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File III

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W. E. Cohn

Date August 18, 1945

Subject ISOTOPE PRODUCTION

To R. L. Doan

From W. E. Cohn

Before reading this document, sign and date below

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FILE "ISOTOPES"

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FOLDER Isotopes

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August 18, 1945
(CL-WEC-1)

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To: R. L. Doan

From: W. E. Cohn

Re: ISOTOPE PRODUCTION

Two questions have been asked:

I. Of what use are isotopes?

II. What isotopes can this project prepare for these uses with existing or projected facilities?

As the section which has been most concerned with the production, separation, preparation and utility of a variety of such materials, C-IV feels a definite responsibility for examining the field and making specific recommendations, insofar as it is able, as to how the various aspects may be approached and studied. Furthermore, radioisotope production and utilization has been one of my major interests during the last eight years, as various memos will testify (see Cohn to Allison, 1/27/44; Cohn to Memo 10/30/44). I indicate below the considerations which this section deems essential to a proper evaluation of the field and outline the method by which we are proceeding to define the project's position.

I. Uses of Isotopes

A. General Considerations

While there is a considerable amount of experience in the scientific and technological world in the use of radioisotopes, the potentialities have not been explored to an appreciable extent. These materials offer new tools to science; each one

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discovered constitutes such a tool in ways which may not be obvious. Specialized thinking and consultation is essential if waste, frustration and physical danger are to be avoided and if the maximum usefulness is to be approached. Without going to extreme lengths, we outline below the criteria by which an isotope may be evaluated with respect to any contemplated use, whether this use be general or specific.

1. Isotopic purity (carrier; other isotopes; chains) before and after disintegration.

2. Chemical state (properties; forms; purity) before and after disintegration (including organic molecules).

3. Amounts available (grams, curies) from working units (cross-sections; existing processes).

4. Radiation characteristics, if any, of self and daughters, if any (period; radiations; energies), which influence production, transportation, utility, measurements, safety precautions, etc.

5. Production methods and facilities: status in relation to above criteria.

6. Control over use (safety, scarcity, maximum usefulness, responsibilities).

B. Uses and Potential Demand

1. Tracer in biological, chemical, industrial work.

   a. To investigate mechanisms, pathways, rates, equilibria.

   b. To aid or simplify analysis.

   c. To locate material (e.g., radioautograph)

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2. Radiobiological work

   a. Investigation of biological effects of radiation, of mechanism of action.

   b. Medical: diagnostic and therapeutic; internally or externally applied; physically or radiochemically measured.

3. Radiographic work: medical (see 2 above), industrial.

4. Radiation chemistry work (Hyperphoto chemistry): effects of radiation on self, on substrate, on catalysts (source of radiation energy and recoil energy).

5. Physics research, with active or inactive isotopes (γ, n and other reactions; energetics; pure isotopes; new elements, etc.).

6. Chemistry research (see 1 and 4 above; pure isotopes; new elements; recoil phenomena; etc.).

In view of these essential criteria, it is clear that the correct answer to question 2 cannot be stated by a mere listing of isotopes or of elements, even if all the possible isotopes which can be produced by our piles were known. However, the approach to the compilation of such a list should be made by listing all those isotopes which can be made in detectable quantity. This list can be made by a consideration of the <u>types of nuclear reactions</u> by which an isotope may be produced.

II. Isotopes Produced (stable or unstable, before or after decay; knowledge of cross-sections, decay constants, chain relationships, mass numbers, chemistry, radiations, pile fluxes, resonance levels, etc., necessary).

   1. Fission products (of U, Pu, Th and of lighter elements)

   2. First order n-reactions: (n, γ), (n, p), (n,α), etc., reactions on stable nuclei with slow neutrons and various fast neutrons (U, Li + D fasts, etc.), with or without Szilard-Chalmers process.

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[redacted]

3. Higher order n-reactions: $(n,\gamma)(n,\gamma)$; $(n,p)(n,\gamma)$; etc. (Probably unimportant in present piles).

4. Other pile-produced projectiles (tritons, recoil nuclei, α-particles, etc.); unexplored except for t,n reaction.

5. Proton, deuteron and α-particle reactions (use other instruments: cyclotron, etc.).

6. Beta and gamma ray reactions (minor importance).

We realize full well that this is a long-range, large-scale undertaking that will never be completed. We can, at this time, furnish some information about some isotopes and make calculations and guesses about others. I am also prepared to make some predictions as to the actual existing demand for certain isotopes in specific fields with which I have been associated, together with estimates as to how this demand may be met.

W. E. Cohn

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