bravo cloud. The figures indicate the number of days between detonation and the first ground observation of fission products.

Source: Matcha et al. (1956)

ESSAIS D'EXPLOSIONS NUCLÉAIRES ATMOSPHÉRIQUES

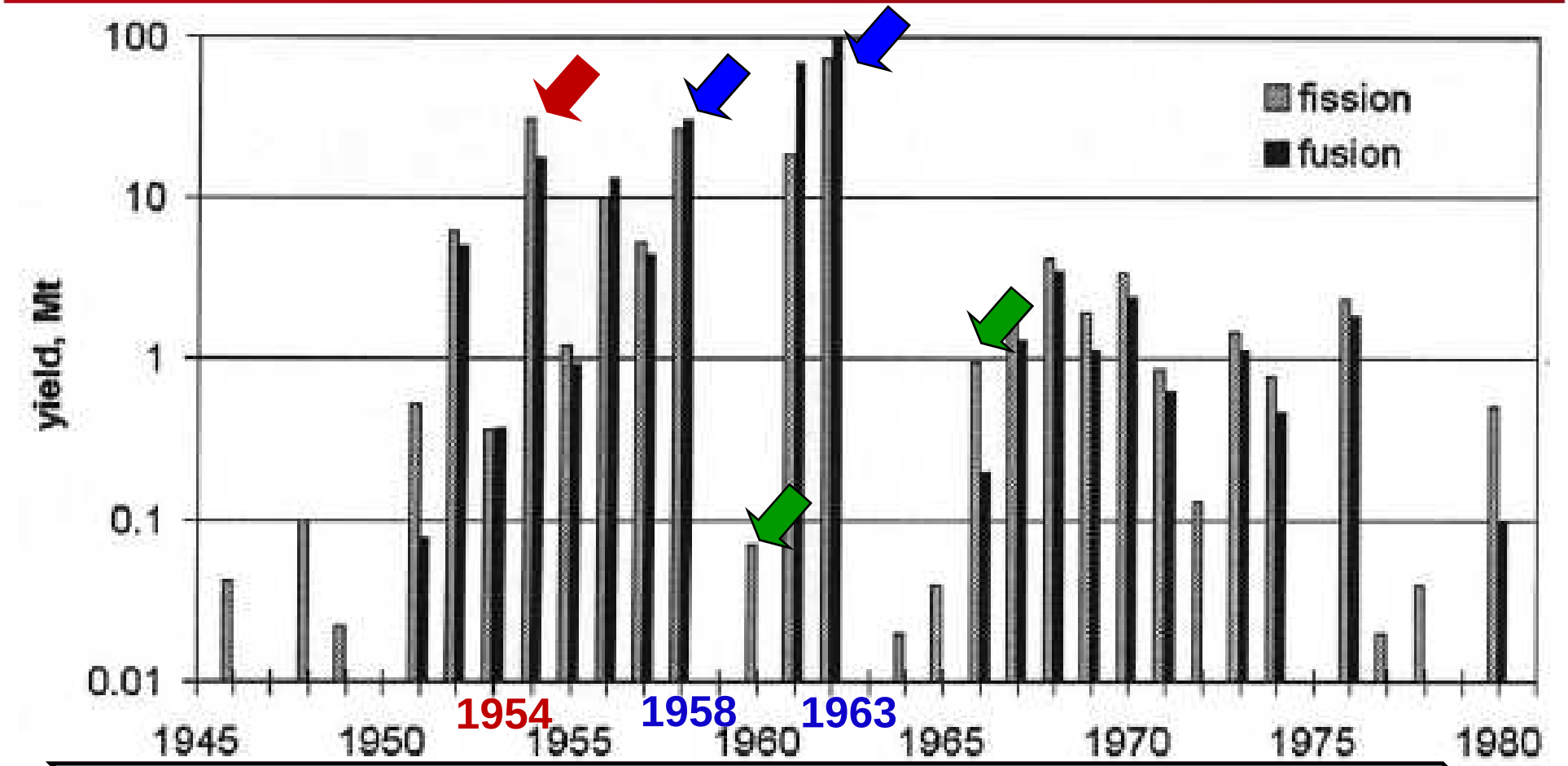


Fig.

L'augmentation de la puissance des essais d'explosions conduit à une inquiétude grandissante et une activité diplomatique visant à les limiter et ralentir la course aux armements nucléaires

DATES CLEFS

18 octobre 1945: Création du Commissariat à l'énergie atomique

1950: Création de la Commission internationale de protection radiologique

1951: Premières recommandations de la CIPR: dose admissible recommandée de 0,3 roentgen/semaine (30 Gray) de travail pour les rayons X et gamma

Mars 1954 : *Essai Castle Bravo sur l'atoll de Bikini*

- **Le système de radioprotection des population et des travailleurs se met en place progressivement aux niveaux national et international**
- **Prise de conscience des risques potentiels d'accidents technologiques et de l'importance de la surveillance de l'environnement**

13 novembre 1956: Création du Service central de protection contre les radiations ionisantes (SCPRI)

