[The isotope sluice was an alternative form of gaseous diffusion invented by Erich Bagge. The principle was that in a beam of energetic uranium atoms/ions/molecules, lighter U-235 would travel slightly faster than heavier U-238. If that beam had to traverse a series of portals that quickly opened and closed with the right timing, the faster U-235 would be more likely to make it through than the slower U-238. The portals were generally holes in rapidly spinning disks. Because the isotope sluice involved energetic uranium beams and high-speed rotating machinery, it also had some characteristics of electromagnetic separators and centrifuges. Bagge led a team that successfully demonstrated isotope sluice prototypes during the war, and he tried unsuccessfully to attract enough support for the approach in the European nuclear industry after the war.

See pp. 3653–3662.]

Background investigation of Erich Bagge. 7 April 1952 [NARA RG 330, Entry A1-1B, Box 6, Folder Bagge, Erich]

On 28 March 1952, Frau Charlotte PRAGER nee BRINKMANN, a German national... now residing in BERLIN-Dahlem, Boltzmannstr. 19, was interviewed, and stated substantially as follows: BAGGE had lived in the neighborhood in 1941 with his wife and two (2) children. BAGGE worked in the Kaiser Wilhelm Institute for Physics; however, SOURCE was not sure what type of work BAGGE performed. In 1944, BAGGE and his family presumably departed for VIENNA (O49/X49), Austria. Since this time SOURCE has never seen or heard about BAGGE. [...]

[Did Bagge help transition his uranium-235 enrichment system to industrial-scale production someplace in Austria, such as at Gusen?]

Erich Bagge and Karl-Friedrich Leisinger. Patent DE1058024. Vorrichtung zur Trennung von Isotopen mit der Isotopenschleuse in der Gasphase. [Device for the Separation of Isotopes with the Isotope Sluice in the Gas Phase.] Filed 6 May 1955.

Es ist möglich, Isotope mit Hilfe der Isotopenschleuse nach einem von E. Bagge entwickelten Verfahren zu trennen. Die Methode besteht darin, daß man sich für das zu trennende Isotopengemisch einen Atom- oder Molekularstrahl herstellt, welcher ein System von intermittierenden Blenden durchsetzen muß. Die Blenden sind so eingerichtet, daß durch periodisches Öffnen und Schließen der Atom- oder Molekularstrahl in kleine Wölkchen zerhackt wird.

Die Wölkchen müssen dann über eine kurze Wegstrecke durch den Raum fliegen, wobei sich eine teilweise Trennung der Isotope vollzieht, indem sich die leichteren und dadurch schnelleren Teilchen an den Kopf des Wölkchens setzen, während die schwereren zurückbleiben. Das zweite Blendsystem sorgt dafür, daß die Wölkchen abermals zerteilt werden, indem die Spitze durchgelassen wird, während der Rest des Wölkchens zwischen den Blenden zurückbleibt. Auf diese Weise ist es möglich, aus dem ursprünglichen Atomstrahl einen neuen intermittierenden Strahl zu gewinnen, in dem die leichteren Isotope angereichert sind. Zur Ausbildung des primären Atomstrahls wird vor die erste intermittierende Blende eine raumfeste oder ein ganzes System räumlich feststehender Blenden gebracht. Das Verfahren, das sich in dieser Form auf Atomstrahlen leicht kondensierbarer Metalldämpfe mit Erfolg anwenden läßt, kann auch auf Gase übertragen werden.

It is possible to separate isotopes by means of the isotope sluice according to a method developed by E. Bagge. The method consists in producing an atomic or molecular beam for the isotope mixture to be separated, which must enforce a system of intermittent diaphragms. The apertures are arranged so that the atomic or molecular beam is chopped into small clouds by periodically opening and closing.

The small clouds then have to fly over a short distance through space, with a partial separation of the isotopes takes place by the lighter and thus faster particles sit on the head of the cloud, while the heavier remain behind. The second blend system causes the clouds to be split again by letting the tip through while leaving the rest of the cloud between the baffles. In this way, it is possible to obtain from the original atomic beam a new intermittent beam in which the lighter isotopes are enriched. To form the primary atom beam, a space-fixed or an entire system of spatially fixed diaphragms is brought before the first intermittent diaphragm. The method, which can be successfully applied in this form to atomic beams of easily condensable metal vapors, can also be applied to gases.

G 124 (ref. no. 3)

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Über die Möglichkeit ~~zur~~ einer Anreicherung der leichten Uranisotope mit der Isotopenschleuse.

Von E. Bagge.

In einer früheren Mitteilung[1] wurde ein Verfahren angegeben, mit dem es möglich sein muss, in einem Isotcpengemisch die Gruppe der leichteren oder die der schwereren Partner anzureichern und dabei gleichzeitig zu technisch verwertbaren Mengen des gewünschten Stoffes zu gelangen. Es soll in dieser Arbeit die Leistungsfähigkeit der Methode im Hinblick auf eine Anreicherung der leichten Uranisotope kurz besprochen werden.

1.) Die Isotopenschleuse.

Die Anreicherungsmethode besteht darin, dass man einen Dampfstrahl des Isotopengemisches durch ein Blendensystem hindurchsendet, das von zwei rotierenden Scheiben gebildet wird. (sh. Abb. 1)

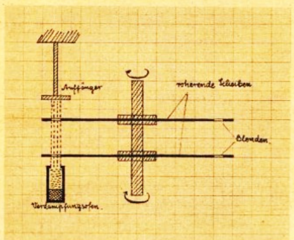


Abbildung 1

[1] E.Bagge: Ein rasch arbeitendes Verfahren zur Entmischung von Isotopen. (Bericht eingereicht im April 1941).

- 2 -

Umlaufszahl und Anordnung der Löcher auf den Scheiben müssen so eingerichtet sein, dass alle Atome, deren Geschwindigkeiten grösser sind als eine vorgegebene Geschwindigkeit V_o, durch das Blendensystem hindurchgelassen werden und den Auffänger erreichen können, während die Atome mit geringerer Geschwindigkeit zwischen den Scheiben aufgefangen werden. Dies führt infolge der verschiedenen Geschwindigkeitsverteilungen der isotopen Atcmarten im Dampfstrahl unmittelbar zu einer Anreicherung der leichten Isotopen auf dem Auffänger.

Man erkennt dies leicht an den in Abb. 2 wiedergegebenen

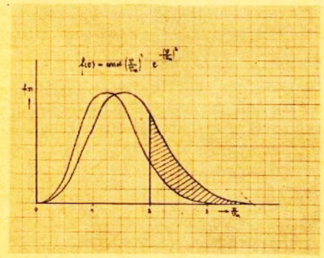


Abbildung 2.

Verteilungsfunktionen für zwei Isotopenarten. Die Atome mit der kleineren Massenzahl haben im Dampfstrahl im Mittel eine etwas grössere Geschwindigkeit als die schwereren. Ihre Verteilungsfunktion ist darum in dieser Richtung verschoben. Schneidet man jetzt beide Verteilungsfunktionen oberhalb einer gewissen Geschwindigkeit ab (in der Abb. oberhalb $\frac{v_o}{v_m} = 2$), sc erhält man eine Anreicherung der leichteren Isotope, wie sie in Abb. 2 der schraffierten Fläche entspricht.

- 3 -

2.) Trenneffekt und ideale Ausbeute.

Der Betrag des Trenneffektes lässt sich unmittelbar berechnen. Die Geschwindigkeitsverteilung der Atome im Dampfstrom ist gegeben durch:

$$f(v)\,dv = 2\,\frac{v^3}{v_m^3}\,e^{-\frac{v^2}{v_m^2}}\,\frac{dv}{v_m} \qquad (1)$$

Dabei ist V_m bestimmt durch die Bedingung:

$$\frac{m v_m^2}{2kT} = 1 \qquad (2)$$

Massgebend für den Trenneffekt und die ideale Ausbeute ist jetzt das Integral:

$$A = \int_{v_o}^{\infty} f(v)\,dv = \left(1+\frac{v_o^2}{v_m^2}\right) e^{-\frac{v_o^2}{v_m^2}} \qquad (3)$$

Die Grenzen des Integrals sind dabei den Verhältnissen angepasst, wie sie durch die Wirkung des rotierenden Blendensystems auf den Dampfstrahl entstehen. Die Grösse A gibt im Falle des Urans, bei dem ja das Isotop ^{238}U in überwiegender Menge vorhanden ist, unmittelbar an, welcher Teil der Atome, die den Zwischenraum zwischen dem rotierenden Blenden erreichen, auch zum Auffänger gelangen. Sie stellt also die ideale Ausbeute dar. Die praktische Ausbeute hingegen, das Verhältnis der am Auffänger niedergeschlagenen Menge zur Menge des verdampften Urans, ist noch um einen Faktor kleiner, der durch die geometrischen Bedingungen der Strahlerzeugung bestimmt ist.

Der Trenneffekt τ für zwei verschiedene Isotopensorten folgt jetzt aus dem Verhältnis der entsprechenden Integrale (3) für die beiden Atomarten. Man bildet dazu zweckmässig den Ausdruck:

$$\tau = 1 - \frac{A_1}{A_2} = 1 - \frac{1+\frac{v_o^2}{v_{m1}^2}}{1+\frac{v_o^2}{v_{m2}^2}}\,e^{-v_o^2\left(\frac{1}{v_{m1}^2}-\frac{1}{v_{m2}^2}\right)} \qquad (4)$$

Da bei Uran die Massen der verschiedenen Isotope nur um kleine Beträge im Verhältnis zu ihrer Gesamtmasse verschieden

- 4 -

sind, kann man den Ausdruck (4) nach der Massendifferenz $\Delta m = m_2 - m_1$ unter Berücksichtigung von (2) entwickeln und erhält in ausreichender Näherung:

$$\tau = \frac{\Delta m}{m}\,\frac{\left(\frac{v_o}{v_m}\right)^4}{1+\left(\frac{v_o}{v_m}\right)^2} \qquad (5)$$

$$\approx \frac{\Delta m}{m}\,\frac{v_o^2}{v_m^2} \quad \text{für} \quad v_o \gg v_m \qquad (5a)$$

Während also nach (3) die Ausbeute A mit wachsendem V_o exponentiell abnimmt, steigt der Trenneffekt τ nach (5a) quadratisch mit der Abschneidegeschwindigkeit an.

Die durch die Formeln (3) und (5) beschriebenen Verhältnisse sind für die beiden Atomsorten ^{235}U und ^{238}U in der Abb. 3

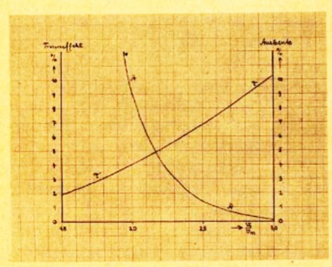
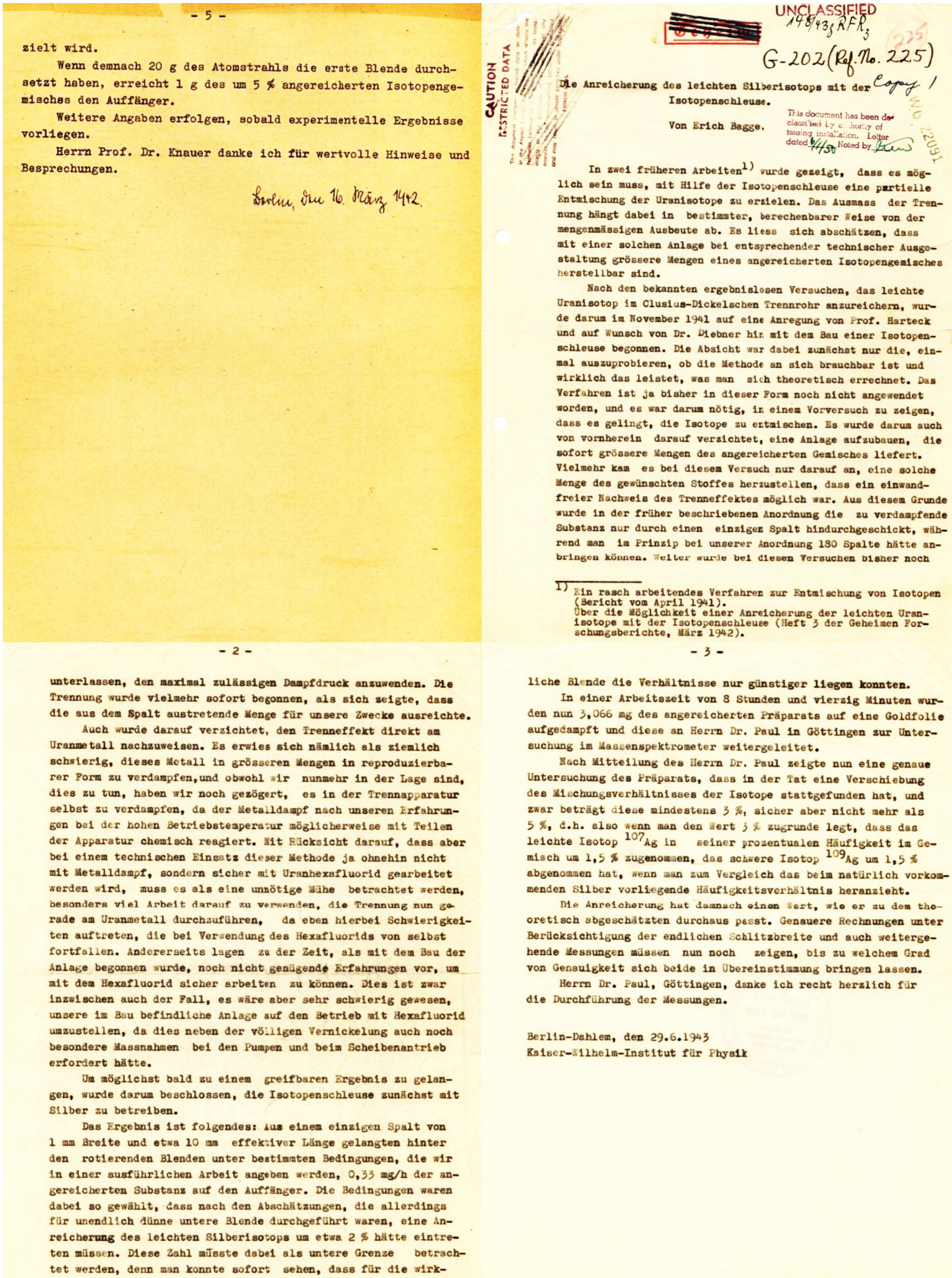


Abbildung 3.

eingetragen. Trenneffekt und Ausbeute sind unmittelbar in Prozenten angegeben, und man sieht z.B., dass bei einer Anreicherung um 5 %, das heisst bei einem Anheben des Isotopenverhältnisses von 140:1 auf 133:1, eine Ausbeute von auch etwa 5 % er-

Figure D.245: During the war, Erich Bagge led a team that invented, built, and demonstrated the "isotope sluice," an alternative form of gaseous diffusion enrichment [G-124].



\- 5 -

zielt wird.

Wenn demnach 20 g des Atomstrahls die erste Blende durchsetzt haben, erreicht 1 g des um 5 % angereicherten Isotopengemisches den Auffänger.

Weitere Angaben erfolgen, sobald experimentelle Ergebnisse vorliegen.

Herrn Prof. Dr. Knauer danke ich für wertvolle Hinweise und Besprechungen.

Berlin, den 16. März 1942.

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Die Anreicherung des leichten Silberisotops mit der Isotopenschleuse.

Von Erich Bagge.

In zwei früheren Arbeiten[1] wurde gezeigt, dass es möglich sein muss, mit Hilfe der Isotopenschleuse eine partielle Entmischung der Uranisotope zu erzielen. Das Ausmass der Trennung hängt dabei in bestimmter, berechenbarer Weise von der mengenmässigen Ausbeute ab. Es liess sich abschätzen, dass mit einer solchen Anlage bei entsprechender technischer Ausgestaltung grössere Mengen eines angereicherten Isotopengemisches herstellbar sind.

Nach den bekannten ergebnislosen Versuchen, das leichte Uranisotop im Clusius-Dickelschen Trennrohr anzureichern, wurde darum im November 1941 auf eine Anregung von Prof. Harteck und auf Wunsch von Dr. Diebner hin mit dem Bau einer Isotopenschleuse begonnen. Die Absicht war dabei zunächst nur die, einmal auszuprobieren, ob die Methode an sich brauchbar ist und wirklich das leistet, was man sich theoretisch errechnet. Das Verfahren ist ja bisher in dieser Form noch nicht angewendet worden, und es war darum nötig, in einem Vorversuch zu zeigen, dass es gelingt, die Isotope zu entmischen. Es wurde darum auch von vornherein darauf verzichtet, eine Anlage aufzubauen, die sofort grössere Mengen des angereicherten Gemisches liefert. Vielmehr kam es bei diesem Versuch nur darauf an, eine solche Menge des gewünschten Stoffes herzustellen, dass ein einwandfreier Nachweis des Trenneffektes möglich war. Aus diesem Grunde wurde in der früher beschriebenen Anordnung die zu verdampfende Substanz nur durch einen einzigen Spalt hindurchgeschickt, während man im Prinzip bei unserer Anordnung 180 Spalte hätte anbringen können. Weiter wurde bei diesen Versuchen bisher noch

1) Ein rasch arbeitendes Verfahren zur Entmischung von Isotopen (Bericht vom April 1941).
Über die Möglichkeit einer Anreicherung der leichten Uranisotope mit der Isotopenschleuse (Heft 3 der Geheimen Forschungsberichte, März 1942).

\- 2 -

unterlassen, den maximal zulässigen Dampfdruck anzuwenden. Die Trennung wurde vielmehr sofort begonnen, als sich zeigte, dass die aus dem Spalt austretende Menge für unsere Zwecke ausreichte.

Auch wurde darauf verzichtet, den Trenneffekt direkt am Uranmetall nachzuweisen. Es erwies sich nämlich als ziemlich schwierig, dieses Metall in grösseren Mengen in reproduzierbarer Form zu verdampfen, und obwohl wir nunmehr in der Lage sind, dies zu tun, haben wir noch gezögert, es in der Trennapparatur selbst zu verdampfen, da der Metalldampf nach unseren Erfahrungen bei der hohen Betriebstemperatur möglicherweise mit Teilen der Apparatur chemisch reagiert. Mit Rücksicht darauf, dass aber bei einem technischen Einsatz dieser Methode ja ohnehin nicht mit Metalldampf, sondern sicher mit Uranhexafluorid gearbeitet werden wird, muss es als eine unnötige Mühe betrachtet werden, besonders viel Arbeit darauf zu verwenden, die Trennung nun gerade am Uranmetall durchzuführen, da eben hierbei Schwierigkeiten auftreten, die bei Verwendung des Hexafluorids von selbst fortfallen. Andererseits lagen zu der Zeit, als mit dem Bau der Anlage begonnen wurde, noch nicht genügende Erfahrungen vor, um mit dem Hexafluorid sicher arbeiten zu können. Dies ist zwar inzwischen auch der Fall, es wäre aber sehr schwierig gewesen, unsere im Bau befindliche Anlage auf den Betrieb mit Hexafluorid umzustellen, da dies neben der völligen Vernickelung auch noch besondere Massnahmen bei den Pumpen und beim Scheibenantrieb erfordert hätte.

Um möglichst bald zu einem greifbaren Ergebnis zu gelangen, wurde darum beschlossen, die Isotopenschleuse zunächst mit Silber zu betreiben.

Das Ergebnis ist folgendes: Aus einem einzigen Spalt von 1 mm Breite und etwa 10 mm effektiver Länge gelangten hinter den rotierenden Blenden unter bestimmten Bedingungen, die wir in einer ausführlichen Arbeit angeben werden, 0,33 mg/h der angereicherten Substanz auf den Auffänger. Die Bedingungen waren dabei so gewählt, dass nach den Abschätzungen, die allerdings für unendlich dünne untere Blende durchgeführt waren, eine Anreicherung des leichten Silberisotops um etwa 2 % hätte eintreten müssen. Diese Zahl müsste dabei als untere Grenze betrachtet werden, denn man konnte sofort sehen, dass für die wirk-

\- 3 -

liche Blende die Verhältnisse nur günstiger liegen konnten.

In einer Arbeitszeit von 8 Stunden und vierzig Minuten wurden nun 3,066 mg des angereicherten Präparats auf eine Goldfolie aufgedampft und diese an Herrn Dr. Paul in Göttingen zur Untersuchung im Massenspektrometer weitergeleitet.

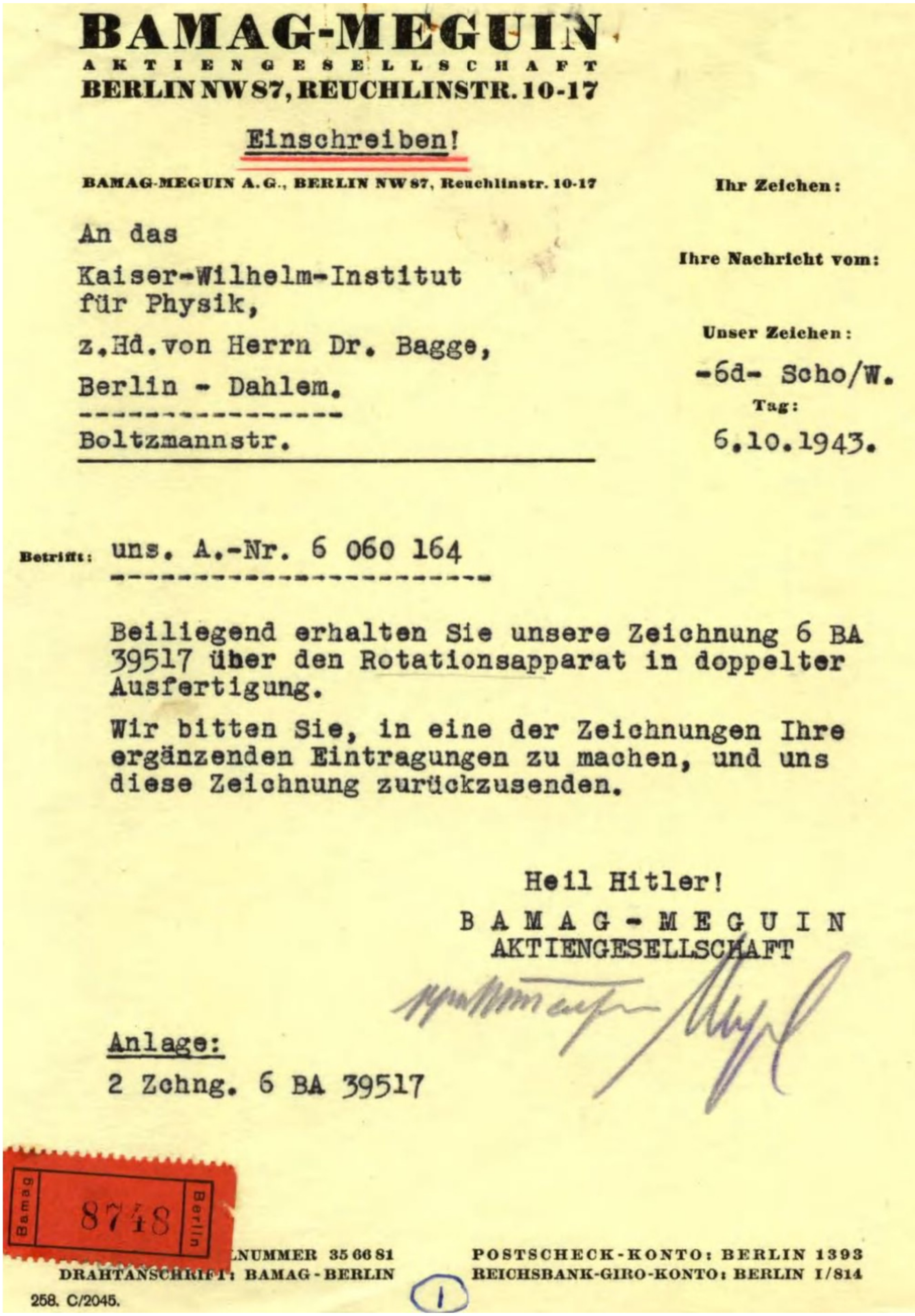
Nach Mitteilung des Herrn Dr. Paul zeigte nun eine genaue Untersuchung des Präparats, dass in der Tat eine Verschiebung des Mischungsverhältnisses der Isotope stattgefunden hat, und zwar beträgt diese mindestens 3 %, sicher aber nicht mehr als 5 %, d.h. also wenn man den Wert 3 % zugrunde legt, dass das leichte Isotop ^{107}Ag in seiner prozentualen Häufigkeit im Gemisch um 1,5 % zugenommen, das schwere Isotop ^{109}Ag um 1,5 % abgenommen hat, wenn man zum Vergleich das beim natürlich vorkommenden Silber vorliegende Häufigkeitsverhältnis heranzieht.

Die Anreicherung hat danach einen Wert, wie er zu dem theoretisch abgeschätzten durchaus passt. Genauere Rechnungen unter Berücksichtigung der endlichen Schlitzbreite und auch weitergehende Messungen müssen nun noch zeigen, bis zu welchem Grad von Genauigkeit sich beide in Übereinstimmung bringen lassen.

Herrn Dr. Paul, Göttingen, danke ich recht herzlich für die Durchführung der Messungen.

Berlin-Dahlem, den 29.6.1943
Kaiser-Wilhelm-Institut für Physik

Figure D.246: During the war, Erich Bagge led a team that invented, built, and demonstrated the "isotope sluice," an alternative form of gaseous diffusion enrichment [G-124; G-202].



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Berlin - Dahlem.
Boltzmannstr.

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Figure D.247: During the war, Erich Bagge led a team that invented, built, and demonstrated the "isotope sluice," an alternative form of gaseous diffusion enrichment [https://digital.deutsches-museum.de/item/FA-002-782/].

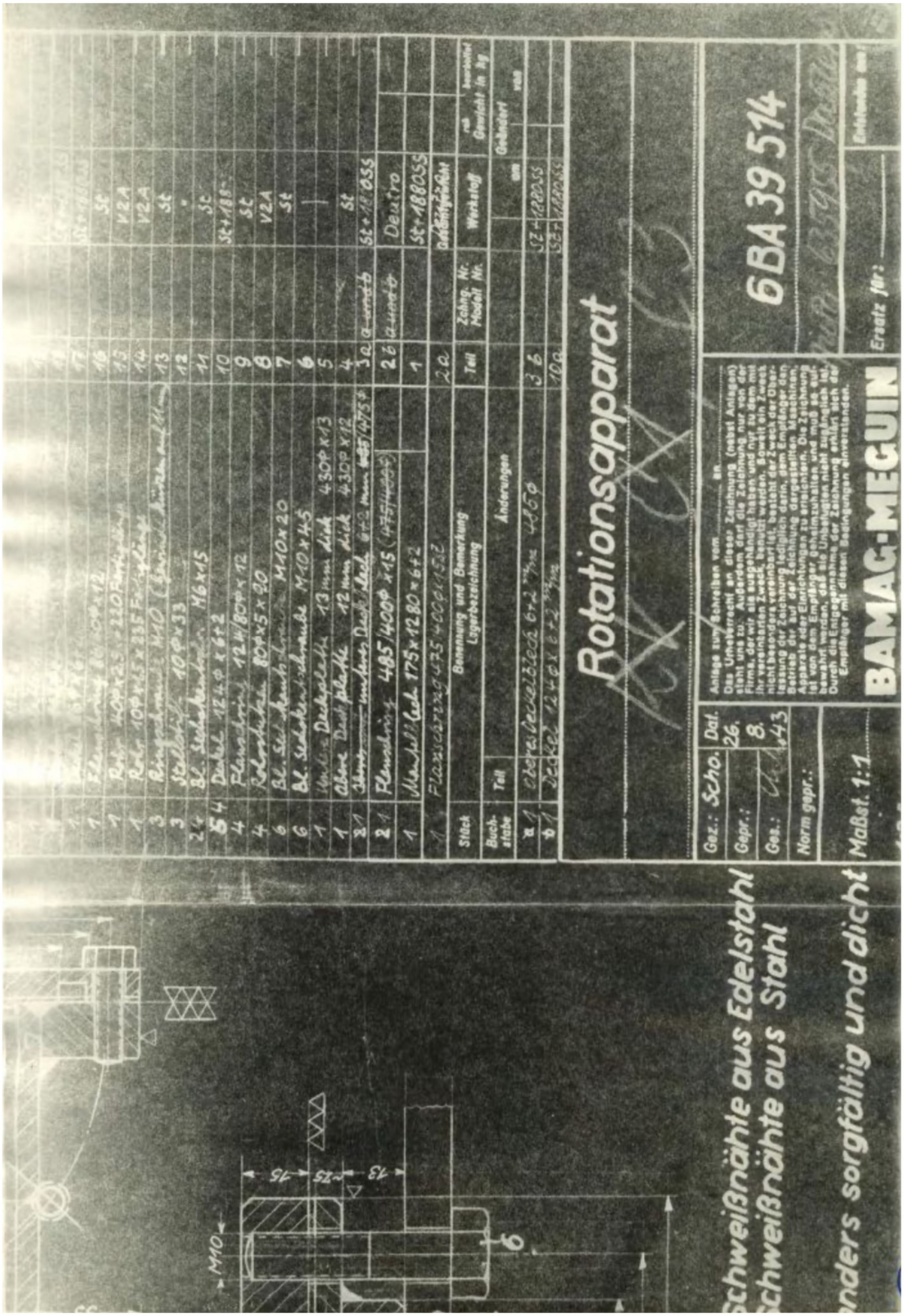


Figure D.248: During the war, Erich Bagge led a team that invented, built, and demonstrated the "isotope sluice," an alternative form of gaseous diffusion enrichment [https://digital.deutsches-museum.de/item/FA-002-782/].