Juillet 1957: Création de l'Agence internationale de l'énergie atomique

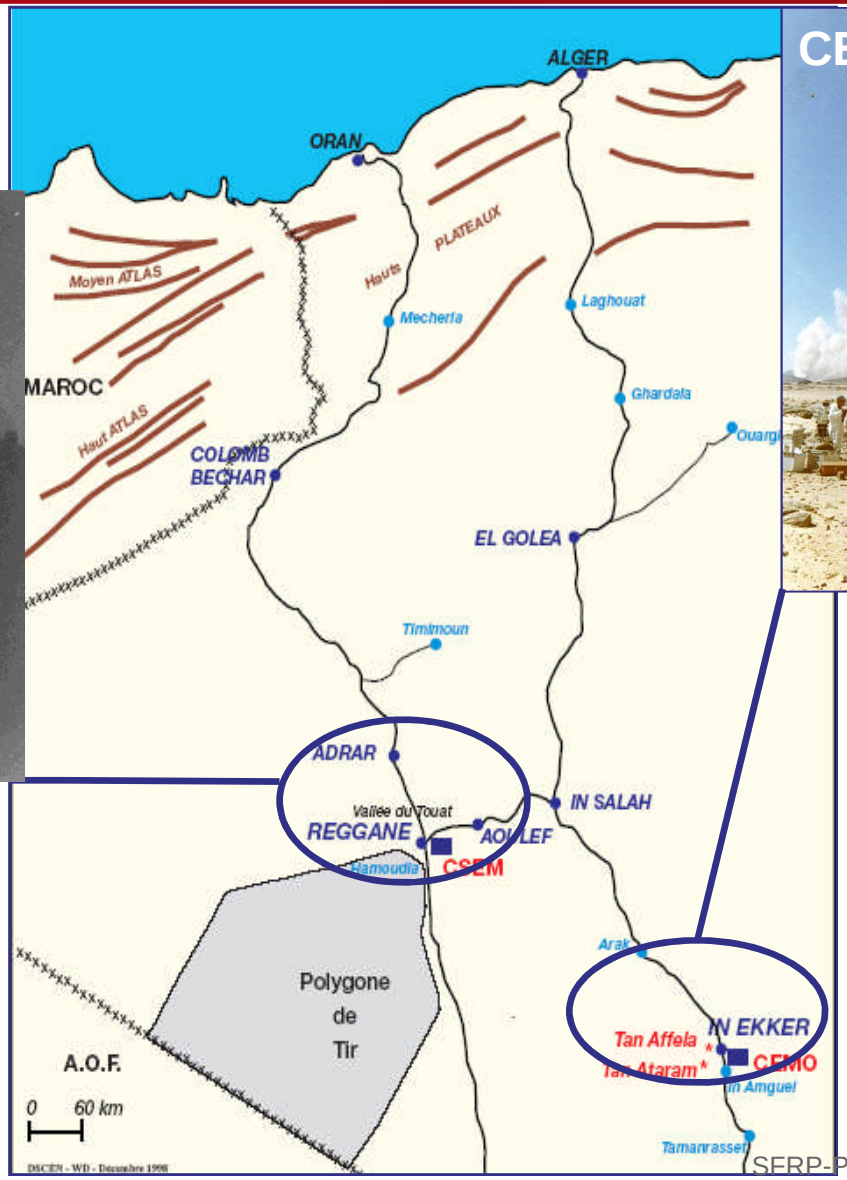
Octobre 1957*: Accident du réacteur britannique installé à Windscale conduit à des retombées atmosphériques sur l'Europe*

1 janvier 1958: traité l'Euratom Normes de base **relatives à la protection sanitaire de la population et des travailleurs contre les dangers résultant des rayonnements ionisants** (**1959 :** Directive fondatrice 359/59)

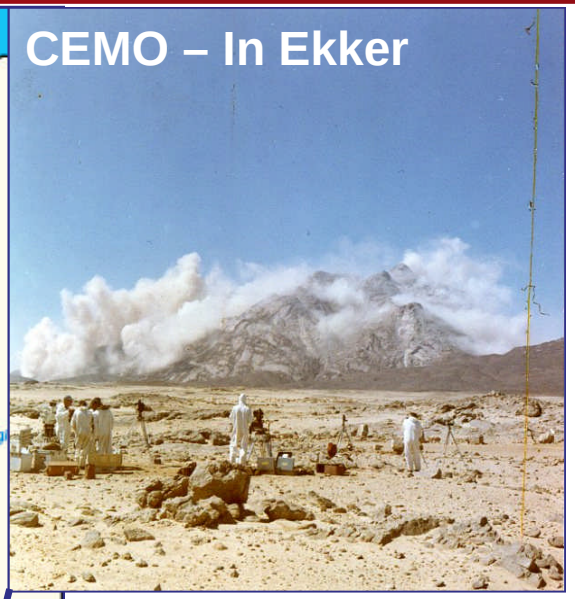
SURVEILLANCE RADIOLOGIQUE SITES ALGÉRIENS

Du 13 février 1960
au 25 avril 1961

- 4 essais atmosphériques (Gerboises)
- Essais de sécurité



CEMO – In Ekker



Du 7 novembre 1961
au 16 février 1966

- **13 essais souterrains en galerie**
- **Essais de sécurité**

SURVEILLANCE RADIOLOGIQUE SITES ALGÉRIENS

REPRODUCED AT THE NATIONAL ARCHIVES

DECLASS
Authority NND
By SMB NARA
No.

No.

SECRET

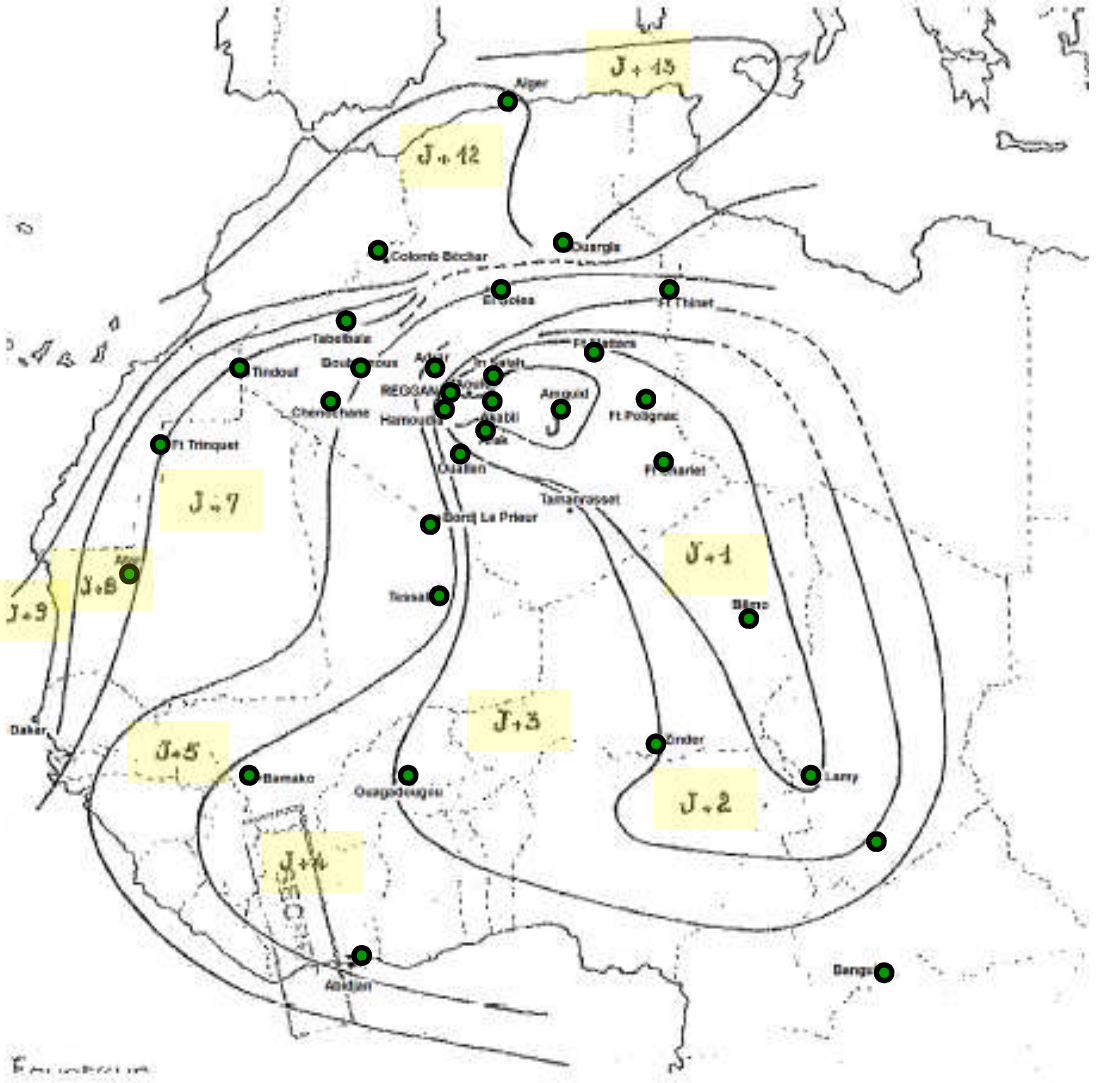
AFN - Mr. Witman, II

AFN - Richard St. F. Post

Coverage of French Underground Tests

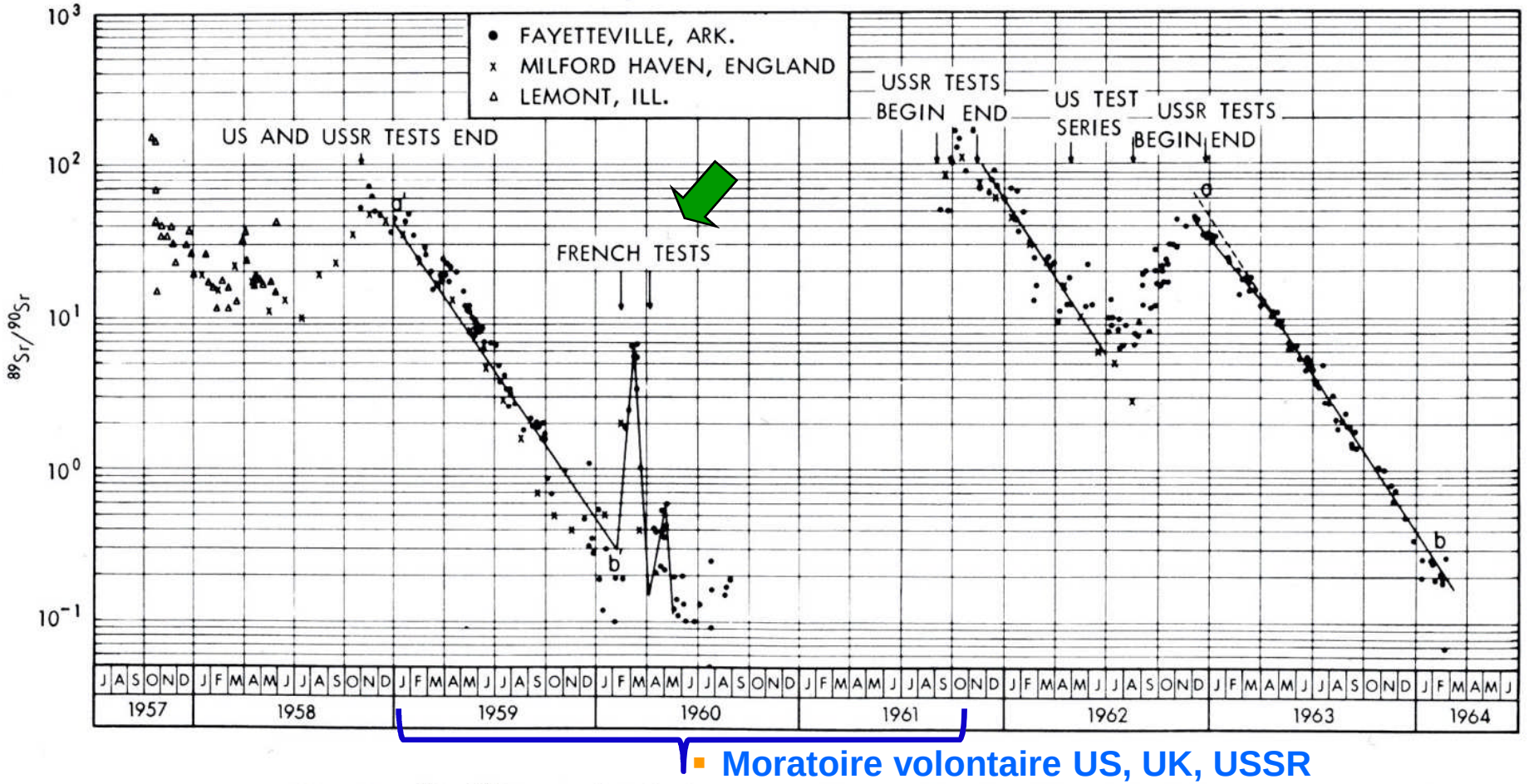
I attended a meeting today in the office
Atomic Energy and Outer Space (S/AE) to explo
three stations of the U. S. Atomic Energy Det
to Algeria to cover French underground atomic
reliable intelligence source, will be taking
March 1952.