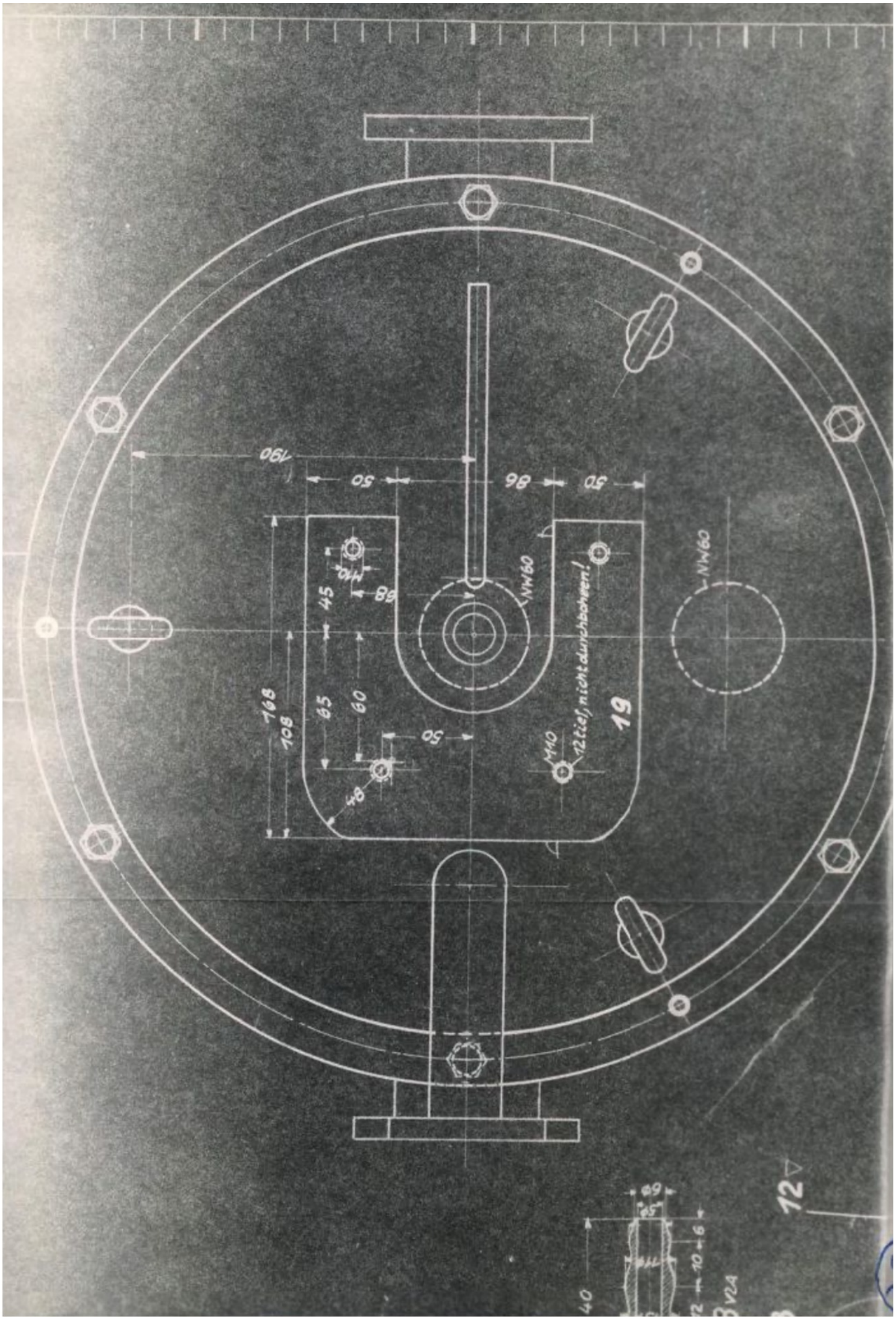


Figure D.249: During the war, Erich Bagge led a team that invented, built, and demonstrated the “isotope sluice,” an alternative form of gaseous diffusion enrichment [https://digital.deutsches-museum.de/item/FA-002-782/].

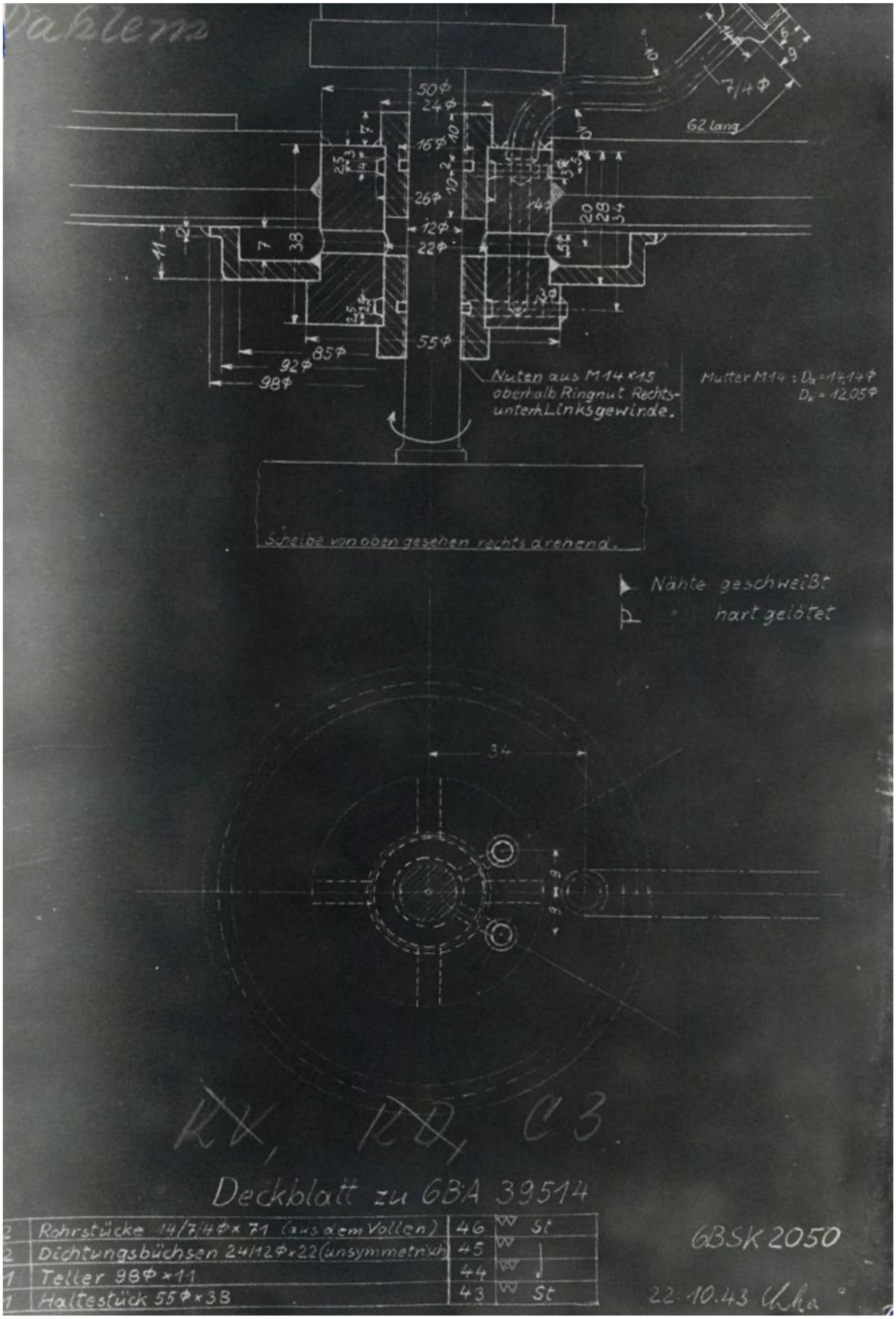
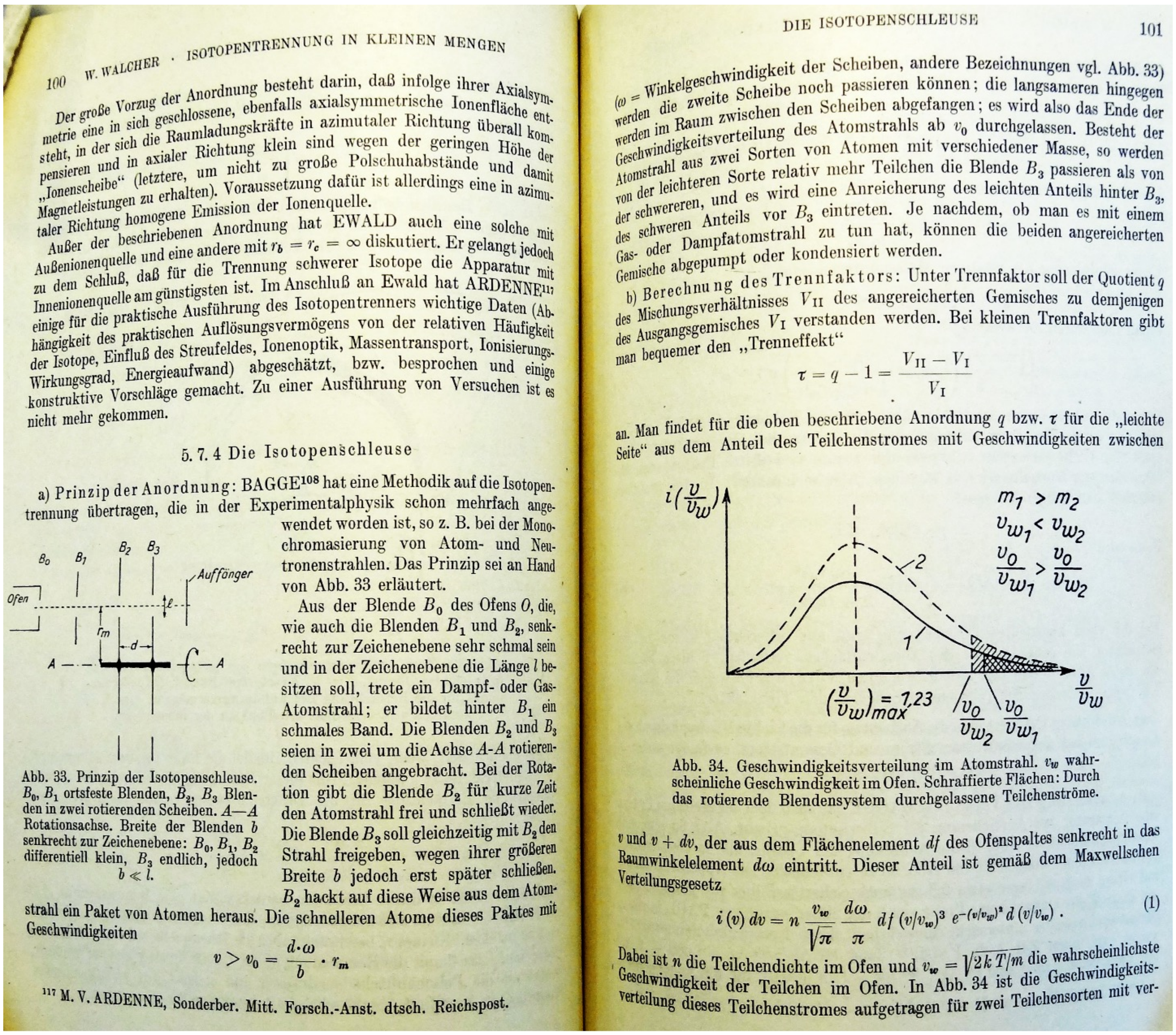


Figure D.250: During the war, Erich Bagge led a team that invented, built, and demonstrated the “isotope sluice,” an alternative form of gaseous diffusion enrichment [https://digital.deutsches-museum.de/item/FA-002-782/].


100 W. WALCHER · ISOTOPENTRENNUNG IN KLEINEN MENGEN

Der große Vorzug der Anordnung besteht darin, daß infolge ihrer Axialsymmetrie eine in sich geschlossene, ebenfalls axialsymmetrische Ionenfläche entsteht, in der sich die Raumladungskräfte in azimutaler Richtung überall kompensieren und in axialer Richtung klein sind wegen der geringen Höhe der „Ionenscheibe“ (letztere, um nicht zu große Polschuhabstände und damit Magnetleistungen zu erhalten). Voraussetzung dafür ist allerdings eine in azimutaler Richtung homogene Emission der Ionenquelle.

Außer der beschriebenen Anordnung hat EWALD auch eine solche mit Außenionenquelle und eine andere mit $r_b = r_c = \infty$ diskutiert. Er gelangt jedoch zu dem Schluß, daß für die Trennung schwerer Isotope die Apparatur mit Innenionenquelle am günstigsten ist. Im Anschluß an Ewald hat ARDENNE[117] einige für die praktische Ausführung des Isotopentrenners wichtige Daten (Abhängigkeit des praktischen Auflösungsvermögens von der relativen Häufigkeit der Isotope, Einfluß des Streufeldes, Ionenoptik, Massentransport, Ionisierungs-Wirkungsgrad, Energieaufwand) abgeschätzt, bzw. besprochen und einige konstruktive Vorschläge gemacht. Zu einer Ausführung von Versuchen ist es nicht mehr gekommen.

5.7.4 Die Isotopenschleuse

a) Prinzip der Anordnung: BAGGE[108] hat eine Methodik auf die Isotopentrennung übertragen, die in der Experimentalphysik schon mehrfach angewendet worden ist, so z. B. bei der Monochromasierung von Atom- und Neutronenstrahlen. Das Prinzip sei an Hand von Abb. 33 erläutert.

Abb. 33. Prinzip der Isotopenschleuse. B_0, B_1 ortsfeste Blenden, B_2, B_3 Blenden in zwei rotierenden Scheiben. A—A Rotationsachse. Breite der Blenden b senkrecht zur Zeichenebene: B_0, B_1, B_2 differentiell klein, B_3 endlich, jedoch $b \ll l$.

Aus der Blende B_0 des Ofens O, die, wie auch die Blenden B_1 und B_2, senkrecht zur Zeichenebene sehr schmal sein und in der Zeichenebene die Länge l besitzen soll, trete ein Dampf- oder Gas-Atomstrahl; er bildet hinter B_1 ein schmales Band. Die Blenden B_2 und B_3 seien in zwei um die Achse A-A rotierenden Scheiben angebracht. Bei der Rotation gibt die Blende B_2 für kurze Zeit den Atomstrahl frei und schließt wieder. Die Blende B_3 soll gleichzeitig mit B_2 den Strahl freigeben, wegen ihrer größeren Breite b jedoch erst später schließen. B_2 hackt auf diese Weise aus dem Atomstrahl ein Paket von Atomen heraus. Die schnelleren Atome dieses Paktes mit Geschwindigkeiten

$$v > v_0 = \frac{d \cdot \omega}{b} \cdot r_m$$

[117] M. V. ARDENNE, Sonderber. Mitt. Forsch.-Anst. dtsch. Reichspost.

DIE ISOTOPENSCHLEUSE 101

(ω = Winkelgeschwindigkeit der Scheiben, andere Bezeichnungen vgl. Abb. 33) werden die zweite Scheibe noch passieren können; die langsameren hingegen werden im Raum zwischen den Scheiben abgefangen; es wird also das Ende der Geschwindigkeitsverteilung des Atomstrahls ab v_0 durchgelassen. Besteht der Atomstrahl aus zwei Sorten von Atomen mit verschiedener Masse, so werden von der leichteren Sorte relativ mehr Teilchen die Blende B_3 passieren als von der schwereren, und es wird eine Anreicherung des leichten Anteils hinter B_3, des schweren Anteils vor B_3 eintreten. Je nachdem, ob man es mit einem Gas- oder Dampfatomstrahl zu tun hat, können die beiden angereicherten Gemische abgepumpt oder kondensiert werden.

b) Berechnung des Trennfaktors: Unter Trennfaktor soll der Quotient q des Mischungsverhältnisses V_{II} des angereicherten Gemisches zu demjenigen des Ausgangsgemisches V_I verstanden werden. Bei kleinen Trennfaktoren gibt man bequemer den „Trenneffekt“

$$\tau = q - 1 = \frac{V_{II} - V_I}{V_I}$$

an. Man findet für die oben beschriebene Anordnung q bzw. τ für die „leichte Seite“ aus dem Anteil des Teilchenstromes mit Geschwindigkeiten zwischen

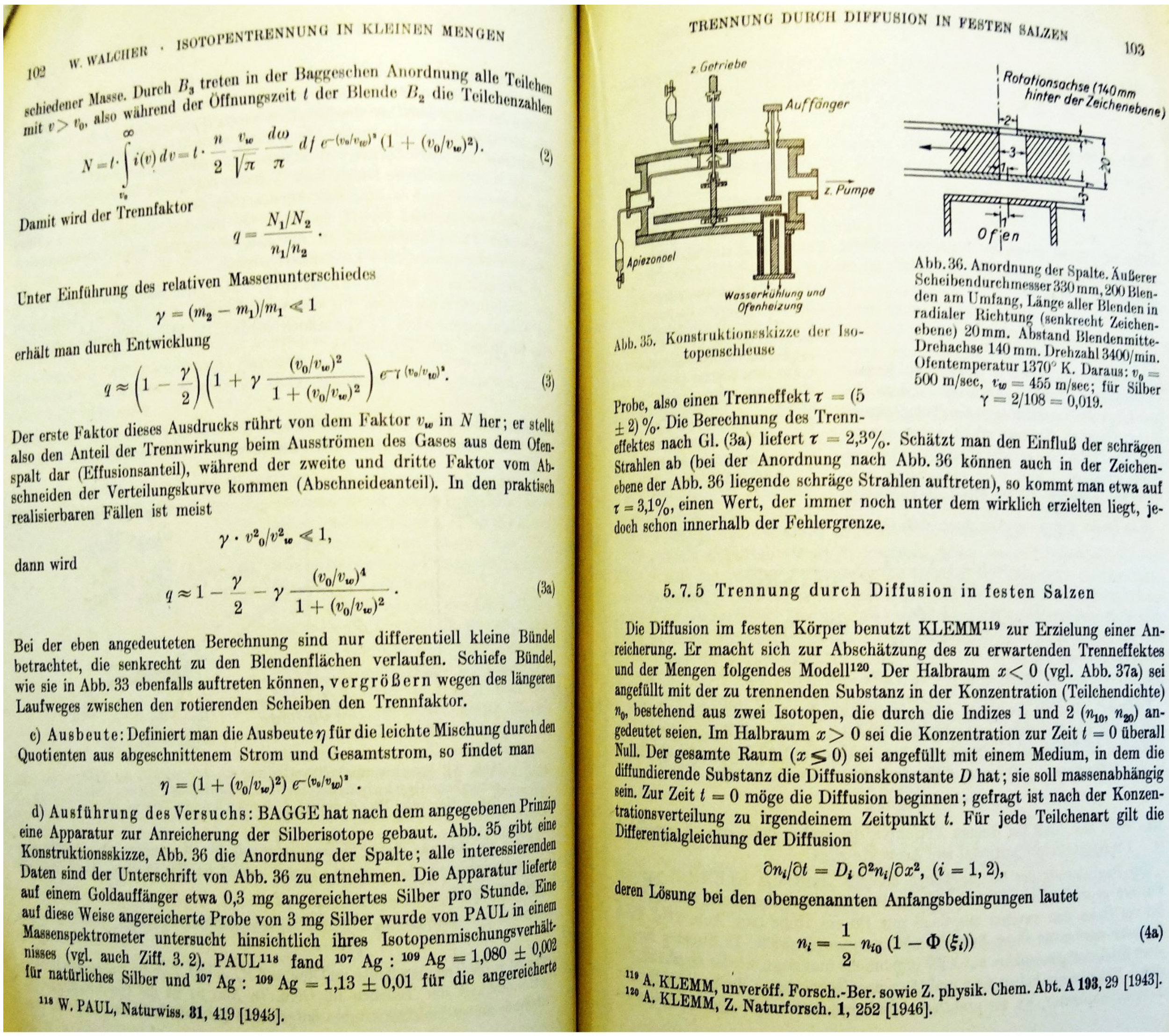
Abb. 34. Geschwindigkeitsverteilung im Atomstrahl. v_w wahrscheinliche Geschwindigkeit im Ofen. Schraffierte Flächen: Durch das rotierende Blendensystem durchgelassene Teilchenströme.

v und $v + dv$, der aus dem Flächenelement df des Ofenspaltes senkrecht in das Raumwinkelelement $d\omega$ eintritt. Dieser Anteil ist gemäß dem Maxwellschen Verteilungsgesetz

$$i(v)\,dv = n \frac{v_w}{\sqrt{\pi}} \frac{d\omega}{\pi} df\,(v/v_w)^3\, e^{-(v/v_w)^2}\, d(v/v_w)\,. \qquad (1)$$

Dabei ist n die Teilchendichte im Ofen und $v_w = \sqrt{2kT/m}$ die wahrscheinlichste Geschwindigkeit der Teilchen im Ofen. In Abb. 34 ist die Geschwindigkeitsverteilung dieses Teilchenstromes aufgetragen für zwei Teilchensorten mit ver-

Figure D.251: During the war, Erich Bagge led a team that invented, built, and demonstrated the “isotope sluice,” an alternative form of gaseous diffusion enrichment [FIAT Rev: *Nuclear Physics and Cosmic Rays* Vol. II, pp. 100–103].



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schiedener Masse. Durch B_3 treten in der Baggeschen Anordnung alle Teilchen mit $v > v_0$, also während der Öffnungszeit t der Blende B_2 die Teilchenzahlen

$$N = t \cdot \int_{v_0}^{\infty} i(v)\, dv = t \cdot \frac{n}{2} \frac{v_w}{\sqrt{\pi}} \frac{d\omega}{\pi}\, df\, e^{-(v_0/v_w)^2} (1 + (v_0/v_w)^2). \quad (2)$$

Damit wird der Trennfaktor

$$q = \frac{N_1/N_2}{n_1/n_2}.$$

Unter Einführung des relativen Massenunterschiedes

$$\gamma = (m_2 - m_1)/m_1 \ll 1$$

erhält man durch Entwicklung

$$q \approx \left(1 - \frac{\gamma}{2}\right)\left(1 + \gamma \frac{(v_0/v_w)^2}{1 + (v_0/v_w)^2}\right) e^{-\gamma (v_0/v_w)^2}. \quad (3)$$

Der erste Faktor dieses Ausdrucks rührt von dem Faktor v_w in N her; er stellt also den Anteil der Trennwirkung beim Ausströmen des Gases aus dem Ofenspalt dar (Effusionsanteil), während der zweite und dritte Faktor vom Abschneiden der Verteilungskurve kommen (Abschneideanteil). In den praktisch realisierbaren Fällen ist meist

$$\gamma \cdot v^2_0/v^2_w \ll 1,$$

dann wird

$$q \approx 1 - \frac{\gamma}{2} - \gamma \frac{(v_0/v_w)^4}{1 + (v_0/v_w)^2}. \quad (3a)$$

Bei der eben angedeuteten Berechnung sind nur differentiell kleine Bündel betrachtet, die senkrecht zu den Blendenflächen verlaufen. Schiefe Bündel, wie sie in Abb. 33 ebenfalls auftreten können, vergrößern wegen des längeren Laufweges zwischen den rotierenden Scheiben den Trennfaktor.

c) Ausbeute: Definiert man die Ausbeute η für die leichte Mischung durch den Quotienten aus abgeschnittenem Strom und Gesamtstrom, so findet man

$$\eta = (1 + (v_0/v_w)^2)\, e^{-(v_0/v_w)^2}.$$

d) Ausführung des Versuchs: BAGGE hat nach dem angegebenen Prinzip eine Apparatur zur Anreicherung der Silberisotope gebaut. Abb. 35 gibt eine Konstruktionsskizze, Abb. 36 die Anordnung der Spalte; alle interessierenden Daten sind der Unterschrift von Abb. 36 zu entnehmen. Die Apparatur lieferte auf einem Goldauffänger etwa 0,3 mg angereichertes Silber pro Stunde. Eine auf diese Weise angereicherte Probe von 3 mg Silber wurde von PAUL in einem Massenspektrometer untersucht hinsichtlich ihres Isotopenmischungsverhältnisses (vgl. auch Ziff. 3. 2). PAUL[118] fand ^{107}Ag : ^{109}Ag $= 1{,}080 \pm 0{,}002$ für natürliches Silber und ^{107}Ag : ^{109}Ag $= 1{,}13 \pm 0{,}01$ für die angereicherte

[118] W. PAUL, Naturwiss. **31**, 419 [1943].

TRENNUNG DURCH DIFFUSION IN FESTEN SALZEN 103

Abb. 35. Konstruktionsskizze der Isotopenschleuse

Abb. 36. Anordnung der Spalte. Äußerer Scheibendurchmesser 330 mm, 200 Blenden am Umfang, Länge aller Blenden in radialer Richtung (senkrecht Zeichenebene) 20 mm. Abstand Blendenmitte-Drehachse 140 mm. Drehzahl 3400/min. Ofentemperatur 1370° K. Daraus: $v_0 =$ 500 m/sec, $v_w = 455$ m/sec; für Silber $\gamma = 2/108 = 0{,}019$.

Probe, also einen Trenneffekt $\tau = (5 \pm 2)$ %. Die Berechnung des Trenneffektes nach Gl. (3a) liefert $\tau = 2{,}3\%$. Schätzt man den Einfluß der schrägen Strahlen ab (bei der Anordnung nach Abb. 36 können auch in der Zeichenebene der Abb. 36 liegende schräge Strahlen auftreten), so kommt man etwa auf $\tau = 3{,}1\%$, einen Wert, der immer noch unter dem wirklich erzielten liegt, jedoch schon innerhalb der Fehlergrenze.

5.7.5 Trennung durch Diffusion in festen Salzen

Die Diffusion im festen Körper benutzt KLEMM[119] zur Erzielung einer Anreicherung. Er macht sich zur Abschätzung des zu erwartenden Trenneffektes und der Mengen folgendes Modell[120]. Der Halbraum $x < 0$ (vgl. Abb. 37a) sei angefüllt mit der zu trennenden Substanz in der Konzentration (Teilchendichte) n_0, bestehend aus zwei Isotopen, die durch die Indizes 1 und 2 (n_{10}, n_{20}) angedeutet seien. Im Halbraum $x > 0$ sei die Konzentration zur Zeit $t = 0$ überall Null. Der gesamte Raum ($x \lessgtr 0$) sei angefüllt mit einem Medium, in dem die diffundierende Substanz die Diffusionskonstante D hat; sie soll massenabhängig sein. Zur Zeit $t = 0$ möge die Diffusion beginnen; gefragt ist nach der Konzentrationsverteilung zu irgendeinem Zeitpunkt t. Für jede Teilchenart gilt die Differentialgleichung der Diffusion

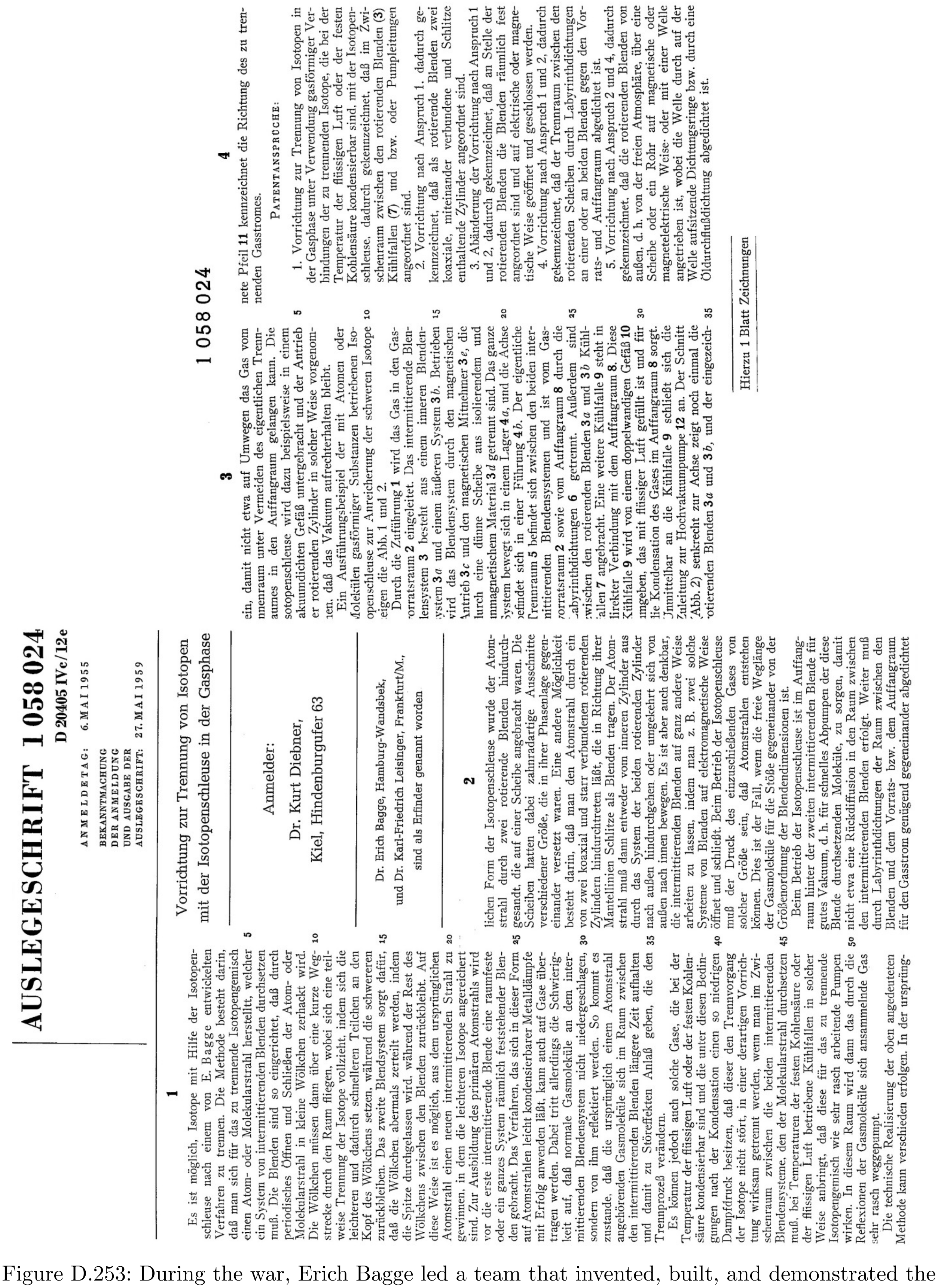
$$\partial n_i/\partial t = D_i\, \partial^2 n_i/\partial x^2, \ (i = 1, 2),$$

deren Lösung bei den obengenannten Anfangsbedingungen lautet

$$n_i = \frac{1}{2} n_{i0} (1 - \Phi(\xi_i)) \quad (4a)$$

[119] A. KLEMM, unveröff. Forsch.-Ber. sowie Z. physik. Chem. Abt. A **193**, 29 [1943].
[120] A. KLEMM, Z. Naturforsch. **1**, 252 [1946].

Figure D.252: During the war, Erich Bagge led a team that invented, built, and demonstrated the "isotope sluice," an alternative form of gaseous diffusion enrichment [FIAT Rev: *Nuclear Physics and Cosmic Rays* Vol. II, pp. 100–103].



AUSLEGESCHRIFT 1 058 024

D 20405 IVc/12e

ANMELDETAG: 6. MAI 1955

BEKANNTMACHUNG DER ANMELDUNG UND AUSGABE DER AUSLEGESCHRIFT: 27. MAI 1959

Vorrichtung zur Trennung von Isotopen mit der Isotopenschleuse in der Gasphase

Anmelder:

Dr. Kurt Diebner,
Kiel, Hindenburgufer 63

Dr. Erich Bagge, Hamburg-Wandsbek,
und Dr. Karl-Friedrich Leisinger, Frankfurt/M.,
sind als Erfinder genannt worden

1

Es ist möglich, Isotope mit Hilfe der Isotopenschleuse nach einem von E. Bagge entwickelten Verfahren zu trennen. Die Methode besteht darin, daß man sich für das zu trennende Isotopengemisch einen Atom- oder Molekularstrahl herstelltt, welcher ein System von intermittierenden Blenden durchsetzen muß. Die Blenden sind so eingerichtet, daß durch periodisches Öffnen und Schließen der Atom- oder Molekularstrahl in kleine Wölkchen zerhackt wird. Die Wölkchen müssen dann über eine kurze Wegstrecke durch den Raum fliegen, wobei sich eine teilweise Trennung der Isotope vollzieht, indem sich die leichteren und dadurch schnelleren Teilchen an den Kopf des Wölkchens setzen, während die schwereren zurückbleiben. Das zweite Blendsystem sorgt dafür, daß die Wölkchen abermals zerteilt werden, indem die Spitze durchgelassen wird, während der Rest des Wölkchens zwischen den Blenden zurückbleibt. Auf diese Weise ist es möglich, aus dem ursprünglichen Atomstrahl einen neuen intermittierenden Strahl zu gewinnen, in dem die leichteren Isotope angereichert sind. Zur Ausbildung des primären Atomstrahls wird vor die erste intermittierende Blende eine raumfeste oder ein ganzes System räumlich feststehender Blenden gebracht. Das Verfahren, das sich in dieser Form auf Atomstrahlen leicht kondensierbarer Metalldämpfe mit Erfolg anwenden läßt, kann auch auf Gase übertragen werden. Dabei tritt allerdings die Schwierigkeit auf, daß normale Gasmoleküle an dem intermittierenden Blendensystem nicht niedergeschlagen, sondern von ihm reflektiert werden. So kommt es zustande, daß die ursprünglich einem Atomstrahl angehörenden Gasmoleküle sich im Raum zwischen den intermittierenden Blenden längere Zeit aufhalten und damit zu Störeffekten Anlaß geben, die den Trennprozeß verändern.

Es können jedoch auch solche Gase, die bei der Temperatur der flüssigen Luft oder der festen Kohlensäure kondensierbar sind und die unter diesen Bedingungen nach der Kondensation einen so niedrigen Dampfdruck besitzen, daß dieser den Trennvorgang der Isotope nicht stört, in einer derartigen Vorrichtung wirksam getrennt werden, wenn man im Zwischenraum zwischen die beiden intermittierenden Blendensysteme, den der Molekularstrahl durchsetzen muß, bei Temperaturen der festen Kohlensäure oder der flüssigen Luft betriebene Kühlfallen in solcher Weise anbringt, daß diese für das zu trennende Isotopengemisch wie sehr rasch arbeitende Pumpen wirken. In diesem Raum wird dann das durch die Reflexionen der Gasmoleküle sich ansammelnde Gas sehr rasch weggepumpt.

Die technische Realisierung der oben angedeuteten Methode kann verschieden erfolgen. In der ursprünglichen Form der Isotopenschleuse wurde der Atomstrahl durch zwei rotierende Blenden hindurchgesandt, die auf einer Scheibe angebracht waren. Die Scheiben hatten dabei zahnradartige Ausschnitte verschiedener Größe, die in ihrer Phasenlage gegeneinander versetzt waren. Eine andere Möglichkeit besteht darin, daß man den Atomstrahl durch ein von zwei koaxial und starr verbundenen rotierenden Zylindern hindurchtreten läßt, die in Richtung ihrer Mantellinien Schlitze als Blenden tragen. Der Atomstrahl muß dann entweder vom inneren Zylinder aus durch das System der beiden rotierenden Zylinder nach außen hindurchgehen oder umgekehrt sich von außen nach innen bewegen. Es ist aber auch denkbar, die intermittierenden Blenden auf ganz andere Weise arbeiten zu lassen, indem man z. B. zwei solche Systeme von Blenden auf elektromagnetische Weise öffnet und schließt. Beim Betrieb der Isotopenschleuse muß der Druck des einzuschießenden Gases von solcher Größe sein, daß Atomstrahlen entstehen können. Dies ist der Fall, wenn die freie Weglänge der Gasmoleküle für die Stöße gegeneinander von der Größenordnung der Blendendimensionen ist.

Beim Betrieb der Isotopenschleuse ist im Auffangraum hinter der zweiten intermittierenden Blende für gutes Vakuum, d. h. für schnelles Abpumpen der diese Blende durchsetzenden Moleküle, zu sorgen, damit nicht etwa eine Rückdiffusion in den Raum zwischen den intermittierenden Blenden erfolgt. Weiter muß durch Labyrinthdichtungen der Raum zwischen den Blenden und dem Vorrats- bzw. dem Auffangraum für den Gasstrom genügend gegeneinander abgedichtet

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ein, damit nicht etwa auf Umwegen das Gas vom nnenraum unter Vermeiden des eigentlichen Trennaumes in den Auffangraum gelangen kann. Die sotopenschleuse wird dazu beispielsweise in einem akuumdichten Gefäß untergebracht und der Antrieb er rotierenden Zylinder in solcher Weise vorgenomen, daß das Vakuum aufrechterhalten bleibt.

Ein Ausführungsbeispiel der mit Atomen oder Molekülen gasförmiger Substanzen betriebenen Isoopenschleuse zur Anreicherung der schweren Isotope eigen die Abb. 1 und 2.

Durch die Zuführung 1 wird das Gas in den Gasorratsraum 2 eingeleitet. Das intermittierende Blenlensystem 3 besteht aus einem inneren Blendenystem 3a und einem äußeren System 3b. Betrieben vird das Blendensystem durch den magnetischen Antrieb 3c und den magnetischen Mitnehmer 3e, die lurch eine dünne Scheibe aus isolierendem und nmagnetischem Material 3d getrennt sind. Das ganze System bewegt sich in einem Lager 4a, und die Achse befindet sich in einer Führung 4b. Der eigentliche Trennraum 5 befindet sich zwischen den beiden intermittierenden Blendensystemen und ist vom Gasvorratsraum 2 sowie vom Auffangraum 8 durch die Labyrinthdichtungen 6 getrennt. Außerdem sind zwischen den rotierenden Blenden 3a und 3b Kühlfallen 7 angebracht. Eine weitere Kühlfalle 9 steht in direkter Verbindung mit dem Auffangraum 8. Diese Kühlfalle 9 wird von einem doppelwandigen Gefäß 10 umgeben, das mit flüssiger Luft gefüllt ist und für die Kondensation des Gases im Auffangraum 8 sorgt. Unmittelbar an die Kühlfalle 9 schließt sich die Zuleitung zur Hochvakuumpumpe 12 an. Der Schnitt (Abb. 2) senkrecht zur Achse zeigt noch einmal die rotierenden Blenden 3a und 3b, und der eingezeichnete Pfeil 11 kennzeichnet die Richtung des zu trennenden Gasstromes.

4

PATENTANSPRÜCHE:

1. Vorrichtung zur Trennung von Isotopen in der Gasphase unter Verwendung gasförmiger Verbindungen der zu trennenden Isotope, die bei der Temperatur der flüssigen Luft oder der festen Kohlensäure kondensierbar sind, mit der Isotopenschleuse, dadurch gekennzeichnet, daß im Zwischenraum zwischen den rotierenden Blenden (3) Kühlfallen (7) und bzw. oder Pumpleitungen angeordnet sind.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß als rotierende Blenden zwei koaxiale, miteinander verbundene und Schlitze enthaltende Zylinder angeordnet sind.

3. Abänderung der Vorrichtung nach Anspruch 1 und 2, dadurch gekennzeichnet, daß an Stelle der rotierenden Blenden die Blenden räumlich fest angeordnet sind und auf elektrische oder magnetische Weise geöffnet und geschlossen werden.

4. Vorrichtung nach Anspruch 1 und 2, dadurch gekennzeichnet, daß der Trennraum zwischen den rotierenden Scheiben durch Labyrinthdichtungen an einer oder an beiden Blenden gegen den Vorrats- und Auffangraum abgedichtet ist.

5. Vorrichtung nach Anspruch 2 und 4, dadurch gekennzeichnet, daß die rotierenden Blenden von außen, d. h. von der freien Atmosphäre, über eine Scheibe oder ein Rohr auf magnetische oder magnetelektrische Weise- oder mit einer Welle angetrieben ist, wobei die Welle durch auf der Welle aufsitzende Dichtungsringe bzw. durch eine Öldurchflußdichtung abgedichtet ist.

Hierzu 1 Blatt Zeichnungen

Figure D.253: During the war, Erich Bagge led a team that invented, built, and demonstrated the "isotope sluice," an alternative form of gaseous diffusion enrichment [German patent DE1058024].

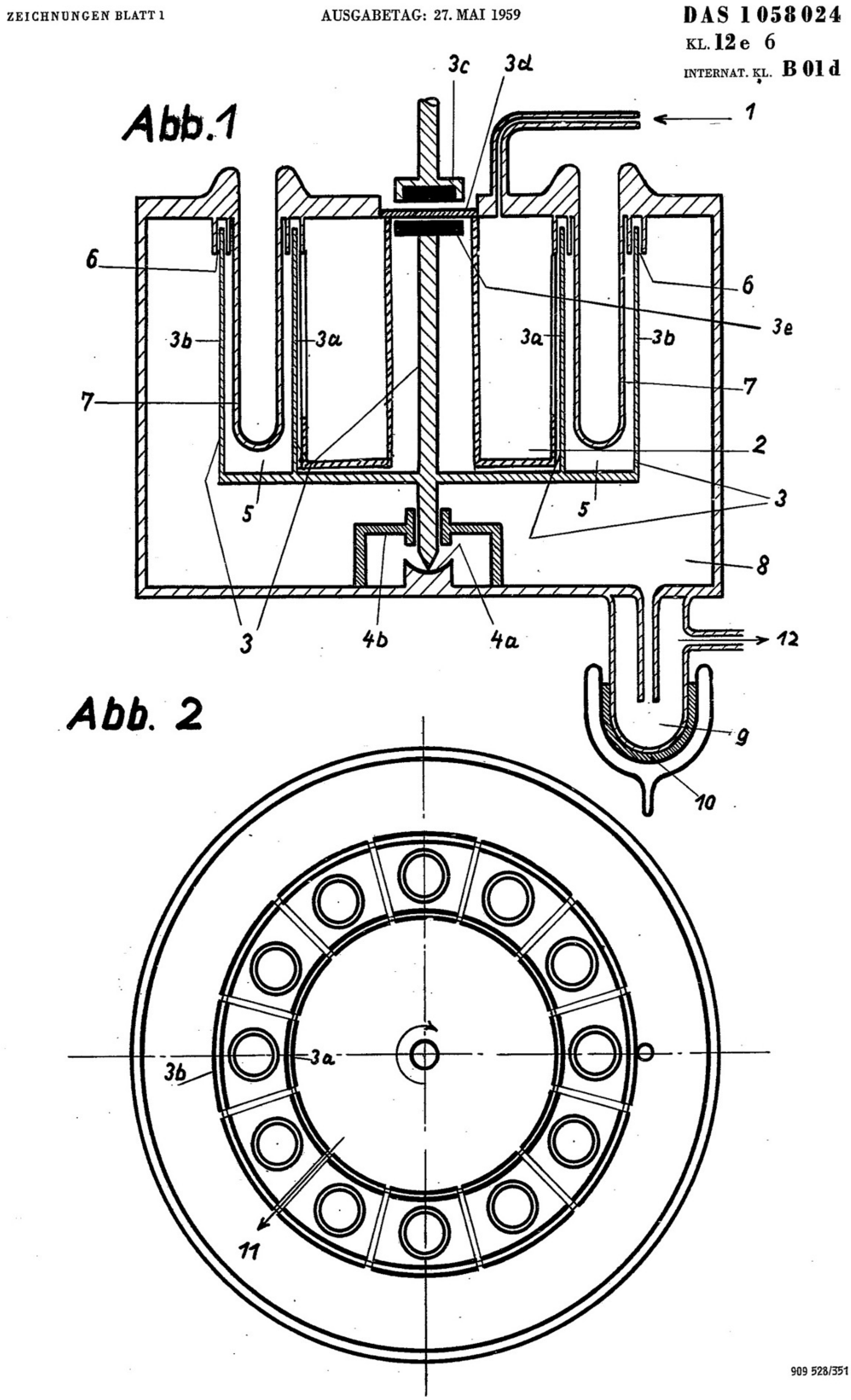
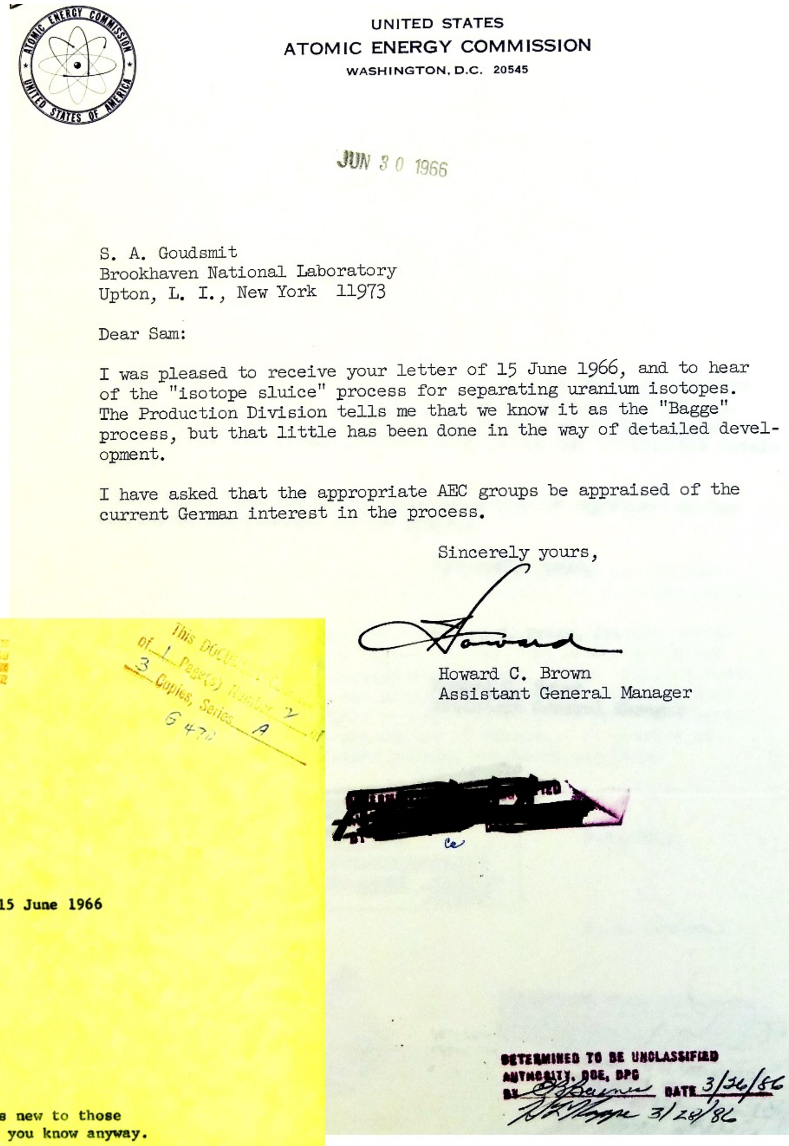


Figure D.254: During the war, Erich Bagge led a team that invented, built, and demonstrated the "isotope sluice," an alternative form of gaseous diffusion enrichment [German patent DE1058024].

NARA RG GOUDS, Entry UD-7420, Box 8, Folder Haycock/Brown/Tape AEC



UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

JUN 30 1966

S. A. Goudsmit
Brookhaven National Laboratory
Upton, L. I., New York 11973

Dear Sam:

I was pleased to receive your letter of 15 June 1966, and to hear of the "isotope sluice" process for separating uranium isotopes. The Production Division tells me that we know it as the "Bagge" process, but that little has been done in the way of detailed development.

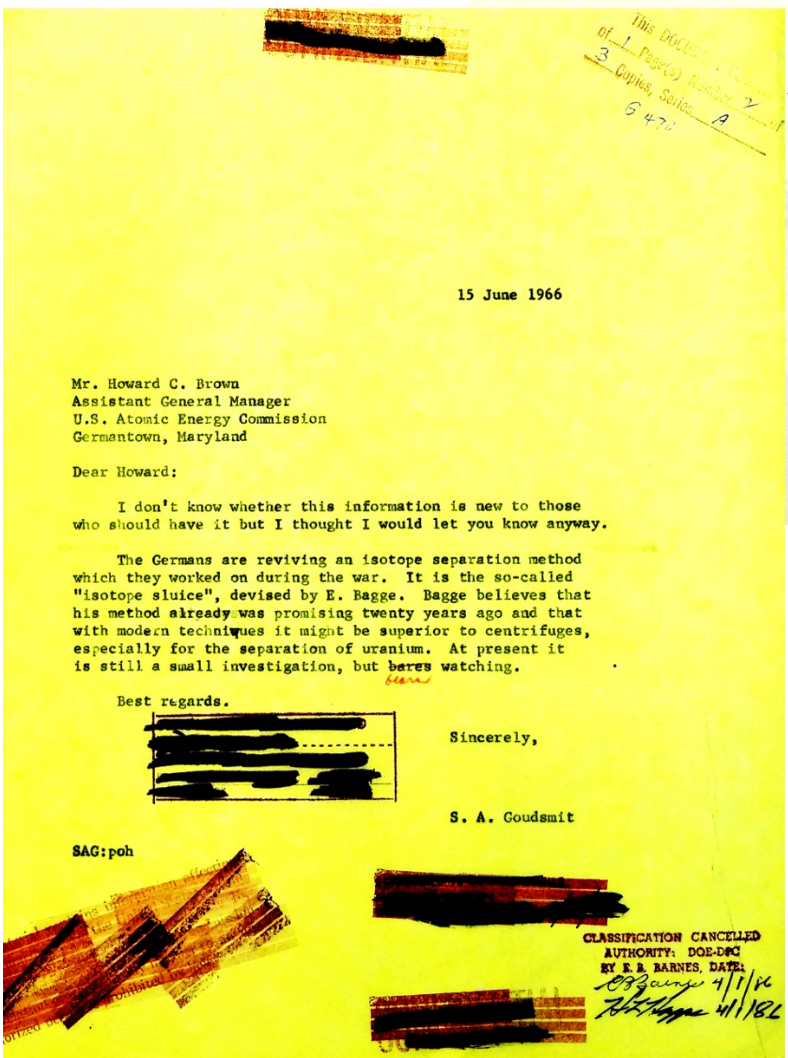
I have asked that the appropriate AEC groups be appraised of the current German interest in the process.

Sincerely yours,

Howard C. Brown
Assistant General Manager

[redacted]

DETERMINED TO BE UNCLASSIFIED
AUTHORITY, DOE, DPC
BY [signature] DATE 3/26/86
[signature] 3/28/86



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This DOCUMENT ... of 1 Page(s) Number 2 of 3 Copies, Series A
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15 June 1966

Mr. Howard C. Brown
Assistant General Manager
U.S. Atomic Energy Commission
Germantown, Maryland

Dear Howard:

I don't know whether this information is new to those who should have it but I thought I would let you know anyway.

The Germans are reviving an isotope separation method which they worked on during the war. It is the so-called "isotope sluice", devised by E. Bagge. Bagge believes that his method already was promising twenty years ago and that with modern techniques it might be superior to centrifuges, especially for the separation of uranium. At present it is still a small investigation, but ~~bares~~ bears watching.

Best regards.

[redacted]

Sincerely,

S. A. Goudsmit

SAG:poh

[redacted]

CLASSIFICATION CANCELLED
AUTHORITY: DOE-DPC
BY E. B. BARNES, DATE:
[signature] 4/1/86
[signature] 4/1/86

[redacted]

DECLASSIFIED
Authority NND 933079

Figure D.255: Samuel Goudsmit to Howard C. Brown. 15 June 1966 [NARA RG GOUDS, Entry UD-7420, Box 8, Folder Haycock/Brown/Tape AEC]. "The Germans are reviving an isotope separation method which they worked on during the war. It is the so-called 'isotope sluice', devised by E. Bagge. Bagge believes that his method already was promising twenty years ago and that with modern techniques it might be superior to centrifuges, especially for the separation of uranium."

D.4.5 Uranium-235 Enrichment via Photochemical Processes

[Beginning in the early 1930s, Stanisław Mrozowski (Polish, 1902–1999), K. Zuber (Swiss, 19??–19??), Werner Kuhn (Swiss, 1899–1963), Hans Martin (German, 19??–19??), and K. H. Eldau (German, 19??–19??) developed photochemical methods of isotope separation and demonstrated them with isotopes of elements such as mercury and chlorine. During the war, Kuhn, Martin, Eldau, Paul Harteck, and others seriously investigated the feasibility of applying such photochemical methods to uranium isotope separation. Publicly available documentation does not indicate how far that research progressed during the war, but given the available light sources, the photochemical enrichment of uranium seems unlikely to have ever gone beyond small-scale laboratory experiments.

Separately from the work on photochemical enrichment, or perhaps even motivated by it, other German-speaking scientists during the same time period worked toward the development of lasers as an improved monochromatic light source (Section C.3). After the war, the combination of the German-derived innovations in photochemical enrichment and laser technology made laser isotope enrichment a reality (p. 5127).]

Stanisław Mrozowski. 1930. *Bulletin of the Academy of Poland* 1:464.

Stanisław Mrozowski. 1932. Stoßerscheinungen bei optischer Anregung verschiedener Quecksilberisotopen. *Zeitschrift für Physik* 78:826–843. https://doi.org/10.1007/BF01342044

Die Konstruktion einer neuen, sehr lichtstarken Anordnung hat es ermöglicht, die Hyperfeinstruktur der mit gefilterter Strahlung angeregten Resonanzstrahlung des Quecksilberdampfes unter verschiedenen Bedingungen zu erforschen und den früher entdeckten Verschiebungseffekt einer der Komponenten mit einer wesentlich höheren Genauigkeit festzustellen. Der Einfluß der nichtauslöschenden Zusatzgase äußert sich durch selektive Stoßüberführungen zwischen verschiedenen Hyperfeinstrukturkomponenten; dagegen wird bei Vergrößerung der Dampfdichte des Quecksilbers gleiche Überführungswahrscheinlichkeit für alle Komponenten beobachtet. Es wurde auch unter denselben Bedingungen ein Füchtbauereffekt erhalten, der bei Zusatz von Stickstoff die Hyperfeinstruktur des sichtbaren Tripletts zu studieren erlaubte. Es zeigt sich, daß die Hyperfeinstruktur von der Zusammensetzung der anregenden Resonanzlinie unabhängig ist, was in dem Einfluß der Stöße der metastabilen Atome mit Quecksilberatomen verschiedener Isotopenarten eine Erklärung findet.

The construction of a new, very high-intensity device has made it possible to explore the hyperfine structure of the resonance radiation of mercury vapor excited with filtered radiation under various conditions and to detect the previously discovered shift effect of one of the components with a much higher accuracy. The influence of the non-quenching additional gases is manifested by selective impact transfers between different hyperfine structure components; on the other hand, when the vapor density of mercury is increased, equal transfer probability is observed for all components. A fugacity effect was also obtained under the same conditions, which allowed to study the hyperfine structure of the visible triplet when nitrogen was added. It is shown that the hyperfine structure is independent of the composition of the exciting resonance line, which finds an explanation in the influence of the collisions of the metastable atoms with mercury atoms of different isotopic species.

K. Zuber. 1935. Die Linienabsorption des Quecksilberdampfes für einzelne Hyperfeinstruktur-Komponenten der Linie 2537 Å.E. *Helvetica Physica Acta* 8:4:370–380. https://dx.doi.org/10.5169/seals-110535

Messungen der Linienabsorption einzelner Hyperfeinstruktur-Komponenten führen zu Ergebnissen, welche mit dem Feinstrukturschema von Schüler und Keyston unter Berücksichtigung der von Inglis angegebenen Korrektur in Einklang stehen, falls man die mittlere Lebensdauer des 2 $^3P_1$-Niveaus im Gegensatz zu Mrozowski für alle Isotope gleich gross annimmt. Aus der Absorption für einzelne Komponenten lässt sich der Absorptionskoeffizient $k_{\lambda o}$ der ganzen Linie berechnen. Dieser Wert steht in guter Übereinstimmung mit den Messungen von Kunze und Ladenburg-Wolfsohn.

Measurements of the line absorption of individual hyperfine structure components lead to results which are in agreement with the fine structure scheme of Schüler and Keyston, taking into account the correction given by Inglis, if one assumes the mean lifetime of the 2 $^3P_1$ level to be the same for all isotopes, in contrast to Mrozowski. From the absorption for individual components, the absorption coefficient $k_{\lambda o}$ of the whole line can be calculated. This value is in good agreement with the measurements of Kunze and Ladenburg-Wolfsohn.

K. Zuber. 1935. Separation of the Mercury Isotopes by a Photochemical Method. *Nature* 136:796. https://doi.org/10.1038/136796a0

When a mixture of mercury vapour and oxygen is irradiated with the mercury resonance line λ 2537, the mercury becomes oxidised. Since excitation is a necessary stage in the oxidation, Mrozowski has suggested that it should be possible to produce a separation of the mercury isotopes by exciting them selectively. If the reaction consists of the primary photochemical process

$$Hg^{+} + O_2 \rightarrow HgO + O$$

only the atomic species which are excited by the incident light should be oxidised.

In my experiments the light from a mercury arc was passed through a Mrozowski filter consisting of a column of mercury vapour in a magnetic field. This transmitted only the hyperfine structure components of the resonance line corresponding to the isotopes 200, 202. After an irradiation of between 10 and 30 minutes, the isotopic composition of the remaining mercury or of that recovered from the oxide was examined by the method of absorption of single hyperfine structure components. The results of the experiments show:

(1) The separation is in every case only partial, so that besides the primary process, secondary reactions must take place.

(2) An addition of nitrogen assists the separation ($p_{O2} : p_{N2} \sim 1 : 1$, $p_{O2} \sim 1$ mm. Hg).

(3) It has been possible to obtain samples in which the ratio $\frac{p_{200,\,202}}{p_{198,\,199,\,201,\,204}}$ was modified by a factor of four.

More detailed information will be published in the *Helv. Phys. Acta.*

K. Zuber. 1936. Trennung der Quecksilber-Isotope nach einer photochemischen Methode. *Helvetica Physica Acta* 9:285–300. https://dx.doi.org/10.5169/seals-110628

Bestrahlt man ein Gemisch von Hg-Dampf und Sauerstoff mit der Resonanzlinie 2537 Å. E., so tritt Oxydation des Quecksilbers ein. Da sich das Oxyd nur nach vorheriger Anregung der Quecksilberatome bildet, schlägt Mrozowski vor, einzelne Isotopensorten anzuregen. Besteht die Reaktion allein aus dem photochemischen Primärprozess $Hg^{*} + O_2 = HgO + O$, so sollten sich im Oxyd nur die vorher angeregten Isotopen wiederfinden. Es ergibt sich: 1. Das Gemisch Hg und O_2 ist für eine Trennung nicht geeignet. Notwendig ist ein Zusatz von Stickstoff. 2. Die Trennung ist immer nur teilweise, wofür sekundäre Reaktionen als Ursache angesehen werden. 3. Durch Wiederholen des Versuches lässt sich die Trennung verbessern. Es konnten Proben hergestellt werden, bei denen das Verhältnis der einzelnen Isotope um den Faktor vier verschieden war.

If a mixture of Hg vapor and oxygen is irradiated with the resonance line 2537 Å. E., oxidation of the mercury occurs. Since the oxide forms only after prior excitation of the mercury atoms, Mrozowski proposes to excite individual isotope species. If the reaction consists solely of the primary photochemical process $Hg^{+} + O_2 = HgO + O$, only the previously excited isotopes should be found in the oxide. It results: 1. The mixture Hg and O_2 is not suitable for separation. An addition of nitrogen is necessary. 2. separation is always partial, for which secondary reactions are considered to be the cause. 3. separation can be improved by repeating the experiment. Samples could be produced in which the ratio of the individual isotopes was different by a factor of four.

Werner Kuhn and Hans Martin. 1932. Photochemische Trennung von Isotopen. *Naturwissenschaften* 20:772. https://doi.org/10.1007/BF01494810

Werner Kuhn and Hans Martin. 1933. Photochemische Trennung von Isotopen. *Zeitschrift für Physikalische Chemie B* 21:93. https://doi.org/10.1515/zpch-1933-2111

Es werden die Grundlagen und Voraussetzungen einer photochemischen Tren-nung von Isotopen in optischer, photochemischer und chemischer Hinsicht auseinandergesetzt und insbesondere im Falle des Phosgens genau diskutiert. Im Anschluss daran wird eine Versuchsanordnung beschrieben, mit welcher äusserst monochromatisches Licht in guter Ausbeute erhalten wird und für die präparative Darstellung benutzt werden kann. Chlor, welches in dieser Weise aus Phosgen freigemacht wurde, zeigte gegenüber gewöhnlichem Chlor eine Atomgewichtsverschiebung von 0.025 Einheiten. Es wird dadurch die Interpretation von Bandenvervielfachungen im Phosgenabsorptionsspektrum als Isotopieeffekt bestätigt, und es können weitere Schlüsse gezogen werden, namentlich mit Bezug auf die Zerfallswahrscheinlichkeiten in den den Prädissoziationsgebieten benachbarten Bereichen diskontinuierlicher Absorption.

The fundamentals and prerequisites of photochemical separation of isotopes in optical, photochemical, and chemical terms are discussed in detail, particularly in the case of phosgene. Subsequently, an experimental setup is described with which extremely monochromatic light is obtained in good yield and can be used for preparative imaging. Chlorine liberated from phosgene in this manner showed an atomic weight shift of 0.025 units compared to ordinary chlorine. This confirms the interpretation of band multiplications in the phosgene absorption spectrum as an isotopic effect, and further conclusions can be drawn, namely with respect to the decay probabilities in the regions of discontinuous absorption adjacent to the predissociation regions.

Werner Kuhn, Hans Martin, and K. H. Eldau. 1941. Anreicherung der Chlorisotopen durch Bestrahlung von Chlordioxyd bei niedrigem Druck. ***Zeitschrift für Physikalische Chemie B*** **50:213–254. https://doi.org/10.1515/zpch-1941-5014**

Anschließend an eine Diskussion der Stoffeigenschaften, welche die photochemische Trennung von Isotopen einerseits ermöglichen, andererseits herabmindern, wird gesagt, daß Chlordioxyd (ClO_2) eine Substanz sein dürfte, mit der bei Benutzung einer geeigneten Lichtquelle gute Ergebnisse erwartet werden können. Es wird darauf eine Apparatur beschrieben, mittels deren sehr reines Chlordioxyd dargestellt und unter einem Drucke von etwa 0.2 mm Hg mit praktisch reinem Lichte der Quecksilberlinien 3650.15, 3654.83 und 3663.27 Å bei Vermeidung von Reaktionsketten bestrahlt werden kann und welche gestattet, das dabei freigesetzte Chlor von unverändertem Chlordioxyd zu trennen. In den mit der Apparatur ausgeführten Versuchen wird einerseits festgestellt, daß die Quantenausbeute unter den gewählten Versuchsbedingungen tatsächlich ungefähr gleich 1 ist und daß als Zersetzungsprodukte praktisch ausschließlich Chlor und Sauerstoff gebildet werden. Andererseits wird in dem photochemisch freigesetzten Chlor eine Vermindeiung des Atomgewichts um 0.016 Einheiten gegenüber gewöhnlichem Chlor festgestellt. Das geringe Ausmaß der erzielten Trennung wird darauf zurückgeführt, daß von den drei genannten Quecksilberlinien nur die dritte mit einer Absorptionsbande von ClO_2 genau zusammenfällt und daß die anderen Linien, welche sich weniger eignen, im Gegensatz zu vorhandenen Literaturangaben eine Intensität besitzen, welche die der "geeigneten" Linie zusammen etwa um einen Faktor 4 übertrifft.

Following a discussion of the properties of the substance which on the one hand make possible the photochemical separation of isotopes and on the other hand reduce it, it is said that chlorine dioxide (ClO_2) is a substance with which good results can be expected when a suitable light source is used. An apparatus is described by means of which very pure chlorine dioxide can be prepared and irradiated under a pressure of about 0.2 mm Hg with practically pure light of the mercury lines 3650.15, 3654.83, and 3663.27 Å, while avoiding reaction chains, and which permits the chlorine thus released to be separated from unchanged chlorine dioxide. In the experiments carried out with the apparatus, it is found, on the one hand, that the quantum yield under the selected experimental conditions is indeed approximately equal to 1 and that practically only chlorine and oxygen are formed as decomposition products. On the other hand, a reduction in atomic weight of 0.016 units is found in the photochemically liberated chlorine as compared with ordinary chlorine. The small extent of the separation obtained is attributed to the fact that, of the three mercury lines mentioned, only the third coincides exactly with an absorption band of ClO_2 and that the other lines, which are less suitable, have, contrary to existing literature data, an intensity which exceeds that of the "suitable" line together by a factor of about 4.

G-156. Paul Harteck. The Separation of Isotopes with Special Reference to the Isotopes of Uranium. Die Trennung von Isotopen unter besonderer Berücksichtigung der Isotopen des Urans. 1942. pp. 10–11, 18.