Col. L. B. Williams of S/AE opened the m
of the proposal, which is expected to yield i
the effectiveness of our underground detectio
description of the types of equipment needed
William Jones of UNP expressed in rather forc
should any U. S. connection with French tests
to the charge, particularly from the Russians
the French tests as a device for securing inf
have therefore not lived up to our self-impos
Mr. Robert Foulon, speaking for AF, noted als
get from African states in general, since the
Africa be a nuclear-free zone. Mr. Jesse M.
proceeded to point out that two of the propos
stations, Mali and Niger, must be excluded fo
would it be almost impossible to conceal such
these two countries, but also it would appear
approval of these two governments before proceeding, and such approval is
likely to be withheld.



Gerboise Bleue. Chronologie des retombées lointaines (document déclassifié 27/154)

SURVEILLANCE RADIOLOGIQUE SITES ALGÉRIENS

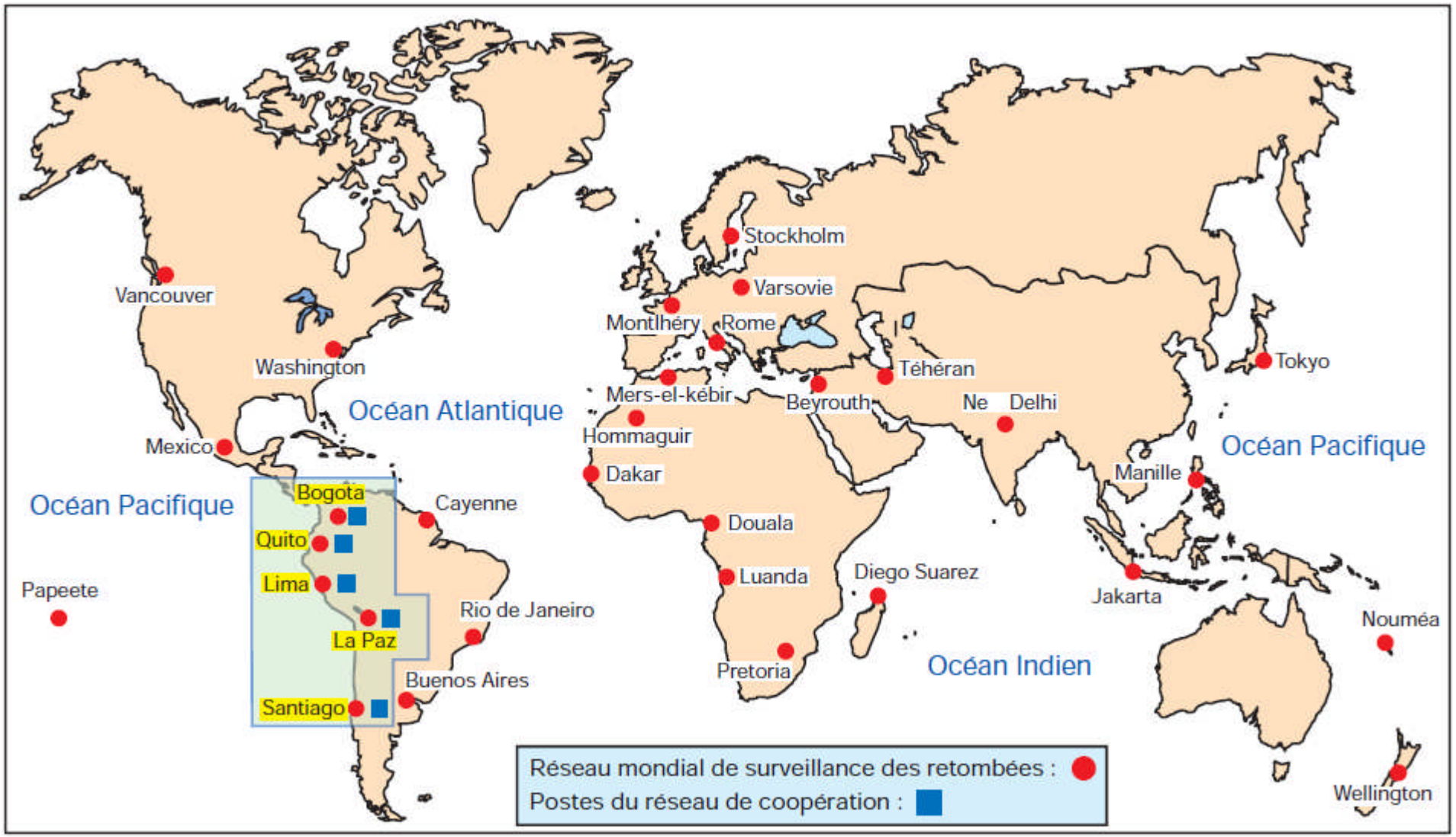


▪ **Moratoire volontaire US, UK, USSR**

Fig. 3—$^{89}Sr/^{90}Sr$ in individual rain samples at Fayetteville, Ark., Milford Haven, England, and Lemont, Ill.