10.) Das von einem Molekül angewendete Bandenspektrum (bezw. sein Absorbtionsspektrum) ist von der isotopischen Zusammensetzung abhängig, da jede Linie im Bandenspektrum durch eine quantenhafte Energieänderung seiner Elektronenenergie, der Schwingungs- und der Rotationsenergie des Moleküls entsteht. Setzt man die reduzierte Masse des Moleküls $\frac{m_1 m_2}{m_1+m_2}$ (wo m_1 und m_2 die Massen der Molekülpartner bedeuten) gleich μ, so ist bei einer Massenänderung von m_1, in m_1', d.h. von μ in μ' die Aenderung der Elektronenenergie in fast allen Fällen zu vernachlässigen; die Aenderung der Schwingungsenergie dagegen bedingt in erster Näherung eine Frequenzverschiebung um den Betrag

10.) The band spectrum applied by a molecule (i.e. its absorption spectrum) depends on the isotopic composition, since each line in the band spectrum is formed by a quantum energy change of its electron energy, the vibrational energy and the rotational energy of the molecule. If one sets the reduced mass of the molecule $\frac{m_1 m_2}{m_1+m_2}$ (where m_1 and m_2 mean the masses of the molecular partners) to μ, then with a mass change of m_1, in m_1', i.e. of μ in μ' to neglect the change of the electron energy in almost all cases; the change of the oscillation energy, on the other hand, causes in a first approximation a frequency shift of the magnitude

$$11. \qquad \Delta\nu_s = \left(\sqrt{\frac{\mu}{\mu'}} - 1\right)\nu_s$$

(ν_s = Frequenz der ursprünglichen Linie);

(ν_s = frequency of the original line);

die Aenderung der Rotationsenergie bewirkt näherungsweise eine Frequenzverschiebung um

the change of the rotational energy approximately causes a frequency shift by

$$12. \qquad \Delta\nu_{rot} = \left(\frac{\mu}{\mu'} - 1\right)\nu_{rot}$$

doch ist dieser Effekt sehr viel kleiner als der Schwingungsanteil, da ν_s sehr viel grösser als ν_{rot} ist.

but this effect is much smaller than the vibration component, because ν_s is much larger than ν_{rot}.

Zahlreiche photochemische Reaktionen werden durch optische Anregung eines der an ihnen beteiligten Moleküle ausgelöst. Verwendet man zur Anregung eine Linie, die nur von einem der isotopisch verschiedenen Moleküle absorbiert wird, so kann eine Trennung der Isotopen erreicht werden, wenn es gelingt, eine Abreaktion des abgespaltenen Atoms zu verhindern. W. Kuhn und H. Martin[16)] gelang nach dieser Methode eine Anreicherung des Chlorisotops ^{35}Cl unter Verwendung der photochemischen Dissoziation des Phosgens $COCl_2$, K. Zuber[17)] eine Anreicherung der Quecksilberisotope nach der photochemischen Reaktion (Hg + $h\nu$) + O_2 = HgO + O.

Numerous photochemical reactions are triggered by optical excitation of one of the molecules involved. If a line is used for excitation which is only absorbed by one of the isotopically different molecules, a separation of the isotopes can be achieved if it is possible to prevent an abreaction of the split atom. W. Kuhn and H. Martin[16)] succeeded in enriching the chlorine isotope ^{35}Cl with this method using the photochemical dissociation of phosgene $COCl_2$, K. Zuber[17)] enriched the mercury isotopes using the photochemical reaction (Hg + $h\nu$) + O_2 = HgO + O.

16) W. Kuhn u. H. Martin, Z. phys. Chem. (B) 21, 93 (1933)

17) K. Zuber, Helvet. phys. Acta 9, 285 (1936)

[From 1930 onward, papers such as those above demonstrated that a finely tuned metal plasma lamp could emit intense light of just the right wavelength to separate isotopes of that same type of metal, such as a mercury plasma lamp to separate mercury isotopes. In principle, a uranium plasma lamp could similarly be used to separate uranium isotopes, and it appears that there was significant wartime research in Germany to investigate that possibility. See the brief discussion in the Farm Hall transcripts about a photochemical process to enrich uranium (p. 3339).

In practice, a uranium plasma lamp probably would have consumed too much electrical power and produced too little light at just the right wavelength to be suitable for industrial-scale uranium isotope separation. Thus if there was any large-scale uranium isotope separation in the wartime German nuclear program, it probably relied on one or more of the methods covered in previous sections: centrifugation, electromagnetic separation, isotope sluice, and gaseous diffusion.

Nonetheless, this 1930s–1940s research in the German-speaking world on photochemical methods of isotope separation, together with research toward the development of lasers that was being conducted at the same time in the German-speaking world (Section C.3), was transferred to other countries during and after the war, and ultimately led to successful laser isotope separation programs decades later (p. 5127). For more information on the history, see:

V. S. Letokhov and C. B. Moore. 1976. Laser Isotope Separation (Review). *Soviet Journal of Quantum Electronics* 6:2:129–150. https://doi.org/10.1070/QE1976v006n02ABEH010865

V. S. Letokhov. 1979. Laser Isotope Separation. *Nature* 277:605–610.
https://doi.org/10.1038/277605a0]

D.4.6 Possible Locations of Uranium Enrichment Facilities

[In order to enrich enough uranium to a high enough concentration of uranium-235 for a bomb, it would have been necessary to have not just one enrichment unit (a centrifuge, electromagnetic separator, isotope sluice, or gaseous diffusion cell), but a large number of them operating in parallel and/or in series. Presumably after a prototype enrichment unit had been developed and proven to be satisfactory in small-scale laboratory experiments, the unit would have been mass-produced. The mass-produced units would have been set up in a new location with more room and better security.

The United States conducted its corresponding work at one massive facility in Oak Ridge, Tennessee. Proponents of the conventional view that Germany did not have a nuclear weapons program emphasize the apparent absence of an Oak-Ridge-like facility in wartime Germany. However, there are many counterarguments that must be considered:

- Oak Ridge enriched enough uranium for a gun-type bomb (Little Boy) that did not compress the uranium, was thus highly inefficient, and required ∼64 kg of ∼80% uranium-235. In contrast, as shown in Section D.8, the German atomic bomb was apparently a spherical implosion design (like the U.S. Gadget/Fat Man), which would have been much more efficient and would have required far less uranium ($\leq$ 10 kg). Therefore the German bomb program would have needed a far smaller production capacity than Oak Ridge.
- To minimize the risk that Allied bombing could destroy the whole program, German uranium enrichment would have been distributed among many different small sites, not concentrated in one large target. Indeed, that is exactly what was done, according to a declassified October 1944 OSS report based on information from Adolf Schneider, a senior manager of the Deutsche Waffen und Munitions-Fabrik (pp. 4400–4403).
- Any uranium enrichment conducted in the final years of the war would probably have been underground, like most other major German manufacturing. Being underground would have made it much easier for Germans to hide the enrichment facilities from Allied aerial surveillance during the war, and from Allied ground troops at the end of the war (by blowing up the entrances to the underground facilities).
- As shown in this section, primary source documents mentioned many different installations whose puzzling characteristics suggested that they might have been uranium enrichment facilities. Most of these documents ended up in the foreign intelligence files of the U.S. Manhattan Project, which means that Manhattan Project officials also thought these locations sounded like potential uranium enrichment facilities.
- Most of these potential uranium enrichment facilities were in areas of the Third Reich that ended up being occupied and stripped bare by Soviet forces, without western Allies ever having had the chance to study them.
- Even if some or all of the specific facilities mentioned in these documents were not doing nuclear-related work, they serve as excellent examples of how widespread, how sophisticated, and how secret German wartime industrial and weapons programs were, and how little we know about them to this day. Under these circumstances, it is difficult to rule out the possibility of nuclear-weapons-related production plants operating somewhere within the Third Reich, even if we cannot rule them in by pointing to their exact locations right now.

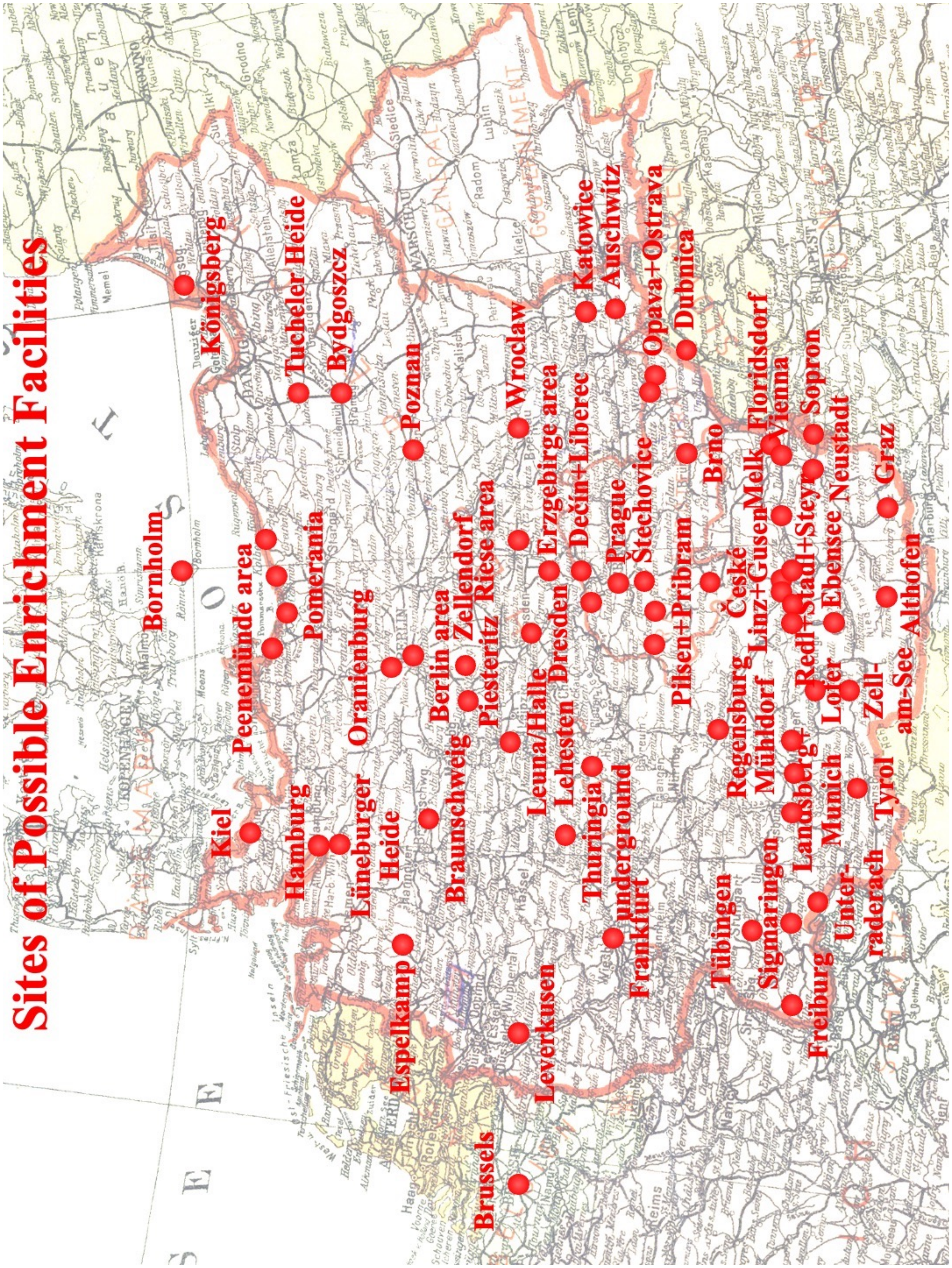

Figure D.256: Sites of possible enrichment facilities for the German nuclear program.

Some locations that may have been involved in uranium enrichment or other nuclear-related work include (see maps on pp. 3671 and 2086–2099):

Sites now in Germany:

- Berlin area, numerous locations (pp. 3438–3439, 3461–3463, 3608–3617, 3688, 3708–3709, 3926–3928, 4068, 4635–4639) [Hayes 2004; Nagel 2016].
- Bitterfeld, I.G. Farben facilities (pp. 3492–3493, 4050–4051, 4110, 4128, 4133–4137) [Karlsch 2005, p. 110; Sadovsky 2011b].
- Braunschweig, Buchler (pp. 3420, 3430–3431, 3458, 3460–3463, 3465, 4980).
- Dresden (pp. 3423, 3426, 4305, 4507).
- Erzgebirge, SS facility (p. 3708).
- Espelkamp [Preuss and Eitelberg 2003].
- Essen, Krupp (pp. 3458, 3461–3463, 3465–3467]).
- Frankfurt/Griesheim area, Degussa, Radium-Chemie, I.G. Farben, and other facilities (pp. 3440–3441, 3458, 3461–3465, 3678–3680, 4066–4067) [Hayes 2004; Nagel 2016].
- Freiburg-im-Breisgau/Feldberg area (pp. 3512–3540, 3681, 3696).
- Göttingen (pp. 3542–3544).
- Halle, I.G. Farben facilities (pp. 4052–4055).
- Hamburg area (pp. 3458, 3461–3463, 3465, 3494–3516, 4056–4061).
- Heinschenwall (pp. 3682–3683).
- Hohenzollern castle (p. 3696).
- Johanngeorgenstadt/Schneeberg/Freiberg area, Saxony (pp. 3416, 3424, 3426–3428, 3433–3437, 3445, 3456, 3468–3469, 3708, 4922) [Zeman and Karlsch 2008].
- Kaufering/Landsberg (p. 3692).
- Kiel (pp. 3494–3515).
- Koralle, north of Berlin (p. 3694).
- Lehesten (pp. 3689, 3696, 4080).
- Leuna, I.G. Farben facilities (pp. 4042–4050).
- Leverkusen, I.G. Farben facility (pp. 3488–3489, 3934–3935).
- Lübeck, Dräger Werke (pp. 4062–4063).
- Lüneburger Heide area, south of Hamburg (pp. 4176–4182, 4406).

- Müggenberg (pp. 4064–4065).
- Mühldorf (p. 3689).
- Munich area universities, research institutes, and industry (pp. 3498–3507, 4068).
- Neustadt an der Orla (pp. 3633–3638, 5052, 5055–5057).
- Nordhausen area (pp. 5289–5294).
- Oranienburg (pp. 3446, 3458, 3461–3463, 3465, 4180, 4182, 4980) [Nagel 2016].
- Peenemünde (p. 3696).
- Piesteritz, near Wittenberg (pp. 4082, 4452–4453).
- Regensburg vicinity, I.G. Farben facility (p. 3694).
- Rügen island (pp. 4390–4435).
- Saalfeld (p. 3689).
- Stassfurt vicinity, Salzbergwerke (p. 3697).
- Sigmaringen (p. 3696).
- Tegernsee (p. 3696).
- Thuringia, numerous facilities (pp. 3468–3469, 3708–3709, 3854–3868, 4436–4438, 4478–4571, 4635–4639) [Hayes 2004; Nagel 2016; Zeman and Karlsch 2008].
- Tübingen (p. 3696).
- Unterraderach/Friedrichshafen area (pp. 3921–3925).
- Villingen-Schwenningen am Neckar, W. Maier KG Radiumchemische Industrie und Laboratorium [Oleynikov 2000].
- Wittingen, W. de Boer (pp. 3458, 3461–3463, 3465).
- Zellendorf (p. 3694).
- Zeuthen-Miersdorf, near Berlin (p. 3608).
- Other possible sites in Germany?

Sites now in Austria:

- Althofen: Treibacher Chemische Werke (pp. 3420, 3432–3437, 3458, 3460, 4980) [Gollmann 1994].
- Ebensee (pp. 3718–3741, 5297–5299).
- Graz (pp. 4611–4612).
- Linz (pp. 3877–3880).

- Lofer (p. 4974).
- Melk vicinity or associated sites, underground facilities that were part of the Quarz development (pp. 3732, 4078–4079)) [Schmitzberger 2004].
- Redl Zipf/Voecklamarkt/Voecklabruck area (pp. 3718–3741).
- Rheinfelden, Degussa plant on Drau river (pp. 4080–4081).
- Stadl Paura (pp. 3718–3741).
- Steyr.
- St. Georgen/Gusen/Langenstein area (e.g., pp. 3874–3920 and 4962–4970).
- Vienna area universities, research institutes, and industry, including Floridsdorf (e.g., p. 3696).
- Weer, near Wattens, Tyrol (pp. 4072–4077).
- Weissenstein, Austrian Chemical Works plant on Drau river (pp. 4080–4081).
- Wiener Neustadt vicinity, underground facility (pp. 3732, 3748).
- Zell-am-See (p. 4788).
- Other possibles sites in Austria (pp. 3490–3491)?

Sites now in Poland:

- Baltic coast/Pomerania, many military test ranges (p. 4396).
- Bydgoszcz/Bromberg, underground facility (p. 4456).
- Gdansk/Danzig, uranium enrichment (pp. 3560, 4406, 4521).
- Oświęcim/Auschwitz area (pp. 4069, 4443–4477) large I.G. Farben facility (including heavy water plant), and nearby Auergesellschaft uranium facility at Katowice/Kattowitz.
- Poznan/Posen (pp. 2562–2575, 3245–3246).
- "Riese" area of Silesia (pp. 3328, 3424, 3429, 3445, 3471, 3712–3714, 4069, 4504–4519).
- Tuchola Forest/Tucheler Heide (p. 4902).
- Wrocław/Breslau (pp. 3712–3714, 4070–4071, 4316–4317, 4522).
- Other possibles sites in Poland?

Sites now in the Czech Republic:[11]

- Brno/Brünn (pp. 3694, 3997).
- Čelakovice/Tschelakowitz cyclotron factory (pp. 3979–4022).

[11] See also Czech information on World War II sites that appear to have radioactive contamination: https://www.sekm.cz and https://kontaminace.cenia.cz

- České Budejovice/Budweis (pp. 3979–4022, 5503–5566).
- Děčín/Tetschen area, Podmokly/Bodenbach/Krizik Works/Weserwerke (pp. 3936–3937, 3987–3998, 5503–5566).
- Durrnaul near Mariánské Lázně/Marienbad (p. 3424).
- Jáchymov/St. Joachimsthal area (pp. 3418–3429, 3445, 3469–3470, 3998, 4978–4984) [Hayes 2004, pp. 132–133, 235, 243].
- Liberec/Reichenberg and Jablonec/Gablonz area, Bedrichov/Friedrichsthal/Benesov nad Ploucnici and numerous other high-tech production facilities (pp. 3979–4022, 5503–5566).
- Litoměřice/Leitmeritz, Richard I, II, and III underground factories (p. 3689).
- Mladkov/Wichstadt (p. 3425).
- Opava/Tropau, I.G. Farben production plant (p. 3748).
- Ostrava/Ostrau and Vitkovice/Witkowitz, I.G. Farben and other industrial production plants (pp. 3748, 3979–4022, 5503–5566).
- Pardubice/Pardubitz/Wesser (pp. 3446, 4082–4083).
- Plzeň/Pilsen (p. 4974).
- Prague/Praha/Prag universities and other laboratories (pp. 3979–4022, 5503–5566).
- Příbram/Przibram/Pibrans (pp. 3423–3424, 3470, 3751–3754, 4921, 5696).
- Štěchovice/Stechowitz area, Blaumeise underground facilities (pp. 3755–3782).
- Other possible sites in the Czech Republic (pp. 3770–3771, 3979–4022, 5503–5566)?

Sites now in Slovakia:

- Dubnica/Dubnitz, Skoda underground facility (pp. 3784–3785).
- Other possible sites in Slovakia?

Sites now in Hungary:

- Sopron (pp. 3746–3747).
- Other possible sites in Hungary?

Sites now in Russia:

- Kaliningrad/Königsberg area, East Prussia (pp. 3928–3933).
- Other possible sites now in Russia?

Sites now in Denmark:

- Bornholm island (pp. 3786–3793).

- Other possible sites in Denmark?

Sites now in Belgium:

- Union Minière in Brussels or other locations (pp. 3335, 3408–3414) [Irving 1967, p. 65].
- Other possible sites in Belgium?

Sites now in Norway:

- Vemork (pp. 4031–4039).
- Såheim (p. 4040).
- Notodden (p. 4041).
- Trondheim (pp. 4404, 4436, 5011, 5034).
- Oslo area (pp. 5190–5198).
- Other possible sites in Norway?

Sites now in France:

- Génissiat area (pp. 3710–3711).
- Other possible sites in France?

Sites now in Italy:

- Montecatini plant, Sinigo-Merano, Italy (p. 4069).
- Montecatini plant, Cotrone/Crotone, Italy (p. 4069).
- Other possible sites in Italy?

Sites now in the Netherlands:

- Eindhoven (pp. 3976–3978, 4314–4318, 4832–4853).
- Other possible sites in the Netherlands?

Sites now in Switzerland:

- Factories producing uranium gas centrifuges for export to Germany (pp. 3545–3548).
- Other possible sites in Switzerland?

Sites now in Romania:

- Băiţa-Plai (pp. 3449–3455, 3471).
- Other possible sites in Romania?

Sites now in Bulgaria:

- Sofia area (pp. 3446, 3470, 4588) [Hayes 2004, p. 235; https://ejatlas.org/conflict/life-after-the-uranium-mines-in-buhovo-bulgaria].
- Other possible sites in Bulgaria?

Miscellaneous sites:

- Facilities run by or involving AEG.
- Facilities run by or involving Siemens.
- Other facilities run by or involving I.G. Farben (pp. 3488–3489, 3492–3493, 3678–3680, 3748–3750, 4440–4477) [Mader 1965, pp. 193–202].
- Other facilities run by or involving Degussa.
- Other facilities run by or involving Auer.
- Other facilities run by or involving the SS.
- Other facilities run by or involving the Reichspost.
- Other facilities run by or involving the Heereswaffenamt.
- Other facilities run by or involving the Luftwaffe.
- Other facilities run by or involving the Kriegsmarine.
- Other facilities run by or involving the Organisation Todt.
- Other possible sites?

All of these possible nuclear weapons production sites (and any other candidate sites that can be identified) should be investigated further. Hopefully additional documents could be found that would elucidate whether these sites conducted nuclear or non-nuclear work. If there is significant documentary evidence that a site may have done nuclear work, and if there is reason to believe that that work may have left measurable traces, industrial archaeology should be conducted at that site to measure isotopes, search for remaining pieces of equipment, or identify other evidence.

As already mentioned, the large number, size, and sophistication of all of these sites, and how little information scholars currently have about them, should at the very least emphasize (1) how vast wartime German R&D programs were, (2) how little we still know about some of them, and (3) how unwise it would be for historians currently to categorically state that there was no nuclear-weapons-related development and production anywhere in the Third Reich.]

Known/Reported Sites Now in Germany

[In addition to the sites specifically mentioned in this section, documents elsewhere throughout this appendix name a large number of other sites in Germany that were known or suspected to be conducting nuclear-related work.]

Summary of Bacteriological/Chemical Warfare in Axis Europe. Supp. Report #2. 11 March 1944. [NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)] See document photo on p. 3679.

Southern Bavaria is believed to be the location of the first trials of a new German explosive, manufactured by I. G. Farben and said to be another of Germany's secret weapons. Griesheim is reported to be the location of the I. G. Farben plant where the new explosive is being manufactured. Difficulties have been encountered in its production on required scale owing to the scarcity of the "raw materials required for preparation of two of the constituent compounds."

Further experiments on another of Germany's secret weapons are now being conducted in the neighborhood of Semmering, Germany.

Vienna is said to be an important research center in Germany.

[See document photos on pp. 3679–3680.

This 11 March 1944 intelligence report mentioned planned tests of a new type of German bomb using rare materials that were manufactured (among other places) at I.G. Farben Griesheim.

Independently, it was reported that Griesheim was producing heavy water (pp. 4066–4067).

The Griesheim plant appears to have been occupied and tightly controlled by the U.S. military for nearly a year and a half after the war. See for example:

https://de.wikipedia.org/wiki/Chemische_Fabrik_Griesheim-Elektron

and sources cited therein.]

NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)

SECRET

SUMMARY OF

BACTERIOLOGICAL/CHEMICAL WARFARE

IN AXIS EUROPE

Supp. Report #2

MAR 11, 1944

This report deals principally with plants in Germany and in German-occupied territory having bacteriological capabilities, as well as with leading civilian and military personalities connected with these plants or with bacteriological research.

The report contains nothing of interest to us in the way of scientific personnel but several locations mentioned in connection with research, experimentation and manufacture may be of some interest.

Southern Bavaria is believed to be the location of the first trials of a new German explosive, manufactured by I. G. Farben and said to be another of Germany's secret weapons. Griesheim is reported to be the location of the I. G. Farben plant where the new explosive is being manufactured. Difficulties have been encountered in its production on required scale owing to the scarcity of the "raw materials required for preparation of two of the constituent compounds."

Further experiments on another of Germany's secret weapons are now being conducted in the neighborhood of Semmering, Germany.

Vienna is said to be an important research center in Germany.

Figure D.257: This 11 March 1944 intelligence report mentioned planned tests of a new type of German bomb using rare materials that were manufactured (among other places) at I.G. Farben Griesheim [NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)]. See also pp. 4066–4067.

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I. Plants Which Have Been Specifically Mentioned as Having Bacteriological Capabilities Cont.

Location	Name	Remarks
A. GERMANY Cont.		
Vienna	Vienna University	An important research center in Germany.
B. FRANCE.		
Suresnes, near Paris	Fondation Foch	German Hygienic Service established a bacteriological laboratory here in 1940.

II. CHECK LIST OF CHEMICAL WARFARE PLANTS WHICH MIGHT HAVE BACTERIOLOGICAL CAPABILITIES.

Location	Name	Remarks
A. GERMANY.		
Bavaria, Southern		First trials of new German explosive, manufactured by I. G. Farbenindustrie were made in southern Bavaria. The new explosive is believed to be another of Germany's secret weapons.
Griesheim	I. G. Farbenindustrie	Manufacturing another of Germany's secret weapons, which takes the form of a new explosive. Difficulties are encountered in its production on the required scale owing to the scarcity of the "raw materials required for the preparation of two of the constituent compounds." (See III/f II report, dated 2/24/44, Griesheim.)

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II. Check List of Chemical Warfare Plants Which Might Have Bacteriological Capabilities Cont.

Location	Name	Remarks
A. GERMANY Cont.		
Mauthausen (southern Bavaria)		Experiments with poison gas were made in Dec. 1942 on political prisoners taken from the concentration camp Mauthausen. The experiments were carried on in an isolated factory about 50 miles from the camp.
Munich	Factory	Believed to be poison gas factory. Source worked with other P/Ws in unloading large quantities of onions and apples - presumed to be for the manufacture of poison gas. Truck loads of steel cylinders seen leaving the factory; destination unknown. P/Ws were never allowed inside the factory.
Semmering		Further experiments on another of Germany's secret weapons is now being conducted in the neighborhood of Semmering. (See Bavaria, southern).
B. FRANCE.		
Lannemezan (Haute Pyrenees)	"ESPA" chemical works	Manufactures spirits of salt, ammonia, carbide and various nitrogen compounds. Has recently started the production of gas for bomb fillings. Entire production exported to Germany.

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NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944). Bacteriological/Chemical Warfare in Axis Europe, Supplementary Report #2, 11 March 1944

Figure D.258: This 11 March 1944 intelligence report mentioned planned tests of a new type of German bomb using rare materials that were manufactured (among other places) at I.G. Farben Griesheim [NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)]. See also pp. 4066–4067.

SECRET (Copy # 1a , of 44)
5 May 1944
1231

Deputy AC of S G-2

SECRET
By authority A. C. of S., G-2,
Date 5 MAY 44 (S.L.C.)
Initials

Information on a secret German underground rocket factory obtained from an Infantry Private captured in Tunisia 7 May 1943. Information received in the U.S. 4 May 1944.

The factory is located according to the prisoner, 1 km. N.W. of Feldberg in Baden. Coordinates of Feldberg are: 47.52 N, 8.2 E.

Information has not been verified by other sources, and should not be accepted at face value.

The prisoner's brother-in-law worked at this secret establishment for some time during the winter of 1940-41, and it is from him that the prisoner derived all information below not specified as his own at first hand.

The prisoner was first told by his brother-in-law that very important wofk was being conducted at the factory which if it turned out well would change the whole aspect of the war for the Germans. At this time he added no further details beyond saying that it was concerned with new explosives and ray weapons. At some point in the winter of 1940-41 he went a little further declaring that the object in view was to produce a terrifically effective liquid explosive. The investigations were already far advanced but had not yet attained precisely what the investigators were looking for. It was, however, his belief that an explosive had even then been developed so powerful that it put all others in the shade. Work was likewise in progress on a television instrument for projectiles, which was to be fitted to the rocket missiles the Germans were developing if it proved successful. At that stage the only difficulty with these rockets, otherwise very satisfactory, was that they did not yet have an adequate range but, in the opinion of prisoner's informant, this was a matter which depended only on the explosive propellant which was exactly what the Germans were endeavoring to improve. In connection with the explosive itself, it was found difficult to store it in very large quantities as it detonated immediately on contact with oxygen. Hence, both the explosive as such had to be stored, and the projectiles loaded with it, in chambers entirely free of air. (It is not explained how any workers could have breathed during the loading of the projectiles under the circumstances, but perhaps the process was entirely mechanical- Editors Note).

In the Spring of 1941 the prisoner's brother-in-law made an attempt to get permission for the prisoner to attend certain important tests which were to be held the following summer but he was unable to do so. He also then told the prisoner more about the television instrument above mentioned. It was to have a beryllium casing. All kinds of other alloys had been tried for this purpose but until beryllium was used nothing worked. The inner circumference of the instrument was 37 cm. and about one fifth of its internal space was occupied by the mechanism. 26 meters of platinum wire were used in the instrument. It was fitted with twelve photographic eyes, of which the openings sloped at an angle forward.

No fears were entertained that the instrument might fall into enemy hands only slightly damaged, because it would automatically be blown to pieces as soon as it came within 150 m. of the ground.

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The ignition for the explosive charge by means of which this was accomplished operated by a system based on terrestrial magnetism.

During the summer of 1941 the prisoner was informed that the explosive to be employed both in the bursting and propellant charges of the rocket projectiles had been finally perfected. It was designated K.Z.O. and was also to be used in new artillery projectiles. A new 125 mm. twin gun had been constructed for that purpose. The barrels for this weapon had to be much stronger than those of an ordinary cannon. They were also somewhat longer. The shells were intended for use as AA, and were capable of reaching a height of 16,000 meters. They had very great explosive force.

Experiments with rocket projectiles went on through the fall of 1941 and the succeeding winter. They achieved a high degree of success. Most of them took place on the Lueneburger Heide. On one occasion some were carried out at the Krupp artillery proving grounds. By the summer of 1942 it was stated to the prisoner that a range of 800 km. could be attained with the rocket projectile. The one then in use had a 15 cm. calibre. The range mentioned was really only reached late in the autumn of 1942. The later experiments involved did not occur on the Lueneburger Heide. At what exact location they were conducted the prisoner does not know, but he was informed that it was somewhere in the North and the rockets were aimed toward Norway. He was not told in just what area they fell.

The last informatiön which the prisoner received from his brother-in-law dates from May 1943. It was to the effect that tests were about to be made with 52-cm. rocket projectiles. The informant then estimated that at earliest the projectiles would come into practical use by the summer of 1944. Great pressure is being exercised in the conversion of industries to produce this new weapon, but, the informant wrote "all good things take time". He likewise estimated that the twin 125 mm. cannon above would be used in the field about November or December, 1943.

From his personal knowledge of his brother-in-law the prisoner is convinced in his own mind that he was not telling lies. He goes on to state (apparently on his own authority) that ever since the summer of 1941 the personnel employed on the above projects have from time to time been sent for their health to a hotel in St. Georgen located a few km. West of Villingen, but not the one on the S.W. edge of Freiburg-in-Breisgau. The prisoner is not certain of the precise identity of the hotel but believes it to be one which is not very well-known. When the personnel go there it is under Gestapo supervision and they are allowed to talk to nobody. There is also a "home" for them somewhere, but all the prisoner knows about it is its existence.

What follows is the prisoner's account of his own visit to the establishment already in part described in the autumn of 1941. He calls it "Kriegslaboratorium"(war laboratory).

The prisoner was met at Freiburg-in-Breisgau by his brother-in-law. They then drove for twenty minutes in a car, stopping in a young forest, where the car was driven into one of several very well camouflaged garages. The prisoner says that if they had not been pointed out to him he would never have believed that there were any garages there. It is his belief that an entrance (presumably underground - Editor's Note) led all the way from the place where they stopped to the laboratory, but he can give no definite information on this subject. In any case, after stopping they walked for two hours. He asked whether it was always necessary to do this in order to reach the laboratory. His brother-in-law laughed at him and a Gestapo agent who accompanied them told him not to be so curious.

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He did not enter what he calls the "Feldberghaus" itself, which his brother-in-law told him was the headquarters of the entire project. Instead they went into a hut which from the outside was exactly like a large hunting lodge. In reality it was the entrance to an elevator. Outside the height of the hut was about 5 or 6 meters but inside steps went down for some 9 meters. At this point a gallery led off but the prisoner knows neither where it went nor anything else about it. They then went down in an elevator, for about twenty meters, according to another Gestapo man who was with them. Here the prisoner was shown the process by which the explosive was drawn off into flasks made of steel, and from then again into still smaller ones. He was supposed to make up his mind whether the "shut-off" apparatus" could be used for torpedoes. In his opinion it could not.

In another room he was shown various explosive projectiles. Steel capsules were here filled with different explosives of which he does not remember the names. The walls of these capsules were 3 cm. thick. None of the types of explosive first used could burst them. Next, two of the capsules were filled with K.Z.O., and the charge ignited. Both burst.

The prisoner then asked to be taken to the storeroom. This was done. They went down to a level of 40 meters, (below the surface? or below the point they had already reached?- Editor's Note). Then they traveled about a kilometer on a level track R.R. They next transferred to another car and traveled a further 2½ km. in a slightly downward direction until they had reached a floor level of 72 meters. The prisoner does not know in what direction they traveled.

The corridor to which they finally came, he estimates to have been about 300 meters long. From it storerooms opened. They then entered a room in which they put on rubber suits which shut them off completely from the air. Afterwards they went into a second room which proved to be only an anti-chamber. When the door had been shut the prisoner states that the air was entirely pumped out of this room, but this he said he did not learn until he got back to the railroad station. They remained in the anti-chamber for approximately ten minutes. The door of the actual storeroom was then opened. In it were kept uncovered containers filled with explosive.

When they were once more outside and had taken off their rubber suits there was a discussion. One of the men said to the prisoner, who seems at that time to have been working with torpedoes,"You are going into the water and we into the air." As this remark was rather puzzling, another man added: "Of course, torpedoes for you and rockets for us." The prisoner felt that he had better conceal from them quite how much he knew already about their activities, so he merely murmured: "Oh yes, storm-rockets." One of the previous speakers looked at him, and then telling him to follow, led him into the room where the rockets were stored. This room was not air-free. He was not allowed to get very near the rockets nor to stay in the room for more than two minutes. The rocket projectiles he saw were, he thinks, about 230 cm. long.

They then returned by the same way they had come. He had been in the establishment, all told, about four hours. One individual whom he mentions having seen there was a Doctor Ernst. Before he left he was obliged to sign a paper to the effect that everything which he had seen or heard in this place was a state secret and that to reveal any of it was an offense punishable with death. The Gestapo agents stayed at the railroad station. He later learned that a good many of them were kept on duty in that vicinity.

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1231 Page 4

In a subsequent talk the prisoner's brother-in-law observed that he was convinced provisions had been made for the work to be continued elsewhere should there by misfortune be an accident with the explosive which destroyed the actual establishment. But he had no idea where the alternative site might be situated. He also told the prisoner that the villages adjacent to the underground factory, where its workers lived, had been bought up some time before. The fields were farmed by the families of the Gestapo men in order not to attract notice by their being left unplanted. He believed that well-trained police dogs were used in the area and that these animals were such as had been employed for similar purposes over many years in Germany or abroad. The entire district was infested with individuals who seemed to be tramps but who were really Gestapo agents. He thought that there were beside various technical security measures, but was ignorant of their nature. In fact, he did not think that there was any single person who knew them all. He believed it more probable that each man was familiar with only one security measure. It was his idea that, when it was considered perfect security had been assured for the project, the area would again be opened to the public. In that case the personnel would have to get out of the Feldberghaus. He knew at least that a new house was being built to the N.W. of this structure, however, he was not aware for what purpose it was intended. Neither could he supply any information about how and when the building of the laboratory had been begun, except that it was his impression that this had taken place in connection with the work on the Western frontier defenses. He asserted that it had not been necessary to carry all the material underground on the elevator which the prisoner saw, saying that other entrances and exits existed for that sort of thing. However, he did not say where they were, observing merely that they were well-placed. Nor did he make any statement about the transportation of materials.

In the Autumn of 1941 the prisoner again met Dr. Ernst, above mentioned, at some kind of a meeting in Magdeburg. The talk turned to the war and the weapons with which it was fought. This led Ernst to put forward the claim that if he was successful in his experiments with certain rays, to which he owed the mutilation of one of his hands, the war would be won. He was convinced that the enemy could find no way of counteracting the effect of the rays, and that they would kill an immense number of men. He spoke too of rays which were to be used against planes. But he gave no additional details whatever about either kihd of ray.

Catesby ap C. Jones
CATESBY ap C. JONES,
Colonel, G.S.C.,
Chief, Prisoner of War Branch.

DIST:

DEP A C of S G-2	1		
CH TH G	2	BE	24-26
EUR	3-12	ETO	27
DISS	13,14	CSDIC (Alg)	28
EO	15	DC	29,30
AIR UN	16,17	JIS	31
AIR INT	18-20	AAF CO	32
ASF	21	POW	33-37
NAVY	22,23		

NARA RG 77, Entry UD-22A, Box 165, unlabeled gray folder

Figure D.259: Gatesby ap C. Jones. 5 May 1944. PW interrogation report 1231 [NARA RG 77, Entry UD-22A, Box 165, unlabeled gray folder]. From the description, this Feldberg facility sounds like a potential nuclear site, and Leslie Groves's Foreign Intelligence Unit also thought it sounded like a potential nuclear site.

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NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July–October 1944)

Col Brown CPM

ANS/rlj SECRET (Copy 20, of 50)
ccc 23 October 1944
1353 SECRET
By authority A.C. of S., G-2
Date [illegible] ([illegible])
Initials

REPORT FROM CAPTURED PERSONNEL AND MATERIAL BRANCH

Information from several German army Ps/W captured in France in August 1944 and two Ps/W captured in Italy in June and July 1944. Obtained in the U. S. 13 - 16 October 1944. Believed reliable, not verified from other sources.

1353 (P. 10)

XIV. HEINSCHENWALL NEAR BREMEN - UNDERGROUND FACTORY: (cf. attached sketch)

P/W studied chemistry for two years (1942-43) at the Chemo-technical College (Chemotechinka) in Bremen-Neustadt, president, Prof. Dr. Ernst Schliemann. As part of his studies he worked in laboratories of various factories in the Bremen area and had the opportunity to visit a number of plants.

In the summer of 1942 P/W, together with some other students, made a bicycle trip from Bremen via Bremervoerde to an underground factory located in a part of the Hinzel forest near Heinschenwall called Horner Holz. The area was very heavily guarded by SS with police dogs. Everybody passing through the gate was automatically photographed from two sides. Roads, storage rooms and other buildings could be seen to stretch underground for a considerable distance and there were elevators leading to the surface. The only building P/W entered was a laboratory for testing the strength of the cement used in building the underground installation, where construction was still under progress. Very modern testing machines were used in this laboratory. P/W saw workers carrying small yellow cartons, approximately 40 x 40 x 20 cm., very carefully one at a time to a storage room, although they did not seem to be heavy. One of his fellow students, who had been there before, said that special bombs, including "freezing" bombs and torpedoes, were made and stored in that underground installation. Aboveground some cemented guard bunkers and some guard towers could be seen.

Figure D.260: Report from Captured Personnel and Material Branch. 1353. 23 October 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)].

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NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July–October 1944)

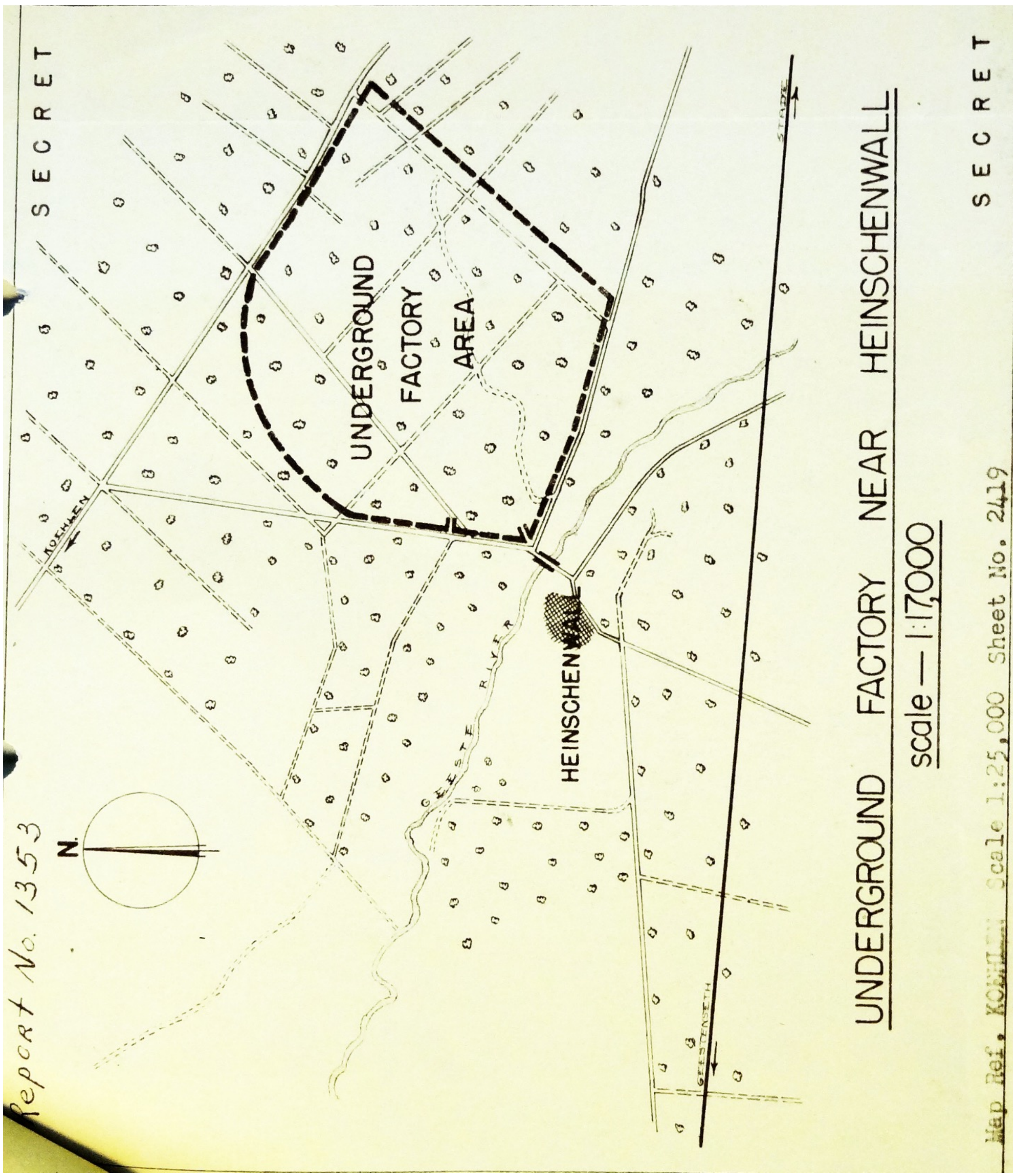

Figure D.261: Report from Captured Personnel and Material Branch. 1353. 23 October 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)].

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-1 GERMANY: US Wartime Positive Int. (July 42–June 44). Horace Calvert to Robert Furman. Undated but apparently Feb. 1944.

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9416

MEMORANDUM FOR MAJOR R.R. FURMAN:

Subject: German Plants that might be working with Uranium.

A prel. survey of the German Chemical industry has been made for the purposes of determining possible chemical plants within Germany that are possibly engaged in the production of U. metal, and the bomb damage sustained by each, if any. Inasmuch as there are some 17,141 chemicals plants in Germany proper this survey was limited mainly to the two largest German Chemical units, namely, I. G. Farbenindustrie, A. G., and Wintershall, A. G., and to those plants that were known to have been engaged in the handling and processing of precious metals before the war. ~~Although~~ However, there was no concerted effort to determine names and localaties of all Germany's precious metal producers inasmuch as FEA has presently undertaken such an assignment at your request. ~~However,~~ A curosy examination was made of all the larger German chemical plants to the extent of the information on file in the FEA, which is very brief in respect to many of the plants.

1. I. G. FARBENINDUSTRIE, A. G.

As you know I. G. Farben is Germany's largest Chemical Combine with its headquarters in Frankfort a/m.

In some important commodity groups, plant management and commodity distribution are concentrated in many cities for attaining desirable ends of decentralization. Thus control over the pharameceutice trade

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written by Calvert

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is centered in the Bayer work at Leverkusen; photographic film and rayon in the Afga headquarters in Berlin; ammonia in the Leuna plant, etc. However, general managerial control, policy, technical supervision, etc., are concentrated in Frankfort.

The larger I. G. plants are as follows:

NAME	CAPITALIZATION IN RM(millions)	RANK ORDER IN GERMANY
Ludwigshafen (Bombed numerous times - overall destruction evaluation is D +)	300	1
Leuna (Bombed numerous times - overall destruction unestimated)	135	2
Leverkusen (Bombed numerous times - overall destruction unestimated)	100	3
Elberfeld	50	8
Frankfort (Bombed numerous times, the latest raids in February of which the reports are not prepared as of date. In the raids of 22 October 1943, 18 November 1943, 25 November 43, the plant sustained slight damage. Received some damage in the raid of 20 December 1943. In the USAAF raid of 29 January 1944 it sustained major damage. Overall classification of bomb damage would be "C".)	60	6.1
Griesheim	60	6.2
Bitterfeld I Bitterfeld II	75	5
Rhienfeld	2	27.1
Offenbach (Bombed on 20 December 1943 sustaining slight damage, probably received additional damage in bombings of February on Frankfort.)	10	10.3
Premnitz (Hadn't received any damage as of 1 February 1944.)	30	4

The I. G. Farbenindustrie is the logical Chemical Company that would be engaged in any German operation of large scale isotope separation, if

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Germany undertook such an operation. The company's experience in heavy chemicals, and, it being a Chemical combine comparable to DuPont would lead me to believe that it is the most likely company to be engaged in such production. From examination of FEA files no new large construction programs were being undertaken by I.G. other than normally building in their established plants. There was nothing on the scale anyways comparable to what is believed to be necessary for such an operation. There was one report of an installation near Brandenburg that was described as a huge plant, "secret factory." The production was not known. The plant was surrounded by huge steel fence. The plant was situated in a swampy and desolate area with few settlements. This plant could be an I.G. plant. This will be investigated further, also topographical terrain will be studied, availability of power supply, etc.

For the reason that it would almost be impossible by such methods to determine possible locations, most of the survey was directed towards those I.G. plants that had experience in Fluorine. The two main I.G. producers of hydrofluric acid are Leverkusen and Bitterfeld and would probably be the most logical location where a K-25 separation would be located provided a separate and individual plant had not been erected for such purposes, Even if there has been separate installation constructed, these plants would be the logical place for a pilot plant for a K-25 job. From RAF reconnaisance pictures there was no evidence of ~~any~~ new construction of any importance at Leverkeusen. Likewise there was no new construction at Bitterfeld with the exception of one new building of app. size, 820" x 150". Utilization of this new building was not given. Both

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Leverkusen and Bitterfeld have sustained rather heavy bomb damage. Bitterfeld sustaining probably ~~more severely~~ the greatest damage due to the large raids on Frankfort during last month. For a detailed list of all the larger I.G. plants see attached list.

2. WINTERSHALL, A. G.

Wintershall Chemical Company is Germany's second largest Chemical company with its home office in Berlin. As a means of comparison in size with I.G., it should be pointed out that Wintershall's capitalization in RM (millions) is 112.5, while I.G.'s capitalization is 800, or in other words Wintershall in terms of capitalization is not even as large as I.G.'s biggest plant--Leuna. Wintershall's chief subsidaries are Sprengstoffwerke Kiesilebach, (50%), and Mitteldeutsche Sprengstoffwerke, Langelshiem (36%). The main products are potash, alkalies. It is the owner of a large number of potassium salt mines and plants for the milling and purification of the salts. They are also producers of nitrogen, ammonia, fertilizers (nitrogen and potassium), and nitric acid. The main plant at Rauxel, 7 miles N.W. of Dortmund. While no evidence of bomb damage to Wintershall could be found, Dortsmound has been bombed numerous times and undoubtedly Wintershall has been damaged, at least indirectly through the bombing of Dortmund. In this survey there was nothing uncovered to give the impression that Wintershall would be of interest to us more than any other large German Chemical company.

3. Refiners of precious metals and bomb damage they have sustained.

A. Deutsche Gold und Silber Scheideanstalt

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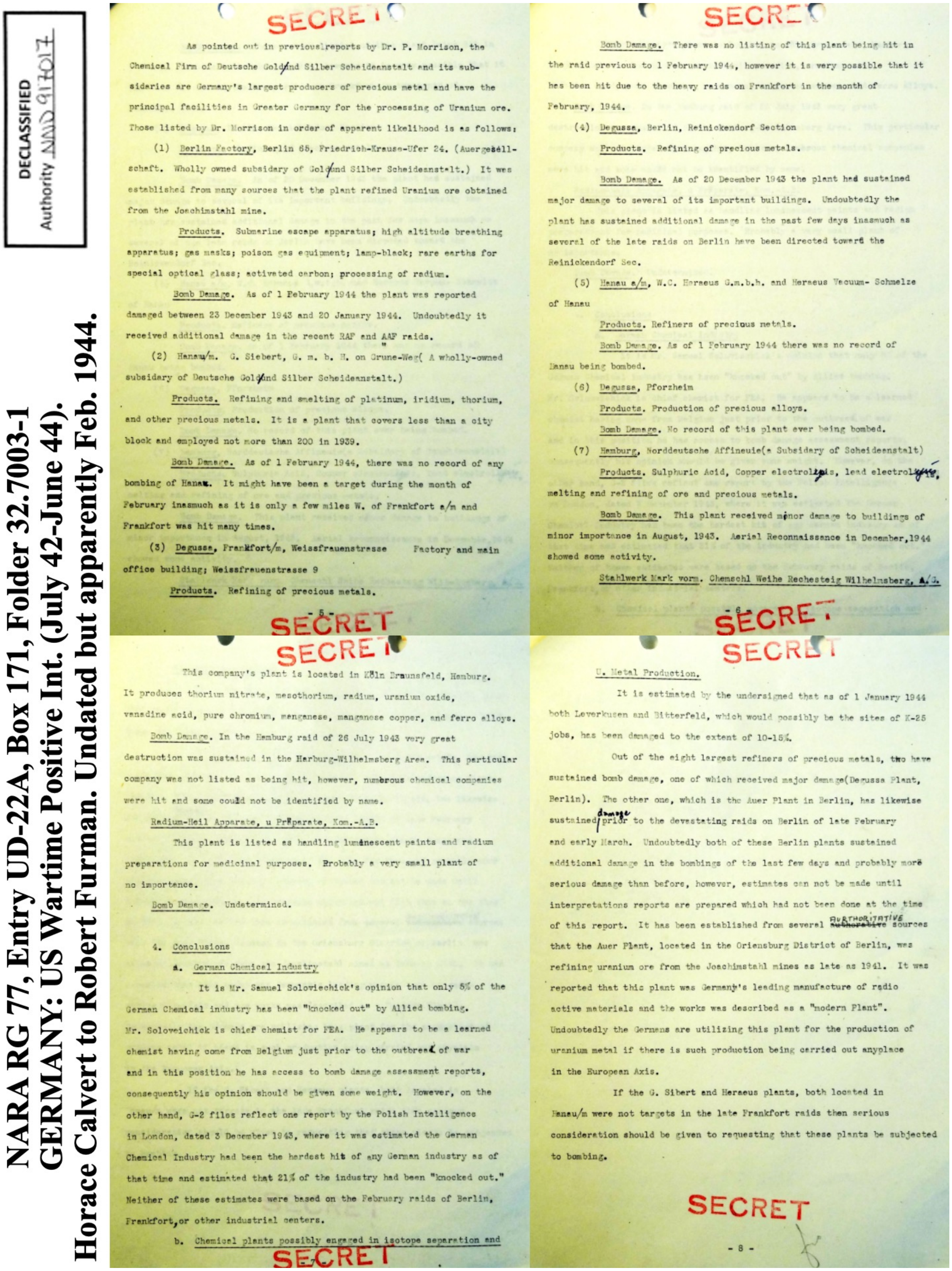
Figure D.262: Horace Calvert to Robert Furman. Undated but apparently February 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-1 GERMANY: US Wartime Positive Int. (July 42–June 44)]



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Authority NND 917017

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-1 GERMANY: US Wartime Positive Int. (July 42–June 44). Horace Calvert to Robert Furman. Undated but apparently Feb. 1944.

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As pointed out in previous reports by Dr. P. Morrison, the Chemical Firm of Deutsche Gold and Silber Scheideanstalt and its subsidaries are Germany's largest producers of precious metal and have the principal facilities in Greater Germany for the processing of Uranium ore. Those listed by Dr. Morrison in order of apparent likelihood is as follows:

(1) Berlin Factory, Berlin 65, Friedrich-Krause-Ufer 24. (Auergesellschaft. Wholly owned subsidary of Gold and Silber Scheideanstalt.) It was established from many sources that the plant refined Uranium ore obtained from the Joachimstahl mine.

Products. Submarine escape apparatus; high altitude breathing apparatus; gas masks; poison gas equipment; lamp-black; rare earths for special optical glass; activated carbon; processing of radium.

Bomb Damage. As of 1 February 1944 the plant was reported damaged between 23 December 1943 and 20 January 1944. Undoubtedly it received additional damage in the recent RAF and AAF raids.

(2) Hanau/m. G. Siebert, G. m. b. H. on Grune-Weg(A wholly-owned subsidary of Deutsche Gold and Silber Scheideanstalt.)

Products. Refining and smelting of platinum, iridium, thorium, and other precious metals. It is a plant that covers less than a city block and employed not more than 200 in 1939.

Bomb Damage. As of 1 February 1944, there was no record of any bombing of Hanau. It might have been a target during the month of February inasmuch as it is only a few miles W. of Frankfort a/m and Frankfort was hit many times.

(3) Degussa, Frankfort/m, Weissfrauenstrasse Factory and main office building; Weissfrauenstrasse 9

Products. Refining of precious metals.

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Bomb Damage. There was no listing of this plant being hit in the raid previous to 1 February 1944, however it is very possible that it has been hit due to the heavy raids on Frankfort in the month of February, 1944.

(4) Degussa, Berlin, Reinickendorf Section

Products. Refining of precious metals.

Bomb Damage. As of 20 December 1943 the plant had sustained major damage to several of its important buildings. Undoubtedly the plant has sustained additional damage in the past few days inasmuch as several of the late raids on Berlin have been directed toward the Reinickendorf Sec.

(5) Hanau a/m, W.C. Heraeus G.m.b.h. and Heraeus Vacuum- Schmelze of Hanau

Products. Refiners of precious metals.

Bomb Damage. As of 1 February 1944 there was no record of Hanau being bombed.

(6) Degussa, Pforzheim

Products. Production of precious alloys.

Bomb Damage. No record of this plant ever being bombed.

(7) Hamburg, Norddeutsche Affineuie(a Subsidary of Scheideanstalt)

Products. Sulphuric Acid, Copper electrolysis, lead electrolysis, melting and refining of ore and precious metals.

Bomb Damage. This plant received minor damage to buildings of minor importance in August, 1943. Aerial Reconnaissance in December, 1944 showed some activity.

Stahlwerk Mark vorm. Chemschl Weihe Rechesteig Wilhelmsberg, A/G.

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This company's plant is located in Köln Braunsfeld, Hamburg. It produces thorium nitrate, mesothorium, radium, uranium oxide, vanadine acid, pure chromium, manganese, manganese copper, and ferro alloys.

Bomb Damage. In the Hamburg raid of 26 July 1943 very great destruction was sustained in the Harburg-Wilhelmsberg Area. This particular company was not listed as being hit, however, numerous chemical companies were hit and some could not be identified by name.

Radium-Heil Apparate, u Präparate, Kom.-A.B.

This plant is listed as handling luminescent paints and radium preparations for medicinal purposes. Probably a very small plant of no importance.

Bomb Damage. Undetermined.

4. Conclusions

a. German Chemical Industry

It is Mr. Samuel Soloviechick's opinion that only 5% of the German Chemical industry has been "knocked out" by Allied bombing. Mr. Soloveichick is chief chemist for FEA. He appears to be a learned chemist having come from Belgium just prior to the outbreak of war and in this position he has access to bomb damage assessment reports, consequently his opinion should be given some weight. However, on the other hand, G-2 files reflect one report by the Polish Intelligence in London, dated 3 December 1943, where it was estimated the German Chemical Industry had been the hardest hit of any German industry as of that time and estimated that 21% of the industry had been "knocked out." Neither of these estimates were based on the February raids of Berlin, Frankfort, or other industrial centers.

b. Chemical plants possibly engaged in isotope separation and

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U. Metal Production.

It is estimated by the undersigned that as of 1 January 1944 both Leverkusen and Bitterfeld, which would possibly be the sites of K-25 jobs, has been damaged to the extent of 10-15%.

Out of the eight largest refiners of precious metals, two have sustained bomb damage, one of which received major damage(Degussa Plant, Berlin). The other one, which is the Auer Plant in Berlin, has likewise sustained damage prior to the devastating raids on Berlin of late February and early March. Undoubtedly both of these Berlin plants sustained additional damage in the bombings of the last few days and probably more serious damage than before, however, estimates can not be made until interpretations reports are prepared which had not been done at the time of this report. It has been established from several ~~authorative~~ AUTHORITATIVE sources that the Auer Plant, located in the Oriensburg District of Berlin, was refining uranium ore from the Joachimstahl mines as late as 1941. It was reported that this plant was Germany's leading manufacture of radio active materials and the works was described as a "modern Plant". Undoubtedly the Germans are utilizing this plant for the production of uranium metal if there is such production being carried out anyplace in the European Axis.

If the G. Sibert and Heraeus plants, both located in Hanau/m were not targets in the late Frankfort raids then serious consideration should be given to requesting that these plants be subjected to bombing.

SECRET

- 8 -

Figure D.263: Horace Calvert to Robert Furman. Undated but apparently February 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-1 GERMANY: US Wartime Positive Int. (July 42–June 44)]

H. W. Dix to Francis J. Smith. 14 April 1945. SUBJECT: AZUSA. [NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL] See document photos on pp. 3687–3688.

From a cable from Stockholm dated 12 April 1945 the information below is paraphrased for your use. The information is dated 7 April 1945 and is obtained from a source which is experienced in weapons, and is reliable.

1. V weapon. The German experimental station at Peenemünde has been evacuated and moved to Wilhelmshafen and Plauen according to definite information. Professor [Herbert A.] Wagner is the head of the experimental station. Rocket bomb type Hs (Henschel) 117, also called Luftgoliath, is the subject of most experiments at present. This controlled rocket bomb is a long range weapon. 8000 meters is the height to which it can be shot with precision. Is propelled vertically towards [from] the ground. This weapon can be directed into groups of enemy planes by means of remote radio control. In October 1944 at Lüneburger Heide in experiments all of a group of 12 of their own [...] remotely controlled planes sent up were shot down with only 1 shot.

4000 of the Hs 117 have now been delivered. [...]

V weapons which are grenades of flying bombs filled with an unknown gas, which is harmless in itself, are, according to vague rumors, manufactured somewhere in Germany (location unknown). When this projectile strikes, a very high pressure is developed which kills living creatures within a radius of from one to four kilometers. Even insects such as beetles are killed by the explosion according to reports. [...]

5. There is an "SS Gebiet" surrounded by double barbed wire charged with high voltage not far from Berlin, at Neunburg. 40,000 [...] forced laborers who may not leave are within this area. Some well known technicians who visit the place sometimes stay more than a week. The product manufactured here is not known. There is very strict guarding by SS, and people have been shot without warning when they wandered too near the barricade.

[There were several independent reports of nuclear-weapons-related plants in or near Lüneburger Heide (e.g., pp. 4172–4182, 4406–4407).

There were also several independent reports of nuclear-weapons-related plants in or near Berlin (e.g., pp. 3608–3617, 4635–4639).]

DECLASSIFIED
Authority NND917017

NARA RG 77, Entry UD-22A,
Box 165, Folder ALSOS MATERIAL

SECRET

OFFICE OF STRATEGIC SERVICES
WASHINGTON 25, D. C.

14 April 1945
AA-175

TO: Major Francis J. Smith
Room 5116, New War Department Building
21st and Virginia Avenue, N. W.
Washington, D. C.

FROM: Colonel H. W. Dix
Technical Section HWD

SUBJECT: AZUSA.

From a cable from Stockholm dated 12 April 1945 the information below is paraphrased for your use. The information is dated 7 April 1945 and is obtained from a source which is experienced in weapons, and is reliable.

1. V weapon. The German experimental station at Peenemunde has been evacuated and moved to Wilhelmshafen and Plauen according to definite information. Professor Wagener is the head of the experimental station. Rocket bomb type HS (Henscheu) 117, also called Luftgoliat, is the subject of most experiments at present. This controlled rocket bomb is a long range weapon. 8000 meters is the height to which it can be shot with precision. Is propelled vertically towards the ground. This weapon can be directed into groups of enemy planes by means of remote radio control. In October 1944 at Luneburger Heide in experiments all of a group of 12 of their own* remotely controlled planes sent up were shot down with only 1 shot.

4000 of the HS 117 have now been delivered. Production began ten days ago.

Manufacture of the HS is at Henschel Factories, Oderwerke in Nordhausen woffleben (Halle-Kassel). Entrance to mine shaft in which weapons are actually manufactured can be observed from the air. Barracks which are used as quarters for workers, offices, and construction offices are erected around the entrance. The Friedrich Listwerke in Plauen Voigtland manufactured the "Kreiseln"**(remote control arrangement) for the HS 117.