Source:

SURVEILLANCE RADIOLOGIQUE EN POLYNESIE



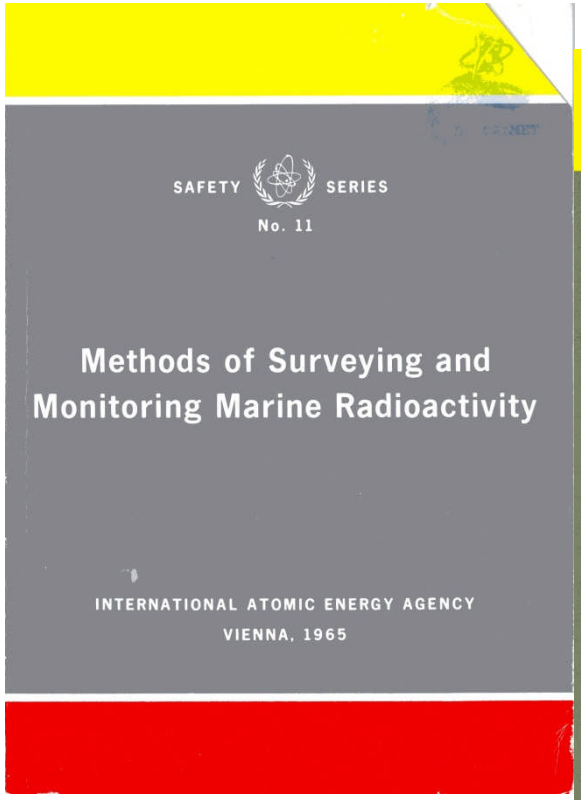
Source: La dimension radiologique des essais nucléaires français en Polynésie

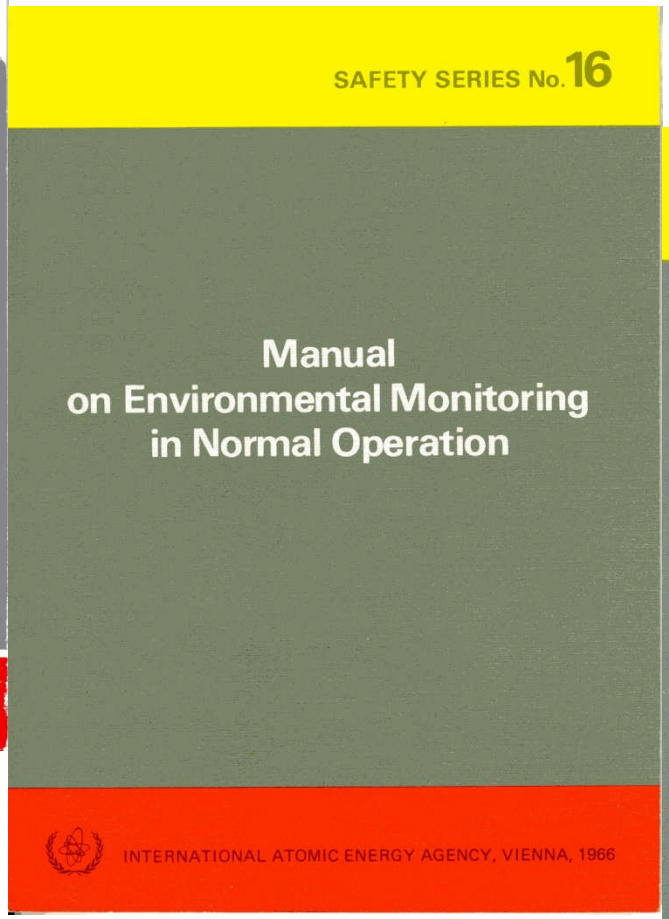
SURVEILLANCE RADIOLOGIQUE EN POLYNESIE

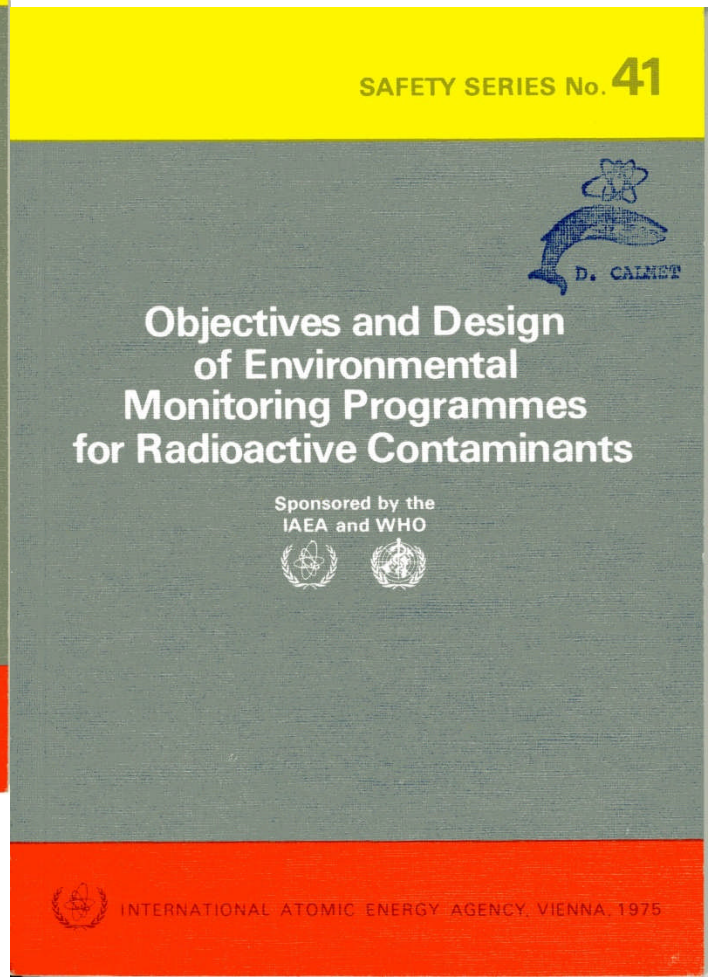
http://www-dam.cea.fr/dossiers/Mururoa/img/La_dimension_radiologique_des_essais_nucleaires_francais_en_Polynesie.pdf

Source: La dimension radiologique des essais nucléaires français en Polynésie

RECOMMANDATIONS INTERNATIONALES (AIEA)