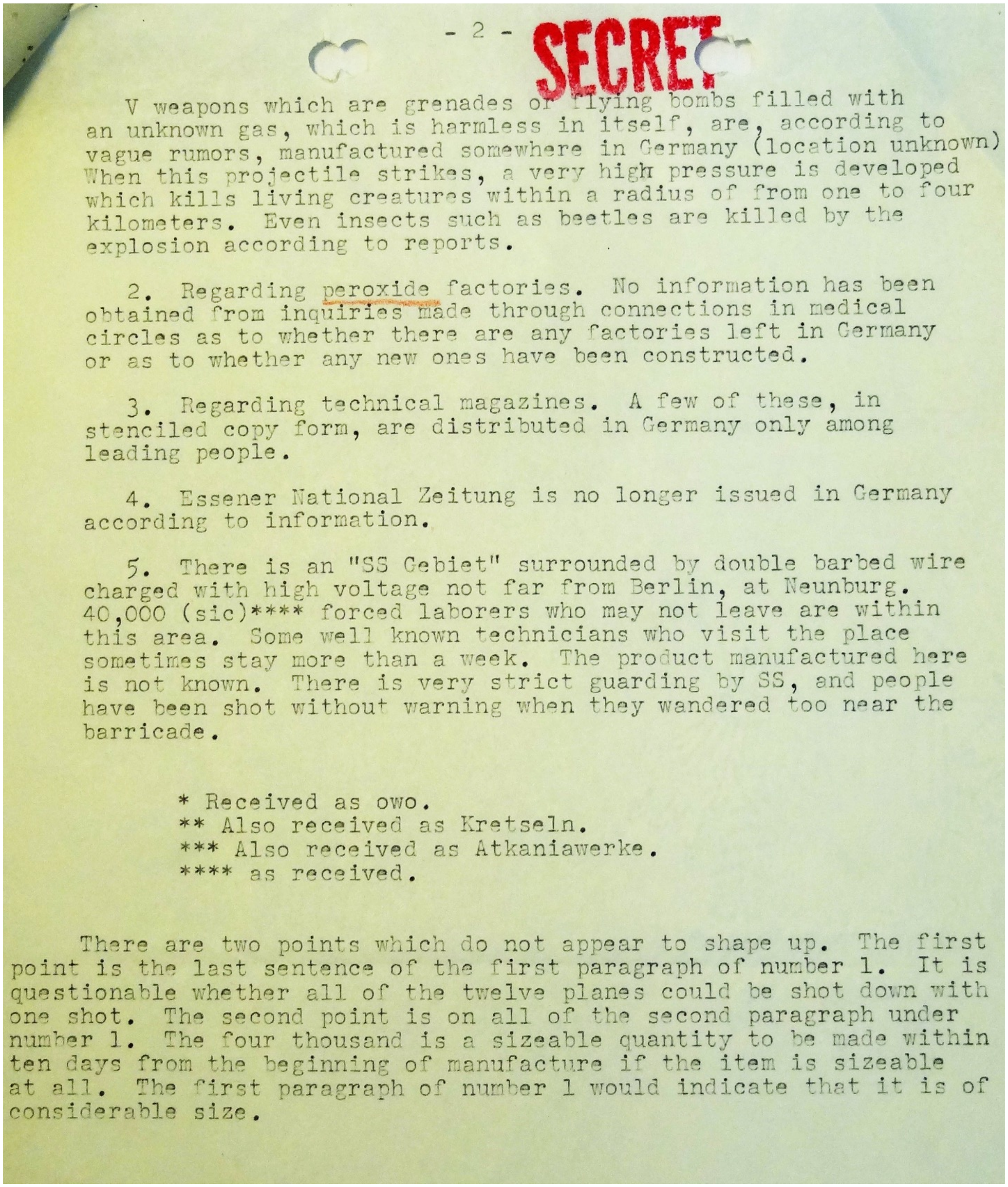
Hornwerke, Oderstrasse 26 in Berlin-Telow makes the rocket engine. Askaniawerke,*** Berlin-Kaiserallee, Friedenau also carries out various details.

Friedenau is also the center for administration for the entire V manufacture.

Figure D.264: H. W. Dix to Francis J. Smith. 14 April 1945. SUBJECT: AZUSA. [NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL]

DECLASSIFIED
Authority NND917017

NARA RG 77, Entry UD-22A,
Box 165, Folder ALSOS MATERIAL



- 2 -

SECRET

V weapons which are grenades or flying bombs filled with an unknown gas, which is harmless in itself, are, according to vague rumors, manufactured somewhere in Germany (location unknown) When this projectile strikes, a very high pressure is developed which kills living creatures within a radius of from one to four kilometers. Even insects such as beetles are killed by the explosion according to reports.

2. Regarding peroxide factories. No information has been obtained from inquiries made through connections in medical circles as to whether there are any factories left in Germany or as to whether any new ones have been constructed.

3. Regarding technical magazines. A few of these, in stenciled copy form, are distributed in Germany only among leading people.

4. Essener National Zeitung is no longer issued in Germany according to information.

5. There is an "SS Gebiet" surrounded by double barbed wire charged with high voltage not far from Berlin, at Neunburg. 40,000 (sic)**** forced laborers who may not leave are within this area. Some well known technicians who visit the place sometimes stay more than a week. The product manufactured here is not known. There is very strict guarding by SS, and people have been shot without warning when they wandered too near the barricade.

* Received as owo.
** Also received as Kretseln.
*** Also received as Atkaniawerke.
**** as received.

There are two points which do not appear to shape up. The first point is the last sentence of the first paragraph of number 1. It is questionable whether all of the twelve planes could be shot down with one shot. The second point is on all of the second paragraph under number 1. The four thousand is a sizeable quantity to be made within ten days from the beginning of manufacture if the item is sizeable at all. The first paragraph of number 1 would indicate that it is of considerable size.

Figure D.265: H. W. Dix to Francis J. Smith. 14 April 1945. SUBJECT: AZUSA. [NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL]

Monthly Intelligence Summary. February 1945. [NARA RG 77, Entry UD-22A, Box 168, Folder 202.3-1 LONDON OFFICE: Combined Intell Rpts.]

II INFORMATION ON POSSIBLE T A SITES

7. Saalfeld-Thüringia.

A report dated 19 April 1944 was received from OSS stating that a new weapon is being manufactured in an underground factory at SAALFELD-THÜRINGIA, Germany. The report added that experimental laboratories formerly in Berlin have been transferred to STRASBOURG and installed in a hospital there. The casings and tubings for the weapon were reported to be manufactured in the mechanical workshops in Bitschwiller (Haut-Rhin). Some significance is attached to this report because of the fact that a laboratory of interest to us has been discovered in a hospital in Strasbourg. Air coverage of the Saalfeld area has been obtained and is now being studied. [...]

10. Leitmeritz.

An ungraded report indicated that the production of precision instruments for V-3 is being carried on by the Germans in the town of LEITMERITZ in Sudetenland. According to this report, a large volume of electric power is being directed to the factory. A power survey and aerial coverage of the area have been obtained and are being forwarded to General Groves' office for review.

11. LEHESTEN.

An OSS report states that possible manufacture of long range projectiles is being carried on in a semi-underground installation about 1.5 K.M. north of Lehesten in Germany. T A interest in the report arises from the fact that Siemens and Halske are said to be in charge of the plant, and a reference to the breaking down of water by electrolysis at this site. Aerial coverage has been requested.

[See document photos on pp. 4764–4765.]

Monthly Intelligence Summary. March 1945. [NARA RG 77, Entry UD-22A, Box 168, Folder 202.3-1 LONDON OFFICE: Combined Intell Rpts.]

k. Air photos of a German plant at Muhldorf were forwarded to Major Smith for submission to Dr. Morrison. Interpreters on this side were unable to establish what sort of work was being pursued here.

Csdic (A) 482

SECRET — 5TH ARMY POW CAGE (Air) — Target Notes A/16
7th November 1944

1. Preamble The following information was obtained from a reasonably intelligent and cooperative P/W. He claims that he deserted at the first opportunity and makes every effort to be accurate and helpful. His information may be considered reliable and dates from his most recent furlough in June 1944. He has been sent to CSDIC (Air) Rome for detailed interrogation.

2. Underground Jet-Propelled A/C Factory, Kloster/Lechfeld — Kaufering In June 1944 approximately 20,000 workers began excavation and construction under Organization TODT on underground work-shops which P/W estimates to be ten in all. Some of these were already partially dug when he saw them in June 1944. P/W describes their size as 25 meters deep, 100 meters long, and 60 meters wide. The depth he describes as being that at which he saw the excavations. He assumes that they were intended to be deeper. The holes were spaced in a straight line about 200 meters apart. P/W recalls seeing one being dug some distance away from this line and claims that others were being dug in the woods west of KAUFERING.

3. Work was begun simultaneously on all but the ones nearest KAUFERING were closer to completion. When the holes exceeded 6 meters in depth camouflaging netting was placed over them. Guards with watch-dogs were on duty about the area whose dual purpose was both to keep the workers in the area and the civilians out. Barbed-wire entanglements were also erected.

4. From KLOSTER/LECHFELD three RR sidings were laid to HURLACH (48 degrees 7'30"N—10 degrees 50'00"E), where the freight depot was being enlarged. This depot was the main RR center for the underground activity.

5. The head architect of the operation, a Herr ANTON LICHTENSTEIN, told P/W that "Turbine Jäger" (Jet-Propelled Air-craft) were to be manufactured here. LICHTENSTEIN's offices were located at MUNCHER STRASSE 9, LANDSBERG.

6. These excavations were located between KLOSTER/LECHFELD and KAUFERING in the area bounded by 48 degrees 05'30"N—10 degrees 49'30"E and 48 degrees 08'30"N—10 degrees 49' 00"E. P/W describes the area as being west of the main highway between AUGSBURG and LANDSBERG, west of the river LECH, and 250 meters west of the small RR line from LECHFELD to KAUFERING.

7. Other Underground Factories P/W claims that a number of underground factories are located between LANDSBERG and SCHONGAU on the west side of the RR line and main highway in a heavily wooded area. P/W did not know what was to be built or whether they were already in operation. He knew, however that were similarly constructed as the above (See paragraph 2). He had his information from members of Organization TODT, who had helped with construction there.

8. Electric Powers Stations, LANDSBERG — SCHONGAU Along the river LECH between LANDSBERG and SCHONGAU four electric power stations are located. Their approximate coordinates are:

a. 47 degrees 53'20"N — 10 degrees 56'E. (West of ROTT)
b. 47 " 56' N — 10 " 53'E. (West of ISSING)
c. 47 " 59' N — 10 " 53'30"E.
d. 48 " 01'30"N — 10 " 53'E.

9. Dynamite A.G. Kaufering at Landsberg This plant was begun in 1939-40 and at that time curious civilians were informed that they need not be concerned as the project was of little importance. However, this did not quiet the suspicions that something highly secret was being performed, suspicions that are still rife today. In May 1943 there was a sudden increase in

Figure D.266: F. A. Duwell. 5th Army POW Cage (Air), Target Notes A/16. 7 November 1944. [AFHRA folder 512.619C-15A 1943–1945; AFHRA A5417 electronic pp. 966–967]

— 2 —

activity after which time the place was put under heavy guard. The entire complex is set in the woods and is heavily camouflaged. An extensive net-work of roads was built into and through the woods. P/W knew that about 30 large tanks were partially buried near the factory, painted green on top, and covered over with trees and shrubs. He also knew that "Press Luft" (Compressed Air) was being prepared here for use in the factory and that some sort of munitions were being manufactured. He describes the location as being at approximately 48 degrees 04'N - 10 degrees 50'E.

10. Dynamite A.G., Bobingen near Augsburg P/W claims that there are two plants of this concern in the woods west of BOBINGEN, and connected with BOBINGEN by a RR spur line. Late in 1942 one of these factories was hit, but during the time of the attack the factory was ~~xxxx~~ idle, while the other, in continual operation, has never been bombed. The approximate area for both factories is 48 degrees 17'N - 10 degrees 47'E.

11. Michel Werke, A/C Parts, Augsburg This plant is located (48 degrees 23'N 10 degrees 53'E) on the DONAUWORTHER STRASSE, est of the main RR line from AUGSBURG to DONAUWORTHER. It is a large five storied building and is identical in appearence to other apartment houses which surround it. P/W knew only that the intention was to manufacture air-craft parts here.

12. Bayrische Pflug Werke, Landsberg am Lech This plant, formerly a manufacturer of plows is now producing 8.8 AA shell casings in addition to a reduced number of plows. It is located on LECH STRASSE between two bridges of which the southern one is the KAROLINE bridge. From this bridge the plant is on the left hand side in the middle of the block. The river LECH runs directly adjoining and parallel to LECH STRASSE. A rail-road line, LANDSBERG to KAUFERING, runs behind and west of the factory. A spur track runs in front of the factory between the building and the street. This spur to the rear of the factory and then alongside the other track continuing as a separate line all the way to the LANDSBERG depot. All shells are shipped from LANDSBERG to KAUFERING. Destination beyond KAUFERINGwas unknown to P/W.

13. This factory consists of two buildings joined to each other at an angle. They are about 30 x 18 meters in size. One of these is new, being put into operation in June 1944. The plant works day and night and according to P/W, each building has 6 lathes each campable of turning out 30-35 shell casings per hour, making a total production for the plant of about 360 casings per hour. P/W claims that until early October 1944 the town of LANDSBERG had not been bombed.

14. Jet-Propelled A/C at Penzing Air-Field In June 1944 P/W had occasion to visit PENZING air-field (48 degrees 04'30"N 10 degrees 55'E). Here he saw 8 jet propelled a/c as well as several Me 410s, Me 210s, and Ju 188s. P/W was told that this air-field was a jet a/c experimental station and that the planes stationed there were able to achieve a speed of 850 kph.

15. P/W spent some time at AMMER LAKE near PENZING where he observed practice maneuvers of the jet a/c. These would appear in pairs at a heigth of 1,500 meters and drop bombs (?) on floating targets in the water. The speed of the planes was so great that the sounds of the explosion would not be heard until the a/c had disappeared. The bombs were dropped at the conclusion of a steep dive at an approximate heigth of 100 meters.

Source: O'Gren. Gottfried LOBMAYR. Age 19.

R E Wark, Lt AC

~~F. A. Duwell~~
2nd Lt., AC,
Air Targets.

Distribution:
MAAF AFHQ
MAAF FIU
CSDIC (Air) Rome
File.

Figure D.267: F. A. Duwell. 5th Army POW Cage (Air), Target Notes A/16. 7 November 1944. [AFHRA folder 512.619C-15A 1943–1945; AFHRA A5417 electronic pp. 966–967]

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[See document photos on pp. 3690–3691.]

PARAGRAPHS 30, 31 of MFIU/HQ/CSDIC/12. Undated but apparently late 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)]

PARAGRAPHS 30, 31 of MFIU/HQ/CSDIC/12

V. EXPLOSIVES

30. Dynamit AG, Kaufering/Landsberg. The source of the following is the same as for paras 28–29 supra. The plant—the approximate location of which is 10^o 50' E., 48^o 4' N—was started at the end of 1939. It was said to be of no importance, but the local people are convinced that something very secret is going on there. In May/43 there was a sudden increase in activity after which date the place was put under heavy guard.

31. The whole complex is set in woods and heavily camouflaged, while an extensive net-work of roads was built into and through the woods. The P/W knew of about 30 tanks being built, partially under ground, near the factory and that these tanks were topped with earth in which trees and shrubs were planted. He was certain that some sort of munitions were being made there.

[See document photo on p. 3693 bottom.]

SECRET

PARAGRAPHS 8, 9, 10 of MFIU/HQ/CSDIC/12

I. "SECRET WEAPONS"

8. Factory nr: Pilsen. (No date). A P/W, who lives near Pilsen, supplies the following information which he had only at second-hand from friends working in Pilsen.

9. A large underground factory is being constructed in the woods within 8-9 km of Pilsen and was said to be finished shortly. Workers of many nationalities were employed in this construction work and were confined to the site of the plant at all times.

10. Rumour has it that one of the secret weapons is to be produced there.

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)

SECRET

PARAGRAPHS 30, 31 OF MFIU/HQ/CSDIC/12

V. EXPLOSIVES.

30. Dynamit A.G., Kaufering/Landsberg. The source of the following is the same as for paras 28-29 supra. The plant - the approximate location of which is: 10° 50' E., 48° 4' N - was started at the end of 1939. It was said to be of no importance, but the local people are convinced that something very secret is going on there. In May/43 there was a sudden increase in activity after which date the place was put under heavy guard.

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Figure D.268: Excerpts from MFIU/HQ/CSDIC/12. Undated but apparently late 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)]

FF4936 Research on Secret Weapons (January 1945) [NARA RG 226, Entry ??, Box 361?, Folder ??. Published in https://www.hsozkult.de/publicationreview/id/reb-7382]. [See document photo on p. 3695.]

FF4936
Date: January 1945
Evaluation: C-3 (7)

Very urgent INTELLIGENCE
Germany

Research on Secret Weapons

A center of research has been set up at KAPPEL, 37 km. north of Berlin, in a disguised woods. Near this center, and camouflaged by the same woods, there is the whole of E. M. de DOENITZ.

Researches are carried on vigorously upon the "atomic explosion", at the SS Technical Academy at ZELLENDORF (700 m. south of the (RR) station) and especially at BRNO in Bohemia. These experiments are pursued intensively by the old establishments of BAYER (the special section of the I. G. Farben near Berlin and in the vicinity of Regensburg).

[Apparently added later:]

see paragraphs 3 and 4 of cable 2877 December 21, 1944, from Bern IN—29784

MAR 20 1945

[It is very interesting that this report took on a renewed urgency for the U.S. on 20 March 1945, and that the information added then refers to a cable from Bern by U.S. spy Moe Berg; note that the actual date of that cable appears to be December 31, not December 21 [Petersen 2008, p. 625].]

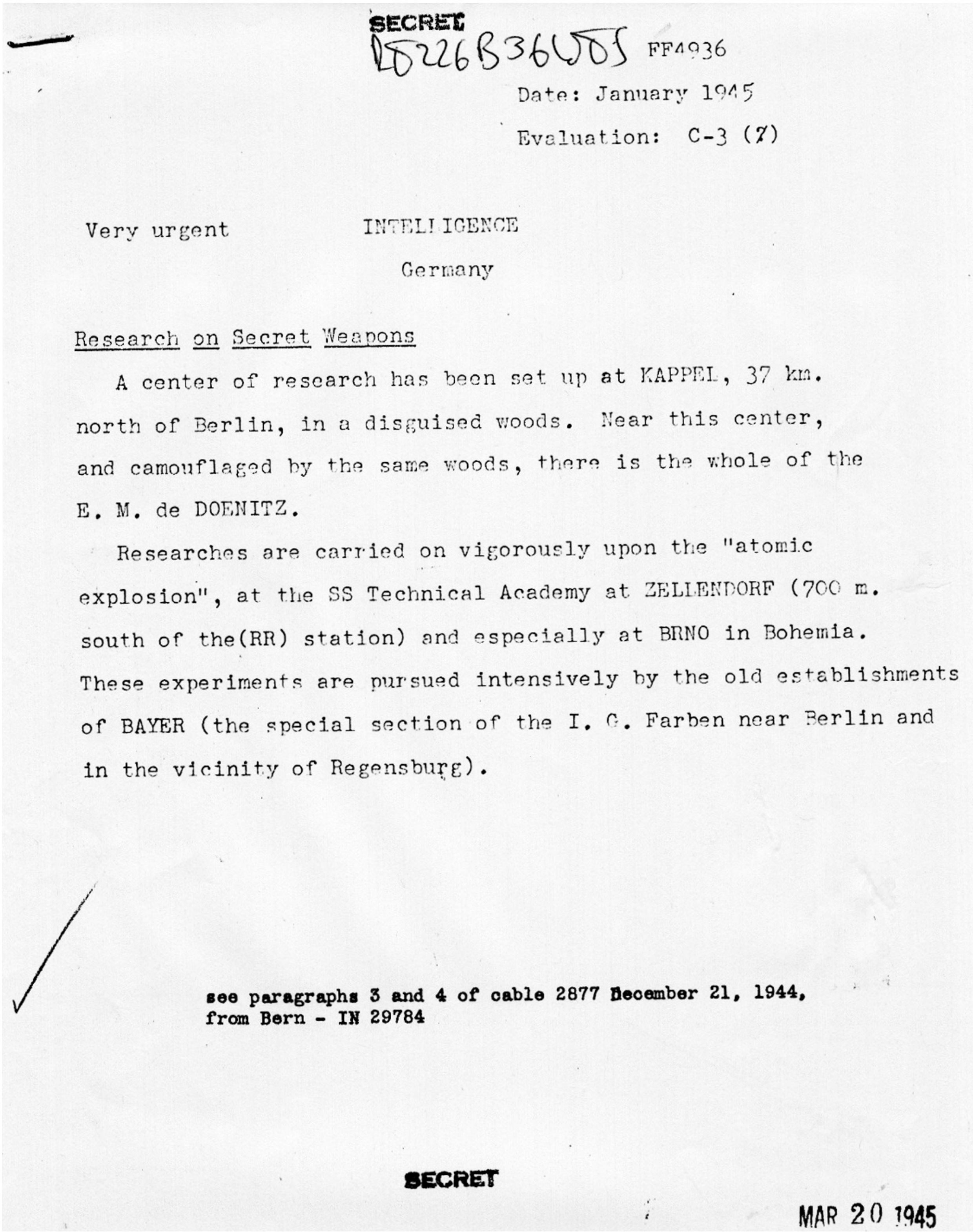
Monthly Intelligence Summary. March 1945. [NARA RG 77, Entry UD-22A, Box 168, Folder 202.3-1 LONDON OFFICE: Combined Intell Rpts.]

c. A report was received that a research center engaged in work on "atomic explosion" has been set up near Koralle, 37 kilometers north of Berlin. A study of air coverage of this area failed to reveal any visual evidence of TA activity.

[The correct name of this site appears to be Koralle as mentioned in the second document, not Kappel as mentioned in the first. (Perhaps the "p"s were "ρ"s, indicating a Slavic origin for this intelligence?) The German Naval High Command was located there during 1943–1945 (the first document mentioned Admiral Doenitz), and there may well have been other facilities in the same general area.]

CSDIC (AFHQ) A 315 (F.N. 721). 5 February 1944. HE 177—Germany's New Bomber Hope: Detailed interrogation report on He 177's shot down on January 23rd and 24th. [AFHRA A5417 electronic pp. 882, 886]

48. In many forest regions of Germany including one near REGENSBURG, the home of the P/W, the manufacture of the secret weapon or weapons is being rushed with utmost energy. Extreme security precautions are taken, such as keeping the workers in the factory, and not permitting them to go home.


SECRET

FF4936

Date: January 1945

Evaluation: C-3 (?)

Very urgent

INTELLIGENCE

Germany

Research on Secret Weapons

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see paragraphs 3 and 4 of cable 2877 December 21, 1944, from Bern - IN 29784

SECRET

MAR 20 1945

Figure D.269: FF4936 Research on Secret Weapons (January 1945) [NARA RG 226, Entry ??, Box 361, Folder ??. Published in https://www.hsozkult.de/publicationreview/id/reb-7382].

[NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)]

OFFICE OF STRATEGIC SERVICES
WASHINGTON, D.C.

DISTRIBUTED	27 March 1945	DISSEMINATION NO.	A-52702
COUNTRY	Germany, Austria, and Protectorate	ORIGINAL REPORT NO.	B-1879, B-2040
SUBJECT	Research Institutes; Alcohol	DATE OF REPORT	6, 15 March 1945
		EVALUATION	F-3
		CONFIRMATION	
SOURCE	Z	SUPPLEMENT	
SUB SOURCE		CORRECTION	
		NUMBER OF PAGES	2
DATE OF INFORMATION	1 March 1945	ATTACHMENTS	
PLACE OF ORIGIN	Switzerland	THEATRE	

Research Institutes

1. According to informant, eight research institutes whose purpose is the development of V-weapons, gases, bacteriological means of warfare, and atom smashing devices have existed or are functioning in Germany and Austria. Their locations are as follows:

   (a) Peenemünde (about 40 km northwest of Swinemünde)

   (b) Tegernsee (about 50 km south-southeast of Munich)

   (c) Schloss Hohenzollern at Sigmaringen

   (d) A stone quarry near Lebestan (sic—this may be Lehesten, about 50 km west of Plauen)

   (e) Tübingen. Nothing definite is known about this institute.

   (f) Floridsdorf, in the northeastern portion of Vienna. The institute is now closed, and its equipment is believed to have been moved to Tegernsee.

   (g) Freiburg-im-Breisgau. The institute is now closed, and its equipment is believed to have been moved to Sigmaringen.

   OSS Washington Comment: According to another informant, the Schloss Hohenzollern mentioned is located about 20 km south-southwest of Tübingen, not at Sigmaringen. This may be the missing eighth location.

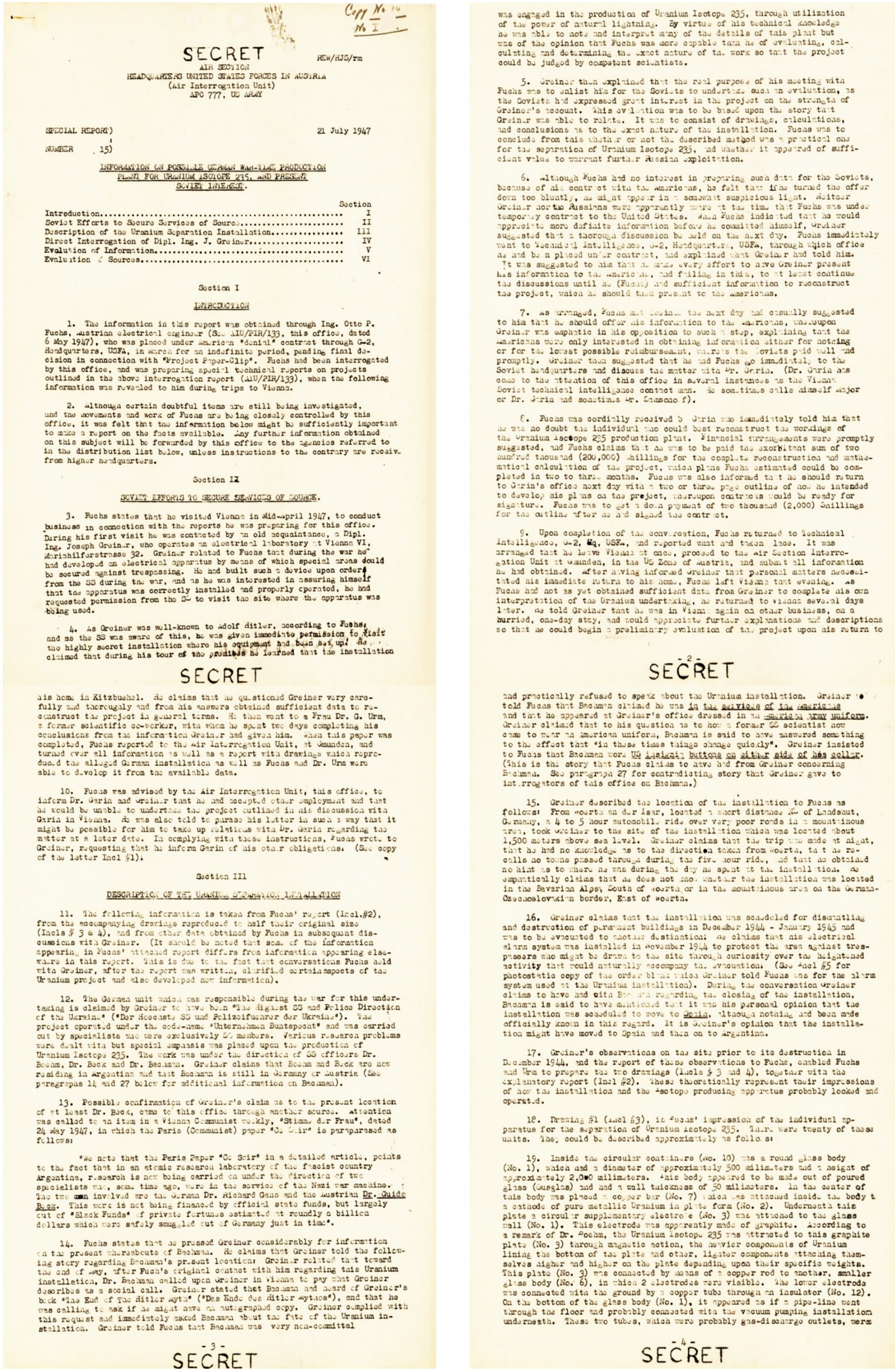
Alcohol

2. A ball bearing factory in Hronow (about 130 km northeast of Prague) is adding alcohol to the gasoline for starting and landing rocket planes and for the new ramming plane (Rammflugzeug).

3. Alcohol is being distilled from wine for this purpose. It is expected that 2,000,000 liters will be obtained from the Schlumberger Co. of Vöslau (30 km south-southwest of Vienna).

Doc. No. 112, Subject: Waldow, Willi (27 September 1946). [NARA RG 319, Entry A1-134A, Box 17, Folder XE 169886, Russian Deportation of German Scientists and Technicians]

[...] Subject, while traveling between the Russian and American Zones on the 29th August 1946, made the acquaintance of a Mr. BRUECKNER in the railroad station STASSFURT (M52/D66). The conversation that took place consisted of BRUECKNER's description of his recent forced employment and subsequent escape from a Russian underground factory, located at SALZBERGWERKE (M52/D66) near STASSFURT. BRUECKNER, a German engineer, formerly engaged in atomic research as early as 1934 stated that a group of between two or three thousand Germans with scientific and technical backgrounds are being forcibly engaged at working on experiments dealing with atomic energy pertaining to development of the atomic bomb, as well as rocket experiments with the "V 2". The site of this factory is supposedly that of a former German underground factory used to manufacture special types of weapons during the war, located as SALZBERGWERKE. According to Subject BRUECKNER further stated that despite his previous knowledge of atomic energy, the work now being conducted is in an entirely new field.



Copy No. 14
No. I

SECRET

REW/HJS/rm

AIR SECTION
HEADQUARTERS UNITED STATES FORCES IN AUSTRIA
(Air Interrogation Unit)
APO 777, US ARMY

SPECIAL REPORT)
NUMBER 15)

21 July 1947

INFORMATION ON POSSIBLE GERMAN WAR-TIME PRODUCTION PLANT FOR URANIUM ISOTOPE 235, AND PRESENT SOVIET INTEREST.

	Section
Introduction	I
Soviet Efforts to Secure Services of Source	II
Description of the Uranium Separation Installation	III
Direct Interrogation of Dipl. Ing. J. Greiner	IV
Evolution of Information	V
Evaluation of Sources	VI

Section I

INTRODUCTION

1. The information in this report was obtained through Ing. Otto P. Fuchs, Austrian electrical engineer (See AIU/PIR/133, this office, dated 6 May 1947), who was placed under American "denial" contract through G-2, Headquarters, USFA, in March for an indefinite period, pending final decision in connection with "Project Paper-Clip". Fuchs had been interrogated by this office, and was preparing special technical reports on projects outlined in the above interrogation report (AIU/PIR/133), when the following information was revealed to him during trips to Vienna.

2. Although certain doubtful items are still being investigated, and the movements and work of Fuchs are being closely controlled by this office, it was felt that the information below might be sufficiently important to make a report on the facts available. Any further information obtained on this subject will be forwarded by this office to the agencies referred to in the distribution list below, unless instructions to the contrary are receive from higher headquarters.

Section II

SOVIET EFFORTS TO SECURE SERVICES OF SOURCE.

3. Fuchs states that he visited Vienna in Mid-April 1947, to conduct business in connection with the reports he was preparing for this office. During his first visit he was contacted by an old acquaintance, a Dipl. Ing. Joseph Greiner, who operates an electrical laboratory at Vienna VI, Mariahilferstrasse 32. Greiner related to Fuchs that during the war he had developed an electrical apparatus by means of which special areas could be secured against trespassing. He had built such a device upon orders from the SS during the war, and as he was interested in assuring himself that the apparatus was correctly installed and properly operated, he had requested permission from the SS to visit the site where the apparatus was being used.

4. As Greiner was well-known to Adolf Hitler, according to Fuchs, and as the SS was aware of this, he was given immediate permission to visit the highly secret installation where his equipment had been set up. He claimed that during his tour of the premises he learned that the installation

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was engaged in the production of Uranium Isotope 235, through utilization of the power of natural lightning. By virtue of his technical knowledge he was able to note and interpret many of the details of this plant but was of the opinion that Fuchs was more capable than he of evaluating, calculating and determining the exact nature of the work so that the project could be judged by competent scientists.

5. Greiner then explained that the real purpose of his meeting with Fuchs was to enlist him for the Soviets to undertake such an evaluation, as the Soviets had expressed great interest in the project on the strength of Greiner's account. This evaluation was to be based upon the story that Greiner was able to relate. It was to consist of drawings, calculations, and conclusions as to the exact nature of the installation. Fuchs was to conclude from this whether or not the described method was a practical one for the separation of Uranium Isotope 235, and whether it appeared of sufficient value to warrant further Russian exploitation.

6. Although Fuchs had no interest in preparing such data for the Soviets, because of his contract with the Americans, he felt that if he turned the offer down too bluntly, he might appear in a somewhat suspicious light. Neither Greiner nor the Russians were apparently aware at the time that Fuchs was under temporary contract to the United States. When Fuchs indicated that he would appreciate more definite information before he committed himself, Greiner suggested that a thorough discussion be held on the next day. Fuchs immediately went to Technical Intelligence, G-2, Headquarters, USFA, through which office he had been placed under contract, and explained what Greiner had told him. It was suggested to him that he make every effort to have Greiner present his information to the Americans, and failing in this, to at least continue the discussions until he (Fuchs) had sufficient information to reconstruct the project, which he should then present to the Americans.

7. As arranged, Fuchs met Greiner the next day and casually suggested to him that he should offer his information to the Americans, whereupon Greiner was emphatic in his opposition to such a step, explaining that the Americans were only interested in obtaining information either for nothing or for the lowest possible reimbursement, whereas the Soviets paid well and promptly. Greiner then suggested that he and Fuchs go immediately to the Soviet headquarters and discuss the matter with Dr. Garin. (Dr. Garin has come to the attention of this office in several instances as the Vienna Soviet technical intelligence contact man. He sometimes calls himself Major or Dr. Garin and sometimes Dr. Samsonoff).

8. Fuchs was cordially received by Garin who immediately told him that he was no doubt the individual who could best reconstruct the workings of the Uranium Isotope 235 production plant. Financial arrangements were promptly suggested, and Fuchs claims that he was to be paid the exorbitant sum of two hundred thousand (200,000) Shillings for the complete reconstruction and mathematical calculation of the project, which plans Fuchs estimated could be completed in two to three months. Fuchs was also informed that he should return to Garin's office next day with a two or three page outline of how he intended to develop his plans on the project, whereupon contracts would be ready for signature. Fuchs was to get a down payment of two thousand (2,000) Shillings for the outline after he had signed the contract.

9. Upon completion of the conversation, Fuchs returned to Technical Intelligence, G-2, Hq, USFA, and reported what had taken place. It was arranged that he leave Vienna at once, proceed to the Air Section Interrogation Unit at Gmunden, in the US Zone of Austria, and submit all information he had obtained. After having informed Greiner that personal matters necessitated his immediate return to his home, Fuchs left Vienna that evening. As Fuchs had not as yet obtained sufficient data from Greiner to complete his own interpretation of the Uranium undertaking, he returned to Vienna several days later. He told Greiner that he was in Vienna again on other business, on a hurried, one-day stay, and would appreciate further explanations and descriptions so that he could begin a preliminary evaluation of the project upon his return to

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his home in Kitzbuehel. He claims that he questioned Greiner very carefully and thoroughly and from his answers obtained sufficient data to reconstruct the project in general terms. He then went to a Frau Dr. G. Urm, a former scientific co-worker, with whom he spent two days completing his conclusions from the information Greiner had given him. When this paper was completed, Fuchs reported to the Air Interrogation Unit, at Gmunden, and turned over all information as well as a report with drawings which reproduced the alleged German installation as well as Fuchs and Dr. Urm were able to develop it from the available data.

10. Fuchs was advised by the Air Interrogation Unit, this office, to inform Dr. Garin and Greiner that he had accepted other employment and that he would be unable to undertake the project outlined in his discussion with Garin in Vienna. He was also told to phrase his letter in such a way that it might be possible for him to take up relations with Dr. Garin regarding the matter at a later date. In complying with these instructions, Fuchs wrote to Greiner, requesting that he inform Garin of his other obligations. (See copy of the letter Incl #1).

Section III

DESCRIPTION OF THE URANIUM SEPARATION INSTALLATION

11. The following information is taken from Fuchs' report (Incl.#2), from the accompanying drawings reproduced to half their original size (Incls # 3 & 4), and from other data obtained by Fuchs in subsequent discussions with Greiner. (It should be noted that some of the information appearing in Fuchs' attached report differs from information appearing elsewhere in this report. This is due to the fact that conversations Fuchs held with Greiner, after the report was written, clarified certain aspects of the Uranium project and also developed new information).

12. The German unit which was responsible during the war for this undertaking is claimed by Greiner to have been "The Highest SS and Police Direction of the Ukraine" ("Der Hoechste SS und Polizeifuehrer der Ukraine"). The project operated under the code-name "Unternehmen Buntspecht" and was carried out by specialists who were exclusively SS members. Various research problems were dealt with but special emphasis was placed upon the production of Uranium Isotope 235. The work was under the direction of SS officers Dr. Boehm, Dr. Beck and Dr. Bachmann. Greiner claims that Boehm and Beck are now residing in Argentina and that Bachmann is still in Germany or Austria (See paragraphs 14 and 27 below for additional information on Bachmann).

13. Possible confirmation of Greiner's claim as to the present location of at least Dr. Beck, came to this office through another source. Attention was called to an item in a Vienna Communist weekly, "Stimme der Frau", dated 24 May 1947, in which the Paris (Communist) paper "Ce Soir" is paraphrased as follows:

"We note that the Paris Paper "Ce Soir" in a detailed article, points to the fact that in an atomic research laboratory of the fascist country Argentina, research is now being carried on under the direction of two specialists who, some time ago, were in the service of the Nazi war machine. The two men involved are the German Dr. Richard Gans and the Austrian Dr. Guido Beck. This work is not being financed by official state funds, but largely out of "Black Funds" of private fortunes estimated at roundly a billion dollars which were safely smuggled out of Germany just in time".

14. Fuchs states that he pressed Greiner considerably for information on the present whereabouts of Bachmann. He claims that Greiner told the following story regarding Bachmann's present location: Greiner related that toward the end of May, after Fuchs's original contact with him regarding this Uranium installation, Dr. Bachmann called upon Greiner in Vienna to pay what Greiner describes as a social call. Greiner stated that Bachmann had heard of Greiner's book "The End of The Hitler Myth" ("Das Ende des Hitler Mythos"), and that he was calling to ask if he might have an autographed copy. Greiner complied with this request and immediately asked Bachmann about the fate of the Uranium installation. Greiner told Fuchs that Bachmann was very non-committal

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and practically refused to speak about the Uranium installation. Greiner told Fuchs that Bachman claimed he was in the services of the Americans and that he appeared at Greiner's office dressed in an American army uniform. Greiner claimed that to his question as to how a former SS scientist now came to wear an American uniform, Bachman is said to have answered something to the effect that "in these times things change quickly". Greiner insisted to Fuchs that Bachman wore US insignia buttons on either side of his collar. (This is the story that Fuchs claims to have had from Greiner concerning Bachman. See paragraph 27 for contradicting story that Greiner gave to interrogators of this office on Bachman.)

15. Greiner described the location of the installation to Fuchs as follows: From Woerth an der Isar, located a short distance NE of Landshut, Germany, a 4 to 5 hour automobile ride over very poor roads in a mountainous area, took Greiner to the site of the installation which was located about 1,500 meters above sea level. Greiner claims that the trip was made at night, that he had no knowledge as to the direction taken from Woerth, that he recalls no towns passed through during the five hour ride, and that he obtained no hint as to where he was during the day he spent at the installation. He emphatically claims that he does not know whether the installation was located in the Bavarian Alps, South of Woerth or in the mountainous area on the German-Czechoslovakian border, East of Woerth.

16. Greiner claims that the installation was scheduled for dismantling and destruction of permanent buildings in December 1944 - January 1945 and was to be evacuated to another destination. He claims that his electrical alarm system was installed in November 1944 to protect the area against trespassers who might be drawn to the site through curiosity over the heightened activity that would naturally accompany the evacuation. (See Incl #5 for photostatic copy of the order blank which Greiner told Fuchs was for the alarm system used at the Uranium installation). During the conversation Greiner claims to have had with Bachman regarding the closing of the installation, Bachman is said to have mentioned that it was his personal opinion that the installation was scheduled to move to Spain, although nothing had been made officially known in this regard. It is Greiner's opinion that the installation might have moved to Spain and then on to Argentina.

17. Greiner's observations on the site prior to its destruction in December 1944, and the report of these observations to Fuchs, enabled Fuchs and Urm to prepare the two drawings (Incls # 3 and 4), together with the explanatory report (Incl #2). These theoretically represent their impressions of how the installation and the Isotope producing apparatus probably looked and operated.

18. Drawing #1 (Incl #3), is Fuchs' impression of the individual apparatus for the separation of Uranium Isotope 235. There were twenty of these units. They could be described approximately as follows:

19. Inside the circular containers (No. 10) was a round glass body (No. 1), which had a diameter of approximately 500 milimeters and a height of approximately 2,000 milimeters. This body appeared to be made out of poured glass (Gussglas) and had a wall thickness of 50 milimeters. In the center of this body was placed a copper bar (No. 7) which was attached inside the body to a cathode of pure metallic Uranium in plate form (No. 2). Underneath this plate a circular supplementary electrode (No. 3) was attached to the glass wall (No. 1). This electrode was apparently made of graphite. According to a remark of Dr. Boehm, the Uranium Isotope 235 was attracted to this graphite plate (No. 3) through magnetic action, the heavier components of Uranium lining the bottom of the plate and other, lighter components attaching themselves higher and higher on the plate depending upon their specific weights. This plate (No. 3) was connected by means of a copper rod to another, smaller glass body (No. 6), in which 2 electrodes were visible. The lower electrode was connected with the ground by a copper tube through an insulator (No. 12). On the bottom of the glass body (No. 1), it appeared as if a pipe-line went through the floor and probably connected with the vacuum pumping installation underneath. These two tubes, which were probably gas-discharge outlets, were

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Figure D.270: Robert E. Work. 21 July 1947. Information on Possible German War-Time Production Plant for Uranium Isotope 235, and Present Soviet Interest. [AFHRA folder 506.619B 1945–47; AFHRA A5183 frames 0497–0504] Postwar interrogations mentioned a wartime electromagnetic uranium enrichment plant at an unspecified site in the Bavarian Alps.

enclosed by an iron casing about 100 milimeters thick (No. 10) which rested upon insulators (No. 12). The iron casing and a cover supposedly made of concrete (No. 11), which could be raised and lowered by means of a small pulley. On the interior of the iron casing was an apparatus (No. 13) in which photographic film presumably recorded the process of gas discharge in the form of an indicator line. The floor of the entire main hall (No. 14) was constructed of heavy concrete.

20. Drawing #2 (Incl #4), is Fuchs' ground plan impression of the entire installation, showing the circular shape of the main building and the estimated number of 20 individual units concerned in the separation of the Uranium Isotope 235 (24 are reproduced in the drawing). The circular building is described as having a diameter of between 20 to 30 meters. It was built of reinforced concrete (No. 15). This circular structure had a wing attached on either side. On the one side (No. 17 and 18) several laboratory rooms were included; on the other side (16) a wing of equal size inclosed 3 barrel-like containers which were connected to the main hall by means of pipes. In the main hall approximately 20 boiler-like structures were arranged in circular fashion about the room. These were the Uranium Isotope production units. Beneath this room, below the ground level, various machines as well as a vacuum pumping station were located. This basement was entered by means of a stairway adjoining one of the laboratory rooms (No. 18). It is believed that it also had another outside entrance (No. 20). A ground level entrance into the main hall is indicated by (No. 19). The main hall could also be entered through doors at (No. 18 and No. 16).

21. Greiner claims that Dr. Boehm told him that one operation process resulted in the production of 13 grams of Uranium Isotope 235. Fuchs believes that this amount was produced by each of the separate units. This claim cannot be substantiated through what Greiner learned from Dr. Boehm, so it is quite possible that the 13 gram figure is intended to indicate the total production figure of all 20 units. This amount was supposed to have been produced each time a lightning charge set the process in operation.

22. Dr. Boehm is also claimed to have stated that there was no other source for the isotope separation process, other than natural lightning. For this reason the installation was erected at a height of 1,500 meters above sea level, in an area where natural lightning frequently occurs. Greiner claimed that the entire installation was covered with a type of lightning-catching net, mounted a short distance above the roof of the installation. The entire lightning load appeared to be conducted into the main hall through a large cable. This lightning net was centripetal in form, the individual copper strands of which had sudden knot-like increases in diameter at the points where cross rods were fastened. This arrangement gave the net the appearance of a sagging spider web.

23. Greiner explained to Fuchs that although the main purpose of the installation was to produce Uranium Isotope 235, it also produced radio active isotopes from other elements between the atomic weights of 36 to 56. He claimed that these by-products were to be used for the production of poisonous radio active gases (Radioaktive Giftgase). Greiner also claimed that the SS scientists indicated that they were not quite satisfied with the results of ~~their Uranium 235 production as they could~~ never quite arrive at a pure product, and although the material they produced was usable it fell considerably short of being satisfactory.

Section IV

~~DIRECT INTERROGATION OF GREINER~~

24. Because Fuchs was obliged to inform Greiner that he could not presently undertake the preparation of an evaluation of the Uranium installation for the Russians, it became impossible for him to continue questioning Greiner on the project. Interrogators from this office thereupon

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let Greiner discover, through indirect channels, that the Americans were interested in various "area protection" devices. It was also made known to Greiner that his name was familiar to the Americans as the inventor of one of these devices. Greiner was then contacted by interrogators of this office and questioned on his "area protection" mechanisms. Greiner had no hesititancy in giving explanations and when asked where these devices were used, he listed various railroad tunnels, bridges and an atomic research institute. The interrogator immediately expressed interest in the atomic installation and in questioning Greiner regarding it obtained the following information:

25. Greiner was picked up in Vienna in December 1944 by an SS major, who told him that his "area protection" device used by "Unternehmen Buntspecht" was not functioning properly and that his presence was required to direct the necessary repairs. He was taken to Moerta an der Isar where the Highest SS and Police Direction of the Ukraine, which controlled "Unternehmen Buntspecht", had its headquarters at that time. Greiner was obliged to wait here until nightfall at which time he was taken by automobile to the Uranium installation. Greiner informed the interrogator that this trip required from 5 to 6 hours over very poor mountainous roads and that he had absolutely no knowledge as to where the installation was located. He claimed that he was not blind-folded and that he did not observe a single clue that would enable him to guess the approximate location of the installation. His account to the interrogator regarding the nature of the installation did not vary appreciably from the story already obtained from Fuchs. From Greiner's replies however, it was quickly apparent that he wanted to impress the interrogators with the fact that he considered the entire undertaking as completely valueless. He claimed that it was his personal opinion that a group of opportunist scientists had presented a proposition to Himmler and had impressed Himmler sufficiently to obtain a considerable appropriation with which to conduct their experiments. He claims that upon his visit to the installation he was impressed with the fact that none of the three leaders of the institute seemed to take their work seriously. He claims that he became convinced that these three were duping Himmler when he noted that none of the personnel connected with the installation wore any sort of protective clothing to guard them against the radio activity and the gamma rays that would necessarily have been present had the production of Uranium 235 really been going on.

26. Greiner additionally claimed that such Austrian scientists to whom he has already described the installation, among them Professor Thirring of the University of Vienna, have all claimed that the production of Uranium 235 by means of lightning energy is completely nonsensical. He also stated that the Russians had questioned him about the installation and that after evaluating his (Greiner's) information, had stated that the method was scientifically, completely unsound. (This is in complete contrast to the intense Russian interest that both Greiner and the Russian, Dr. Garin, described to Fuchs).

27. Greiner was asked by the interrogator as to the present location of the scientists he had met at the installation. In reply to this he confirmed the information already obtained from Fuchs concerning the whereabouts of Boehm and Beck. Regarding Bachmann he told a story which is considerably at variance with the one received from Fuchs. He explains that Bachmann called on him in Vienna on a social visit, and states that he presented Bachmann with a copy of his Hitler book. He states that Bachmann was a Doctor of Physics and Chemistry and that he recalls his full name as Dr. Hugo Bachmann. Greiner made no mention of Bachmann's appearing in an American uniform. He stated instead that Bachmann was elegantly dressed in civilian clothing and that he told Greiner he was expecting an offer of American employment. Greiner describes Bachmann as follows: 6' in height; slight build; blue eyes; blond hair; small blond Hitler moustache; speaks with a North German accent; approximately 35 years of age; speaks English, Spanish, and Italian in addition to German. Greiner stated that he asked Bachmann about the fate of the installation and received the answer that the whole business was now located in Argentina but that he (Bachmann) had no further interest or connection with the undertaking as he had profited

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financially in such a satisfactory manner that he was glad enough to be quit of the whole affair. Greiner then asked him to confirm his suspicion that the entire undertaking had been nothing more than a farce. To this Bachmann is said to have chuckled and answered that too many people had pulled the wool over Himmler's eyes during the war and that it would have been a shame to have let such a golden opportunity pass by. Bachmann is claimed to have stated that he was returning to Munich, Germany, where he would remain for some time.

28. Two conclusions were firmly arrived at by the interrogator during his conversation with Greiner. These were:

a. That Greiner was very careful in not making any remark which might lead to a clarification of the installation's actual location.

b. That Greiner made every effort to impress the interrogator with the scientifically unsound nature of the installation, emphatically insisting that it was his opinion that the whole undertaking was merely an insidious effort to extort huge sums from Himmler.

Section V

EVALUATION OF INFORMATION

29. Only one clue has been discovered by investigators that might indicate the approximate location of the Uranium installation, providing it did, in fact, exist. From Dipl. Ing. Heinz Ludwig Ostertag, the former German War Production Coordinator for the area which includes the Bavarian Alps, it was learned that a Dr. Beck, who had been engaged in some sort of highly secret research, was known to have been quartered from time to time during the war, on an island in Staffel See (See map GSGS 4416 - Y5-5704) coincidentally, a village called Moerta is also located on this island. Ostertag claims to have no further information concerning Beck or the nature of his work.

30. On the strength of this lead the Staffel See area was thoroughly combed but no information was uncovered as to the possible location of the Uranium installation.

31. In evaluating the information available, several theories present themselves as possible conclusions on the veracity of the report.

a. It is possible that the installation, as described above, did not actually exist and that this data is the result of a misconception or faulty observation and evaluation on the part of Dipl. Ing. Greiner. According to this theory an installation may have existed but was actually engaged in research or activities of an entirely different sort.

b. It is possible that a Uranium isotope 235 separation plant did exist as reported by Greiner, but that the Germans decided that they were either on the wrong track or that too much time would be required to bring the project to a successful conclusion, and that, therefore, as Greiner and Bachmann claim and as the "Oe Seir" article indicates (See paragraph 13 above), the installation was moved to Argentina.

c. It is possible that no such installation ever existed and that Greiner, at the instigation of the Soviets, has concocted a story merely to test Fuchs who, it is known the Soviets have wished to employ for some time. Such offers of employment Fuchs has never definitely rejected, as he did not want to arouse the ire of the Soviets. He assures this office that he would not accept such employment under any conditions. If this theory were true, the Soviets would probably be keeping a close surveillance over Fuchs to learn whether he offered the "Soviet concocted" story to the US authorities. No evidence has been uncovered that Fuchs' movements have actually been watched.

d. The theory that Fuchs, himself, may be duping the Americans instead of the Soviets, appears too improbable to consider as a possibility.

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Fuchs presently receives 500 Shillings per month on the strength of his U.S. "denial" contract. It would appear unreasonable that Fuchs should bring this information to the Americans rather than enjoy the comparatively large payments he could receive from the Russians, were it not for the fact that he is obviously directing every effort toward obtaining permanent employment in the United States.

e. The theory to which this office subscribes as most probably true is as follows: During the interrogation of Greiner it appeared that he was becoming considerably embarrassed by the obvious interest in his story. As he did everything possible to impress the interrogator with his own conviction that the project was probably unsound and inasmuch as he refused to make any statements that might aid in locating the site it was concluded that Greiner was doing everything possible to dampen American interest. If the story is not true, it is possible that Greiner, in order to ingratiate himself with the Russians, either concocted the story completely or embellished a half-truth into a sensational Uranium installation. This, of course, would not be in keeping with the present Russian interest. It is not impossible, then, that Greiner's efforts to dampen American curiosity are designed to protect his relationships with the Russians and to preserve the undertaking for further Russian exploitation. The fact that the Russians have shown an avid interest in the undertaking, according to Fuchs, is probably the best evidence that the story should be given some credence.

32. Until this office is informed by competent American authorities that the Uranium isotope 235 processing method outlined in this report is completely unsound, it will consider that the installation may have existed and will continue to exploit any further leads for information that may come to its attention.

Section VI

EVALUATION OF SOURCES

33. Ing. O. P. Fuchs: Fuchs is apparently a scientist of considerable note. He is certainly held in high regard by some of Austria's leading scientists and by the staffs of the physics and chemistry departments of the University of Vienna. His cooperation with this office, probably because of the fact that he hopes to achieve permanent U. S. employment through its efforts, has at all times been of the highest sort. It is believed that his sincerity in bringing the above information to this office cannot be questioned. It is possible however, that his enthusiasm has led him to overemphasize the value and importance of the reported installation. The fact that the Russians did offer him a contract to evaluate the practical possibilities of the installation as described by Greiner is not doubted.

34. Dipl. Ing. Josef Greiner: It is apparent that Greiner is very closely associated with the Russians. He is a leader of the "Austrian Pan-European Association of Vienna", ("Oesterreichischen Paneuropaeischen Verband in Wien"), and an important figure in the "Austrian Society for the Furtherance of Cultural Relations with the Soviet Union". It is believed certain that he with-held information from interrogators of this office. His attitude and conduct are believed motivated simply by the closer relationship he enjoys with the Russians in contrast to his meager contacts with the Americans. It is unlikely that Greiner purposely misinformed Fuchs, unless he was serving a Russian purpose thereby, as Greiner and Fuchs are old acquaintances from before the war. Fuchs' belief that Greiner thought he was doing him a personal favor in recommending him to the Russians for the job of reconstructing the Uranium undertaking, is probably true. Efforts will be made by this office to keep informed as to any further action on Greiner's part, either with the Russians or on his own, regarding the Uranium project.

DISTRIBUTION (Special):
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Robert E. Work
ROBERT E. WORK
Major, Air Corps
Chief Interrogator

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Figure D.271: Robert E. Work. 21 July 1947. Information on Possible German War-Time Production Plant for Uranium Isotope 235, and Present Soviet Interest. [AFHRA folder 506.619B 1945–47; AFHRA A5183 frames 0497–0504] Postwar interrogations mentioned a wartime electromagnetic uranium enrichment plant at an unspecified site in the Bavarian Alps.

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Special Report #25 Captured Personnel and Material Branch 9 Sept. 1944.
M.S.H. / W.O. H.

Estimate of Veracity: Previous information obtained from this source has proven to be reliable.

Subject: REICHSPOST CENTRALE.

Source was employed as an architect and draughtsman at the Reichspost Centrale, Karlsruhe from Oct. 1940 until Jan. 1942. Everything connected with mail, telephone, telegraph, and radio came under the jurisdiction of the Reichspost Centrale. In addition, the Reichspost supported a research department known as the Forschungs Institute der Deutscher Reichspost. This department also financed individuals in research work of value to the Reich.

Source and one other, Helmut Hentz, drew up the plans for remodeling of damaged post office buildings or for new constructions. Hentz was at one time given the task of planning the remodeling of a double house in Heidelberg which at one time had belonged to Dr. Bergius, well known for his many "ersatz" articles.

A certain professor of physics at Heidelberg University desired to purchase the home of Dr. Bergius who at that time was in need of extra funds. The professor was engaged in experiments in photography and needed a laboratory to continue the work. Dr. Bergius asked far more than the house was worth, according to this source, but the Reichspost Minister advanced the required amount and supported the professor in his research. According to source, this research was concerned with the effect temperature changes had on photographs. According to source, Hentz said that, in conversations, the professor had told him that the English were also working on this same problem and that it was believed possible, through the change in colors of several photos taken at intervals in the night, to determine whether a ship might be passing through the Channel.

The remodeling of this house was not begun while source worked for the Reichspost but while he was home on furlough in Nov. 1942, he learned that it was then in progress.

During this period of employment, he also drew plans for a large, new, post office at Karlsruhe, EMMINDINGEN near FREIBURG, WALDSHUT, BADEN BADEN, and LAHR. He also planned repairs at SULZ and many small places in Elsass.

At Karlsruhe:

President der Reichspost Direktion Karlsruhe: KOEHL
Oberpostbaurat LUEDORFF.

According to source, Luedorff was a very intelligent and capable man. He was an outspoken Anti-Nazi and apparently only his value to the Reichspost kept him from being arrested. Luedorff was the final word on construction in this area and later was sent to FRANKFORT AM MAIN. He was last known to be in the HANNOVER Area.

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1.

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-October 1944)

Figure D.272: Special Report #25 Captured Personnel and Material Branch. 9 September 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)].

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Special Report #25 (Cont'd) 9 Sept. 1944.

Also located at Karlsruhe and connected with the Technische Hochschule, is the Chemical Institute. Source worked directly opposite the entrance to the Institute and on several occasions saw a General of the Luftwaffe, accompanied by other high ranking officers enter the Institute. They were in the company of Rudolf Weigel, the director of the Chemical Institute. Weigel was a former student there and had studied "licht technique". He became and assistant professor there and, through intrigue, ousted the former director and took over the job. He is 150% Nazi.

In trying to recall all new plans he had made or new buildings constructed, source disclosed that many garages for busses had been built in the Schwarzwald. Providing transportation also seemed to be the duty of the Reichspost in this area.

In this connection, the writer of this report wishes to add that he himself, while living in Germany from Nov. 1937 until Sept. 1941, heard many rumors of underground construction in the Schwarzwald. Bus loads of soldiers were taken into these projects at night with the added precaution of darkened windows on the busses, so that the soldiers could see nothing. They were not told where they were other than in the Schwarzwald. They remained 24 hours and went out again at dark. The nature of the construction was not disclosed.

Location of Dr. Bergius House: Source had never seen this house and could not pin point it on an aerial photo of Heidelberg. He knows it is located near Philosophenweg, above and to the left of the Karl Theodore Bridge which is the first bridge below the dam. See aerial phot #4010-11 D 558 541 S.O. 14-5-43 F/20.

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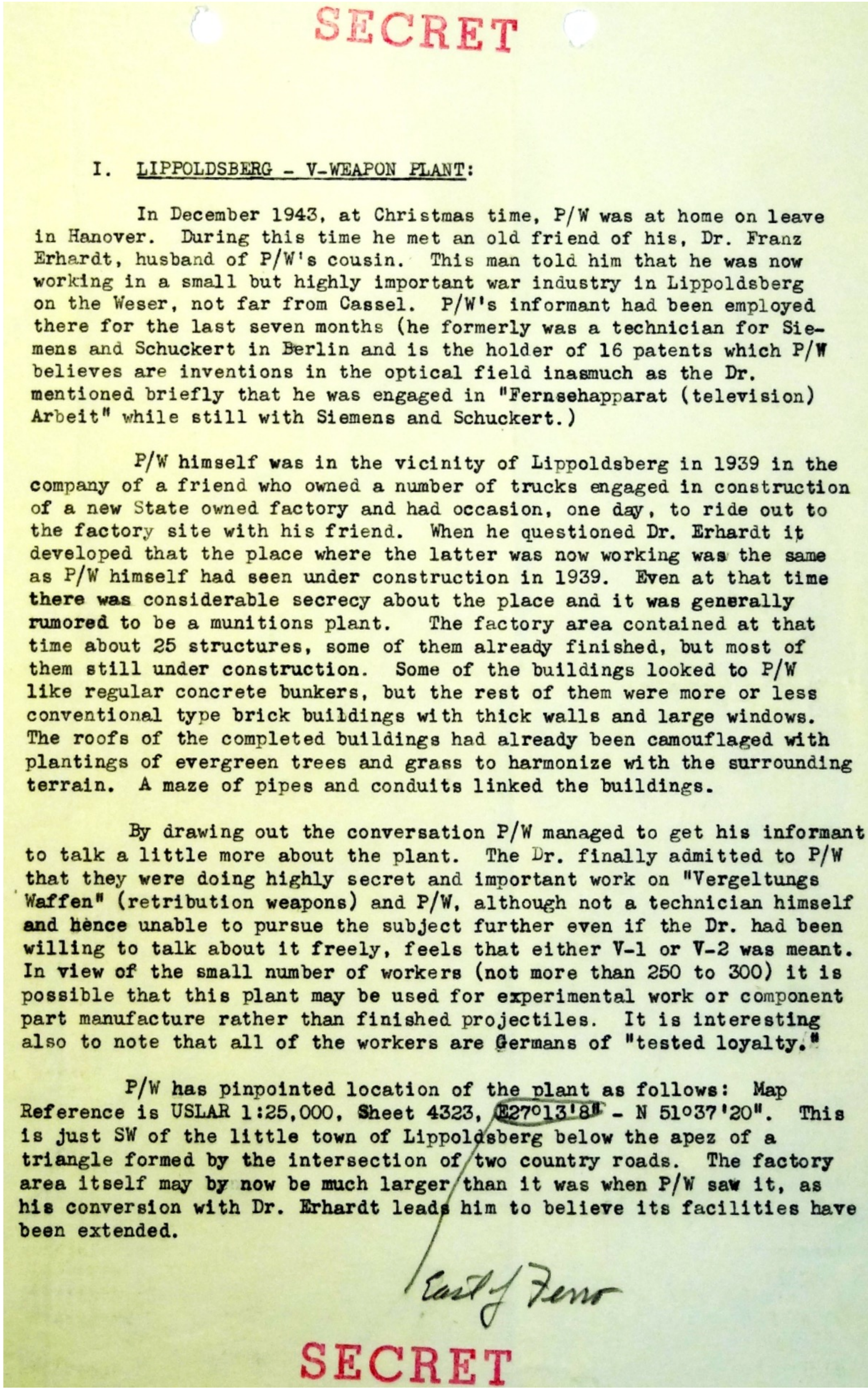
2.

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-October 1944)

Figure D.273: Special Report #25 Captured Personnel and Material Branch. 9 September 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)].

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-October 1944)
Undated but apparently August 1944



SECRET

I. LIPPOLDSBERG - V-WEAPON PLANT:

In December 1943, at Christmas time, P/W was at home on leave in Hanover. During this time he met an old friend of his, Dr. Franz Erhardt, husband of P/W's cousin. This man told him that he was now working in a small but highly important war industry in Lippoldsberg on the Weser, not far from Cassel. P/W's informant had been employed there for the last seven months (he formerly was a technician for Siemens and Schuckert in Berlin and is the holder of 16 patents which P/W believes are inventions in the optical field inasmuch as the Dr. mentioned briefly that he was engaged in "Fernsehapparat (television) Arbeit" while still with Siemens and Schuckert.)