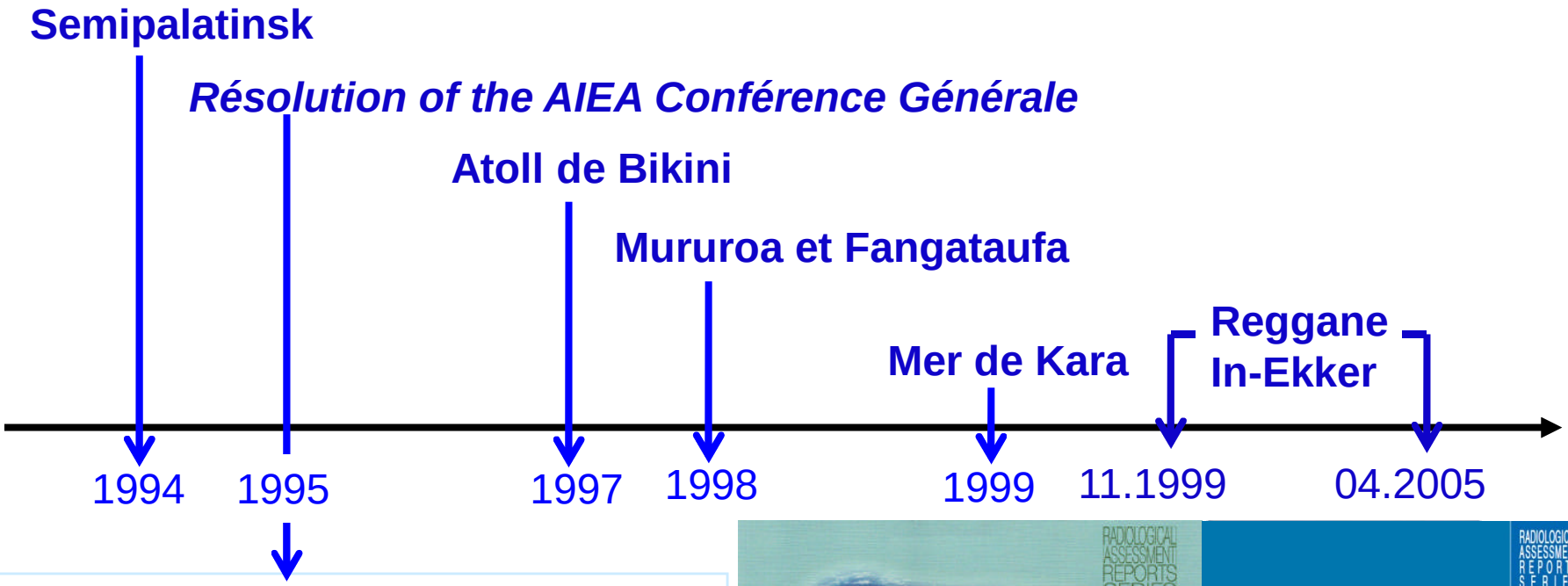




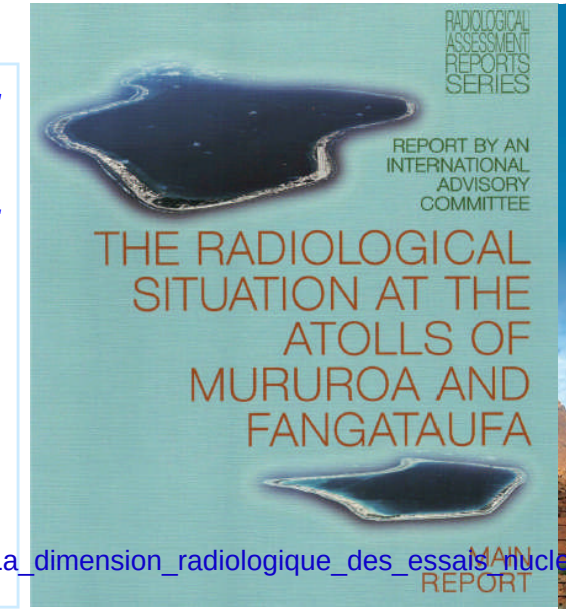


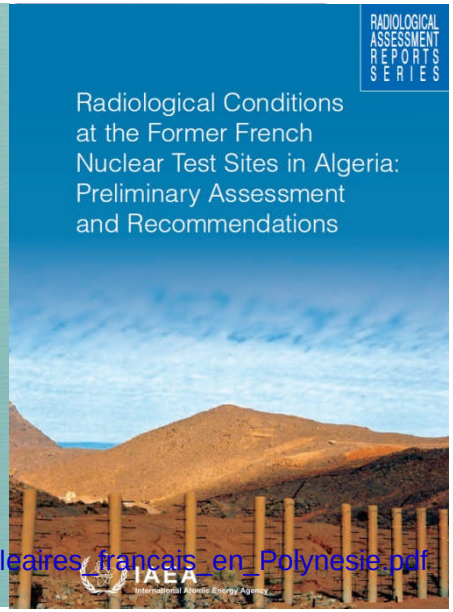
REF.: LE ROY, 2011

Situation radiologique des sites (AIEA)



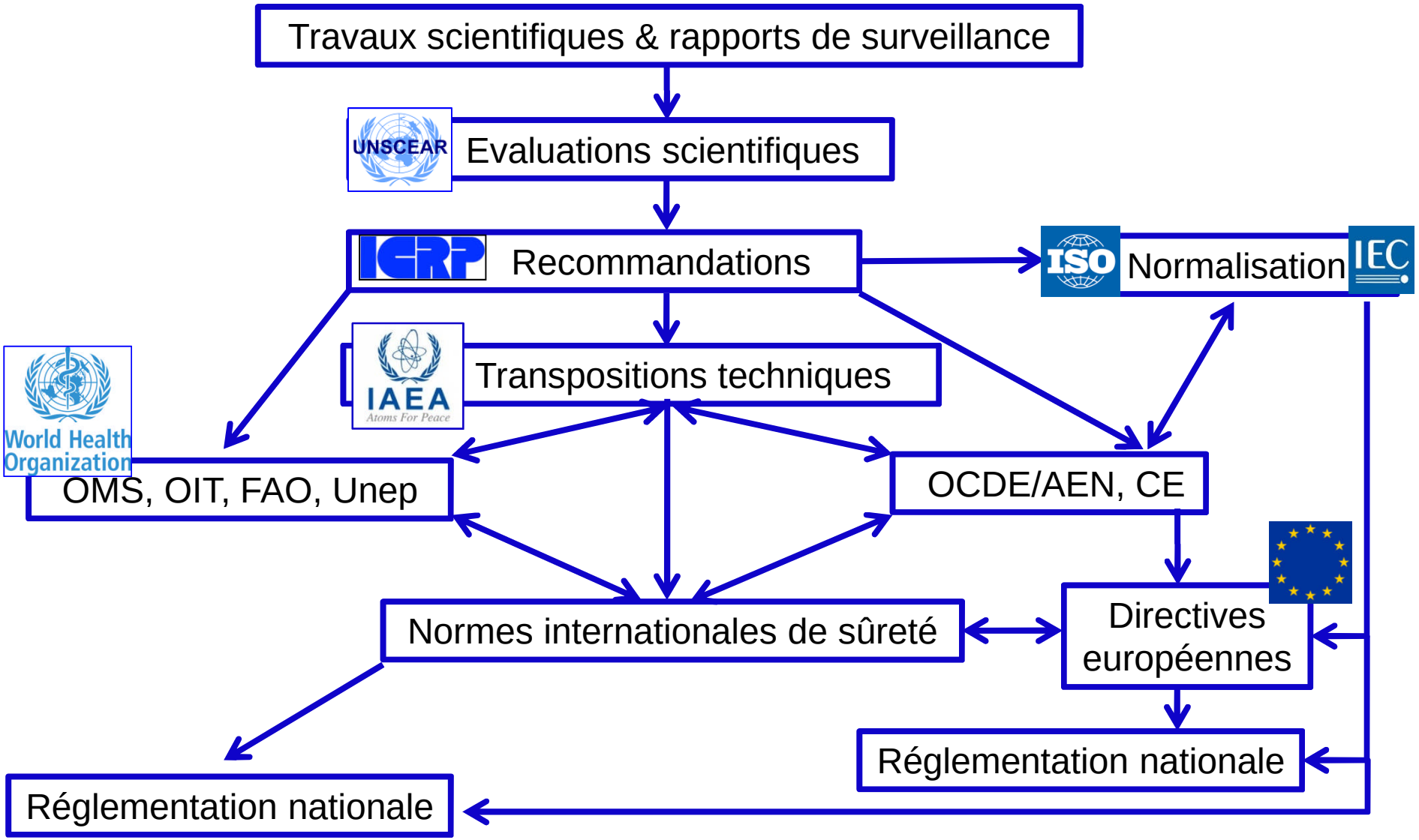
"de remplir leur responsabilité pour assurer que les sites où ont eu lieu des essais nucléaires sont surveillés correctement et que les mesures appropriées sont prises pour éviter que ces essais nucléaires conduisent à des impacts négatifs sur la santé, la sureté et l'environnement."



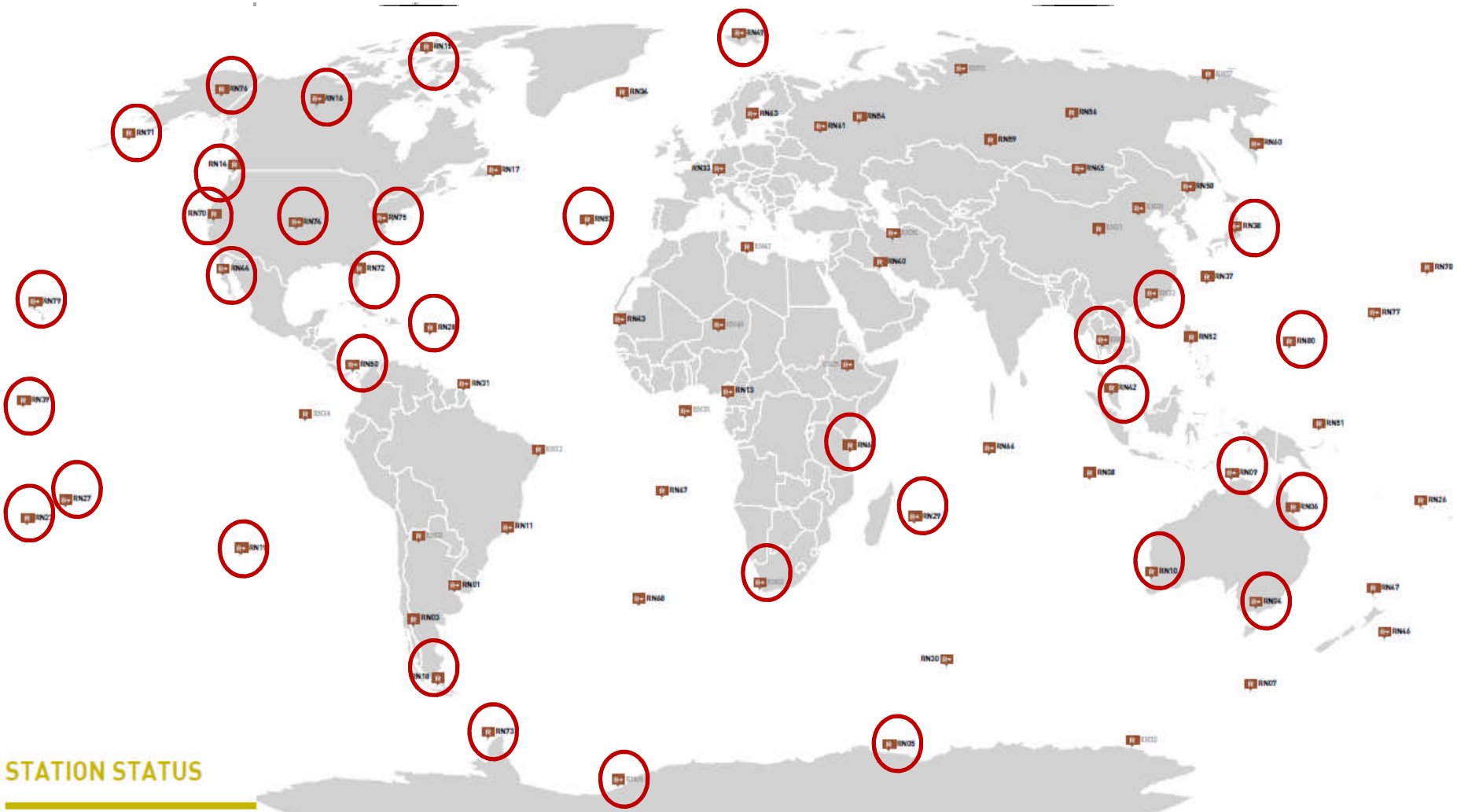


Source : AIEA - http://www.dam.cea.fr/dossiers/Mururoa/img/La_dimension_radiologique_des_essais_nucleaires_francais_en_Polynesie.pdf

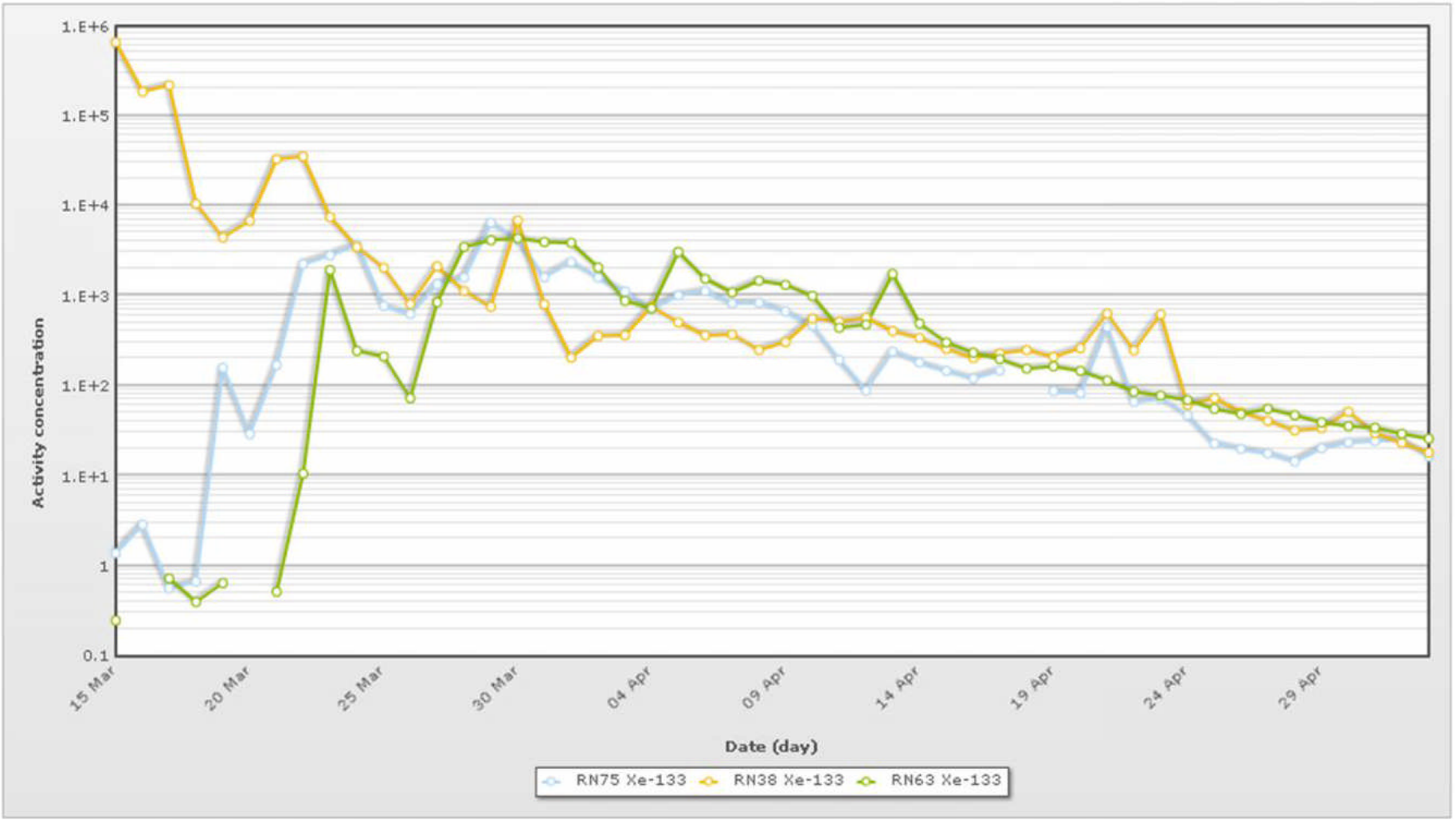
RELATIONS ENTRE ORGANISATIONS INTERNATIONALES



SURVEILLANCE RADIOLOGIQUE OTICE (1996)



OTICE : FUKUSHIMA XENON-133 (mBq/m³)



RN38, Takasaki, Japan *RN63, Stockholm, Sweden* *RN75, Charlottesville, USA*

Merci de votre attention

« Dans la vie rien n'est à craindre, tout est à comprendre »

Marie Curie

SFRP-Paris | 5 novembre 2015

Commissariat à l'énergie atomique et aux énergies alternatives
Centre de Fontenay aux Roses | 18, route du Panorama
92265 Fontenay aux Roses Cedex
France

T. +33 (0)1 46 54 75 02 | Fax. +33 (0)1 46 54 94 37

Risk Control Sector
Nuclear Safety and Protection Division