P/W himself was in the vicinity of Lippoldsberg in 1939 in the company of a friend who owned a number of trucks engaged in construction of a new State owned factory and had occasion, one day, to ride out to the factory site with his friend. When he questioned Dr. Erhardt it developed that the place where the latter was now working was the same as P/W himself had seen under construction in 1939. Even at that time there was considerable secrecy about the place and it was generally rumored to be a munitions plant. The factory area contained at that time about 25 structures, some of them already finished, but most of them still under construction. Some of the buildings looked to P/W like regular concrete bunkers, but the rest of them were more or less conventional type brick buildings with thick walls and large windows. The roofs of the completed buildings had already been camouflaged with plantings of evergreen trees and grass to harmonize with the surrounding terrain. A maze of pipes and conduits linked the buildings.

By drawing out the conversation P/W managed to get his informant to talk a little more about the plant. The Dr. finally admitted to P/W that they were doing highly secret and important work on "Vergeltungs Waffen" (retribution weapons) and P/W, although not a technician himself and hence unable to pursue the subject further even if the Dr. had been willing to talk about it freely, feels that either V-1 or V-2 was meant. In view of the small number of workers (not more than 250 to 300) it is possible that this plant may be used for experimental work or component part manufacture rather than finished projectiles. It is interesting also to note that all of the workers are Germans of "tested loyalty."

P/W has pinpointed location of the plant as follows: Map Reference is USLAR 1:25,000, Sheet 4323, E27°13'8" - N 51°37'20". This is just SW of the little town of Lippoldsberg below the apez of a triangle formed by the intersection of two country roads. The factory area itself may by now be much larger than it was when P/W saw it, as his conversion with Dr. Erhardt leads him to believe its facilities have been extended.

East of Ferro

SECRET

Figure D.274: Lippoldsberg—V-Weapon Plant. Undated but apparently August 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)]. From the description, this sounds like a potential nuclear site, and Leslie Groves's Foreign Intelligence Unit thought it sounded like a potential nuclear site.

DECLASSIFIED
Authority NND 917017

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-Oct. 1944)

C
o
p
y

18 July 1944

MEMORANDUM to THE OFFICER IN CHARGE

Subject: Power Facilties in Germany.

During the course of an interview on other matters, Mr. Erro O. Erkko of Hercules Corporation, Wilmington, Delaware, on 10 July 1944 advised this Agent that, in his opinion, the location of power plants and storage facilities in coal and salt mines in the Ruhr Valley of Germany should be investigated for possible affiliation with a German DSM project. Erkko stated that in 1938, he understood the Germans were building extensive power plants underground in abandoned and sometimes operatible coal and salt mines in the Ruhr Valley. He stated that his personal information did not extend further than that stated. However, he gave the name of Dr. Hans Lebach, presently employed by Habeg Corporation, Wilmington, Delaware, as possessing further information concerning these power plants. Habeg reputedly came to this country in 1940 or 1941 as a refugee and had in his possession at that time photographs and diagrams of the underground power plants of Germany. Erkko stated that he had previously reported this information to Major Cavanaugh of the Army Air Forces, but does not know whether or not it was followed up.

/s/ Bernard W. Menke,
Special Agenc, CIC.

Figure D.275: Bernard W. Menke. 18 July 1944. Subject: Power Facilities in Germany. "Erkko stated that in 1938, he understood the Germans were building extensive power plants underground in abandoned and sometimes operatible coal and salt mines in the Ruhr Valley.... Habeg reputedly came to this country in 1940 or 1941 as a refugee and had in his possession at that time photographs and diagrams of the underground power plants of Germany." [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)]

HEADQUARTERS
EUROPEAN THEATER OF OPERATIONS
UNITED STATES ARMY
Intelligence Branch, G-2

10 July 1944

SUBJECT: Hydro-Electric plants over 50 MW capacity in Germany and Austria that might have been started up in the last 6 months

TO : Lt Col William P. Maddox
OSS
72 Grosvenor Street

1. There is enclosed a list of hydro-electric stations over 50 MW capacity in Germany and Austria which may have been started up in the last 6 months.

2. It is requested that a check of your files be made of the general area surrounding each of these plants for intelligence reports of secret factories, underground plants and analogous reports. Particular attention should be afforded to those areas where plants are located and the disposal of the energy produced is not known for certain, and to the large new plant at Braunau which is reported to be a new aluminum works. Like attention should be given the general area of the power station on the Aache River, which is reported to have been built for a secret purpose.

3. A copy of this letter is being sent to Lt Commander Welch and it is requested that a similar search be made of files available to his office.

H. K. CALVERT
Major, FA

1 Incl
As described above

cc: Lt Commander E. Welch
54 Broadway Buildings, SW 1
Major R. R. Furman (information)

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-October 1944)

Figure D.276: Horace K. Calvert to William P. Maddox. 10 July 1944. SUBJECT: Hydro-Electric plants over 50 MW capacity in Germany and Austria that might have been started up in the last 6 months [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)].

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-October 1944)

Hydro-electric stations over 50 MW capacity
in Germany and Austria which may have been
started up in last six months.

1\. WITZNAU (Germany) — (SCHLUCHSEE HYDRO Scheme). Capacity 176 MW. This is a peak-load pumped-storage station used for general grid supply. It was completed certainly not earlier than the end of 1942 and may have been completed in the last 6 months.

2\. HOHENWARTE (Germany) — (SAALE HYDRO Scheme). Capacity 50 MW. This is a peak load pumped-storage station used for general grid supply. It was partly built before the war but completion was deferred for a time. It is believed that it has since been completed - possibly in the last 6 months.

3\. PIRKSCHMIED (Austria) — (DRAU HYDRO Scheme). Capacity 50 MW. This is a low-head flow station producing about 220 million kWh p.a. The disposal of the energy produced is not known for certain but it is believed that part is supplied to a new local industrial area and the remainder supplied to the grid. The station was completed in 1943 - possibly in the last 6 months.

4\. OBERVERMUNT, RODUND (Austria) — Capacity 30 MW), Capacity 150 MW) (ILLWERKE Hydro Scheme)
These are high-head peak load stations producing a total of about 390 million kWh p.a.
So far as is known almost the entire output is exported to the German grid but there are reports of supplies being given to the following local plants:-

(1) Heinkel plant S.E. of GASCHURN
(2) Allgemeine Stahlwerke plant N of St. GALLENKIRCH.
(3) Daimler Benz plant at VANDANS. The magnitude of these supplies is not known. The stations are believed to have been recently completed - possibly in the last 6 months.

5\. KAPRUN, ORGLERBODEN (Austria) — Capacity 160 MW), Capacity 30 MW) (TAUERN Hydro Scheme)
These are high-head stations producing a total of about 750 million kWh p.a. The disposal of the energy produced is not known for certain but it is believed that it is mostly supplied to the Austria aluminium industry - particularly to the large new plant at BRAUNAU.
The stations are believed to have been completed in the last 6 months.

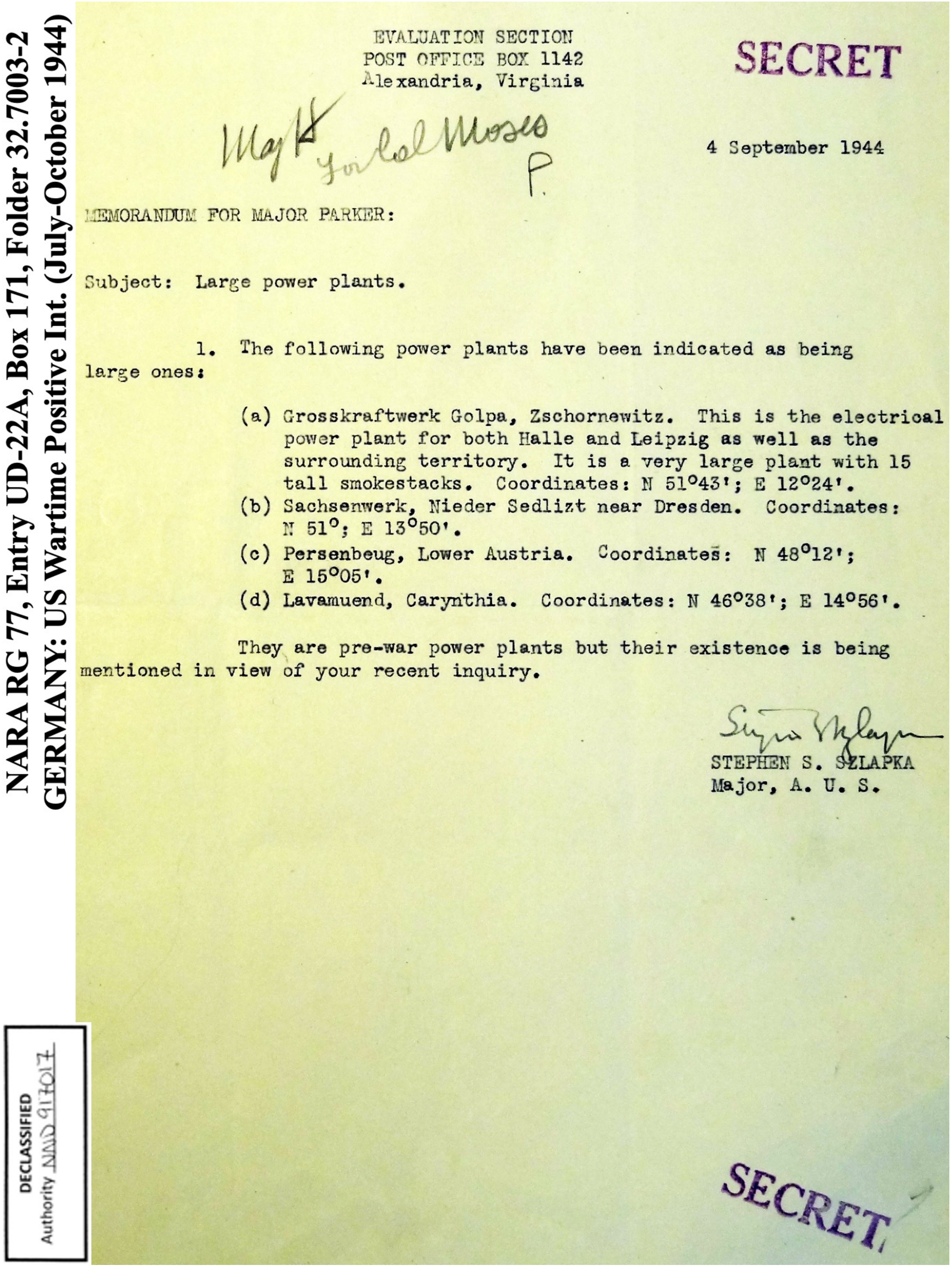
6\. OBERNBERG, ERING, SIMBACH (Austro-German frontier) — Capacity 40 MW), Capacity 40 MW), Capacity 40 MW) (INN Hydro Scheme)
These are low head flow stations producing a total of about 600 million kWh p.a. almost the whole of which is believed to be supplied to the new aluminium works at BRAUNAU. Construction of the stations was reported to have started in 1939 and it is known that Obernberg was nearing completion at the end of 1943. It is possible that all three stations have been completed in the last 6 months.

The only reports of a station being built for a "secret" purpose is CX.12204/P.5/3676 of 26/8/43 which tells of the construction of the largest wind tunnel in the Reich (8m x 8m) at OETZ in the Tyrol which is to use 100,000 HP from an enormous water power station on the AACHE river. The speed of flow in the tunnel is to be faster than the speed of sound.

It is believed that this report may have some connection with the known hydro-electric constructional work in the OTZTAL but the power said to be required by the wind tunnel appears fantastic.

/N.B. There is a village called OETZ (ÖTZ) on the R. ACHE (ÖTZTAL) about 25 km downstream from LANGENFELD (where a large hydro-electric station is believed under construction) and about 5 km from the confluence of the INN/

Figure D.277: Horace K. Calvert to William P. Maddox. 10 July 1944. SUBJECT: Hydro-Electric plants over 50 MW capacity in Germany and Austria that might have been started up in the last 6 months [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)].



NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-October 1944)

EVALUATION SECTION
POST OFFICE BOX 1142
Alexandria, Virginia

SECRET

4 September 1944

MEMORANDUM FOR MAJOR PARKER:

Subject: Large power plants.

1. The following power plants have been indicated as being large ones:

(a) Grosskraftwerk Golpa, Zschornewitz. This is the electrical power plant for both Halle and Leipzig as well as the surrounding territory. It is a very large plant with 15 tall smokestacks. Coordinates: N 51°43'; E 12°24'.
(b) Sachsenwerk, Nieder Sedlizt near Dresden. Coordinates: N 51°; E 13°50'.
(c) Persenbeug, Lower Austria. Coordinates: N 48°12'; E 15°05'.
(d) Lavamuend, Carynthia. Coordinates: N 46°38'; E 14°56'.

They are pre-war power plants but their existence is being mentioned in view of your recent inquiry.

STEPHEN S. SZLAPKA
Major, A. U. S.

DECLASSIFIED
Authority NND 917017

SECRET

Figure D.278: Stephen S. Szlapka. 4 September 1944. Subject: Large power plants [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)].

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3
GERMANY: US Wartime Positive Int. (Nov. 44–June 45)

SECRET

6824 DIC/MIS/NOI-474
20 Dec 44

Name: BRANDSTETTER, Richard
Rank: Soldat
Unit: 1/1/330/183 V. Gren Div
Capt: 17 Nov 44.
Interrogated: 6824 DIC/MIS, 13 Dec 44.

I. Preamble

P/W is a friendly 32 year old electrician from VIENNA. He has been employed by the SIEMENSWERKE since 1931, but as he was always on the road installing high tension lines, and reported only to the works assignment office on NIEBELUNGEN GASSE 8-11, he was unfamiliar with the home concern. Because all "indispensable personnel" lists were cancelled in Jul 44, he received his orders while on a trip when it was too late for his firm to have him reclassified and he was called up in Aug 44.

Reliability: B-2 (Source good, probably true report)

HYDRO-ELECTRIC WORKS

Since the war there has been a high priority on electric power installations for the S Austrian and N Yugoslavian districts. All the hydro-electro and steam-power works were combined into a ring network, which delivered the current to this overland ring from which it was transmitted to the different users. This Austrian network was connected with the German ring so that now practically all of GERMANY and AUSTRIA is supplied by this centralized network. Because the power available was not enough, new stations had to be constructed for S AUSTRIA and N YUGOSLAVIA, between which there were 2 distinct nets; the DRAU and the MUR. In both of these nets are 4 combined hydro-electric works two of which are for the MUR network, located at LEOBEN, 15'05" E, 47'24" N, which acts as the head station. It has 3 turbines running. The other is located at GÖSTING, which is at the end of the chain. The 2 intermediate stations are not known. The DRAU (DRAVA) chain consists of the SCHWABECKER station which acts as the head station, fully completed since 1943, running with three 24 MW powered turbines, producing about 1,000,000 KW. The 2nd in the chain is at LAVAMÜND, having 2 turbines, but with only one in operation. The 2nd turbine was still unfinished in Jul 44, because of material shortage. No one knew when it would be finished. This is also to have 24 MW power. The 3rd in the chain, UNTERDRAUBURG, has two 22 MW turbines operating; one since May 44, the other since Jun 44. Another turbine of the same capacity has not been completely installed. Preparations for the works was begun in the fall of 42; the construction, however, did not commence until the early part of 43. A new RR bridge up stream from this project, started in 41 or 42, was completed in Jan 44. The works at FALL were completed by the Yugoslav government before the war, and consists of 3 old type turbines made in Jugoslavia with a probable output of 70,000 KW.

OTHER ELECTRIC PLANTS

TRIFAIL, YUGOSLAVIA

This works has 3 turbines, only 2 of which are operating, one of 22 MW, the other of 18 MW, both producing about 40,000 KW. Installation of 100 KV transformers on the opposite side of the River SAVA had begun in Feb 44.

REICHENBURG

Steamworks with 1 turbine operating, power unknown.

PARTHENNEN WERKE, PARTHENNEN, Austria. 10'04" E, 46'58" N.

The proposed largest Hydro-electric plant in AUSTRIA is being constructed at the above location. It is supposed to have 6 or 7 turbines each with a capacity of at least 24 MW running under high pressure. P/W received this information from other SIEMENS electricians who had done some work on this project.

Figure D.279: 6824 DIC/MIS/NOI-474. 20 December 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)]. "Since the war there has been a high priority on electric power installations for the S Austrian and N Yugoslavian districts. All the hydro-electric and steam-power works were combined into a ring network.... Because the power available was not enough, new stations had to be constructed for S AUSTRIA and N YUGOSLAVIA...."

Werner Grothmann on enrichment of U-235 [Krotzky 2002]. For a discussion of the background and reliability of this source, see pp. 3396–3397.

[S. 6] Ich weiß allerdings nicht, woher das Material kommen sollte, denn unsere eigene Anlage im Erzgebirge lief ja auch erst ganz kurz und lieferte nur sehr wenig, wie ich hörte.

[p. 6] However, I do not know where the material came from, because our own plant in the Erzgebirge ran only very briefly and delivered very little, as I heard.

[S. 32] Die erste Schwierigkeit bestand in der Herstellung des Materials, also des Sprengstoffes. Das hat sich bis wenige Monate vor Kriegsende auch nicht drastisch verbessern lassen. Erst für 1946 rechneten wir eigentlich mit der Serienproduktion von Atombomben.

[p. 32] The first difficulty lay in the production of the material, the explosive. That did not improve dramatically until a few months before the end of the war. We did not expect mass production of atomic bombs until 1946.

[S. 33] Auch ich habe manches erst sehr spät erfahren und einiges auch erst nach dem Krieg. Zum Beispiel die Sache mit der Anreicherung. Es stimmt wirklich, dass die Reichspost 1944 die großtechnische Trennung der erforderlichen Substanzen für die Bombenfabrikation hinbekommen hat. Es war von Ardennes Verdienst. Die Einrichtung, wo das lief, lag weit außerhalb Berlins und ist vermutlich nach Kriegsende unter russischer Aufsicht noch eine Weile weiterbetrieben worden. Später hat man angeblich die Anlagenteile abgebaut und in den Osten gebracht. Vielleicht stehen die heute noch irgendwo herum. Die Tarnung für diese Anlage war hervorragend, weil sie trotz ihrer enormen Größe nicht auffiel. Das Beste war aber, dass überhaupt kein großer Personalaufwand betrieben werden musste. Das erzeugte Material war aber nur für die Reichspostforschung vorgesehen. Diebner hatte seine—ebenfalls begrenzten—Quellen und wir konnten für unsere Projekte kurz vor Kriegsende auch auf eigene Anlagen zurückgreifen, die aber auch noch lange nicht soviel liefern konnten, wie wir damals wünschten. Die gesamten Mengen kann ich nicht nennen, sie waren nicht umwerfend.

[p. 33] I also learned many things very late, and some things only after the war. For example, the matter of enrichment. It is true that in 1944 the Reichspost achieved the great technical separation of the necessary substances for the bomb production. It was thanks to Ardenne. The facility where it ran was far outside of Berlin and probably continued to operate for a while after the end of the war under Russian supervision. Supposedly they later dismantled the plant parts and brought them to the east. Maybe they are still around somewhere today. The camouflage for this plant was outstanding because it did not attract attention despite its enormous size. The best thing, however, was that a large workforce was not necessary. The material produced was, however, intended only for Reichspost research. Diebner had his—also limited—sources, and we were able to use our own equipment for our projects shortly before the end of the war, but they could not deliver as much as we wanted then. I cannot name the total quantities; they were not overwhelming.

[S. 36] Frau Beinhorn hat ihn uns empfohlen, weil der rund um die Uhr arbeiten konnte und, wie es schien, nie müde wurde. Diebner hat ihn mal [deshalb] als das wandelnde schlechte Gewissen seiner Kollegen bezeichnet. Schwietzke hat [...] auf die Frage nach dem Energiebedarf für eine bestimmte Anlage gesagt, das, was wir da reinstecken, bekommen wir bald hunderttausendfach zurück.

[p. 36] Mrs. Beinhorn recommended him to us because he could work around the clock and, as it seemed, never become tired. Diebner once [therefore] described him as the walking guilty conscience of his colleagues. Schwietzke said [...], when asked about the energy requirements for a particular installation, that what we put in there will soon come back a hundred thousandfold.

[Grothmann stated that he knew very little about where or how enriched uranium was produced, but he gave several important clues:

- The Reichspost had at least one U-235 enrichment facility that was located "far outside Berlin." For security, that facility would likely not be part of some other facility, but for convenience, it might be located near another relevant facility. Most uranium ore in Germany was processed at Auer in Oranienburg, approximately 35 km north of Berlin, so that is one possible location. The Reichspost had major research facilities in Miersdorf (now part of Zeuthen) approximately 22 km southeast of Berlin, Kleinmachnow 19 km southwest of Berlin, and Manfred von Ardenne's mansion in Lichterfelde approximately 12 km southwest of central Berlin, so those are other possible locations [Zeman and Karlsch 2008, p. 12]. Grothmann said that the enrichment facility used von Ardenne's designs, which suggests that it was electromagnetic enrichment similar to the U.S. calutrons at Oak Ridge. (Von Ardenne was an expert on electromagnetic manipulation of charged particles in electron microscopes and television picture tubes, and is known to have designed electromagnetic enrichment devices.) The facility was noteworthy for its "enormous size," which also suggests electromagnetic enrichment; uranium ions are separated out in low-density ion beams that travel up to several meters each, so hundreds of such bulky machines might be required to function in parallel. This facility became fully operational no later than 1944, or 1943 if it supplied fuel for what Grothmann said was a failed autumn 1943 test in the North Sea.
- The SS had at least one U-235 enrichment facility in the Erzgebirge region, but Grothmann did not provide any clues about what enrichment method(s) it used. This region was heavily mined for uranium by the Russians after the war. If the SS chose to locate an enrichment facility there, it suggests that Germans were mining uranium there during the war.
- Werner Schwietzke apparently designed and promised great returns from a special installation; he is known to have spent the war developing uranium gas centrifuges with Werner Holtz for the Army Ordnance Office [p. 3542].
- Kurt Diebner had sources of enriched uranium that were independent of the Reichspost and SS facilities, but Grothmann did not elaborate. Those might be (1) Schwietzke's centrifuges, (2) centrifuges in the Hamburg/Kiel area managed by Paul Harteck, Wilhelm Groth, and Konrad Beyerle, (3) the "isotope sluice," a centrifuge-like device developed by Diebner's close collaborator Erich Bagge, and/or (4) presently unknown additional sources.

It is important to find more information about all of these uranium enrichment facilities. It is also possible that there were other important enrichment facilities that Grothmann did not know about or did not mention in the interviews.]

Known/Reported Sites Now in France

Leslie R. Groves to Robert R. Furman. 25 November 1943 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-1 GERMANY: US Wartime Positive Int. (July 42–June 44)].

1. Colonel Dix [OSS] came over and told me that there was some new generative capacity going in at Génissiat on the Rhône River about 5 kilos from Belgarde. He stated that two generators were in and tested, that two were nearly installed and that two more were to come in two or three months.

2. I secured two reports from the Chief's office which bear on this subject. [...]

3. I cannot understand why the Germans are permitting this installation of power equipment to go on unless they have some definite need for it. This section of the country should not be overlooked and by section I mean anything within reasonable reach by high tension lines.

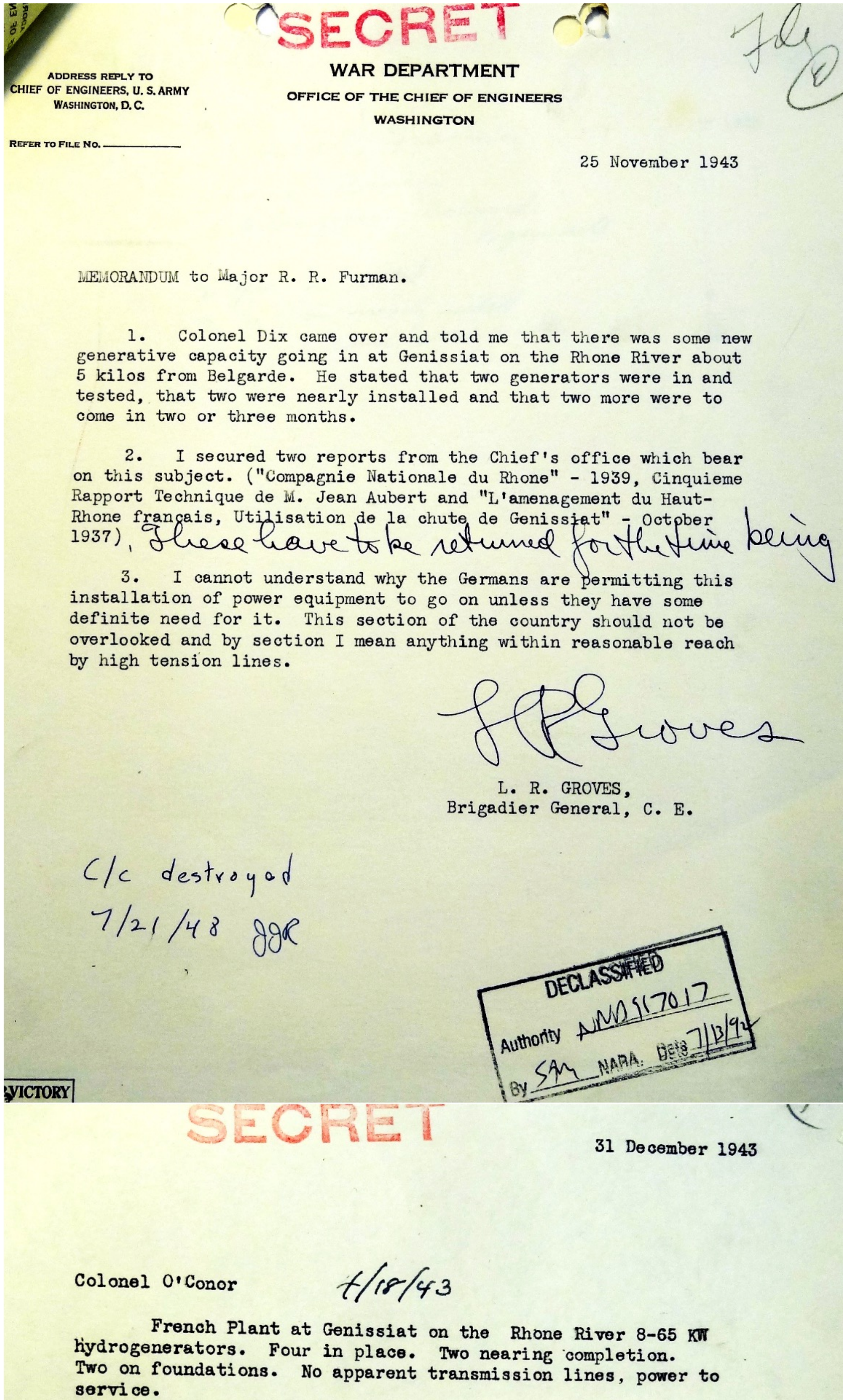
[From or to?] Colonel O'Conor. 31 December [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-1 GERMANY: US Wartime Positive Int. (July 42–June 44)].

French Plant at Génissiat on the Rhône River 8—65 KW Hydrogenerators. Four in place. Two nearing completion. Two on foundations. No apparent transmission lines, power to service.

[See document photos on p. 3711.

Leslie Groves and the OSS were concerned that occupying Germans could be building the large Génissiat hydroelectric plant on the Rhône river in eastern France to power a nearby uranium enrichment facility.]

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-1
GERMANY: US Wartime Positive Int. (July 42-June 44)



SECRET

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON

ADDRESS REPLY TO
CHIEF OF ENGINEERS, U. S. ARMY
WASHINGTON, D. C.

REFER TO FILE NO. ________

25 November 1943

MEMORANDUM to Major R. R. Furman.

1. Colonel Dix came over and told me that there was some new generative capacity going in at Genissiat on the Rhone River about 5 kilos from Belgarde. He stated that two generators were in and tested, that two were nearly installed and that two more were to come in two or three months.

2. I secured two reports from the Chief's office which bear on this subject. ("Compagnie Nationale du Rhone" - 1939, Cinquieme Rapport Technique de M. Jean Aubert and "L'amenagement du Haut-Rhone francais, Utilisation de la chute de Genissiat" - October 1937), These have to be returned for the time being

3. I cannot understand why the Germans are permitting this installation of power equipment to go on unless they have some definite need for it. This section of the country should not be overlooked and by section I mean anything within reasonable reach by high tension lines.

L. R. Groves

L. R. GROVES,
Brigadier General, C. E.

C/c destroyed
7/21/48 JJR

DECLASSIFIED
Authority NND 917017
By SAM NARA, Date 7/13/94

VICTORY

SECRET

31 December 1943

Colonel O'Conor 1/18/43

French Plant at Genissiat on the Rhone River 8-65 KW hydrogenerators. Four in place. Two nearing completion. Two on foundations. No apparent transmission lines, power to service.

Figure D.280: Leslie R. Groves to Robert R. Furman. 25 November 1943 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-1 GERMANY: US Wartime Positive Int. (July 42–June 44)]. Groves was concerned that occupying Germans could be building the large Génissiat hydroelectric plant on the Rhône river in eastern France to power a nearby uranium enrichment facility.

Known/Reported Sites Now in Poland

Karl Cohen to Philip Morrison. 7 August 1944. [NARA RG 77, Entry UD-22A, Box 168, Folder 203.11 Tech-Countermeasures + RW 1943–1944]

1. I have your memo of August 1. Pursuing your thought that we should take definite steps to counter enemy use of a device, I add the following suggestions:

4. Most of the threat would disappear if Upper Silesia were neutralized. If the Russians are not able to force a rapid decision in this sector, we should urge heavy strategic bombing of all power plants in this region from Russian bases.

8. We have ample evidence to justify bombing the Auer works on a strategic basis. This firm certainly has a key role in any program of consequence, and should be given special attention. Have we reconnaissance pictures of Auer?

[See document photo on p. 3713.

Based on intelligence not specifically described here, Leslie Groves's Foreign Intelligence Unit believed that there were important German nuclear weapons plants in Upper Silesia. They also recommended bombing Auergesellschaft in Oranienburg, which the U.S. ultimately did.]

LIMITED SECRET

Countermeasures
Feb 7

MEMORANDUM TO: P. Morrison August 7, 1944.

FROM: K. Cohen

1. I have your memo of August 1. Pursuing your thought that we should take definite steps to counter enemy use of a device, I add the following suggestions:

2. A defense group prepared not only for scientific detective work, but also for the more obvious civil defense measures, should be set up in England immediately. It must be mobile and equipped to determine what area after an explosion is still habitable. The nucleus of specialists experienced in field tests which has been established for Site X can furnish the cadres. Adequate attention must be paid to the psychological side of the defense group. It should be given a false front of the best-publicized scientists of both countries and given a good newspaper name like "Atomic Warfare Defense Section". For morale purposes it would be most important for the public to feel that we were well prepared in advance. The "false-front" need not be notified for the present.

3. The above measures are not alarmist; they are prophylactic, and are dictated by the possibilities shown in our last report.

8-7-44

4. Most of the threat would disappear if Upper Silesia were neutralized. If the Russians are not able to force a rapid decision in this sector, we should urge heavy strategic bombing of all power plants in this region from Russian bases.

5. Personally, I would prefer this procedure to the bombing of Bisingen on present evidence. At any event, Bisingen should not be attacked without <u>detailed</u> reconnaissance and analysis.

6. Reflection on last week's conversations highlighted the following points

a) It is <u>possible</u> for the enemy to produce devices at a dangerous rate.
b) We have no <u>direct evidence</u> that he is doing so.

a) and b) together infer that the enemy is <u>probably</u> doing nothing. But this is not enough! We need a crucial experiment.

7. In this respect the reaction of the enemy to an 'accidental' (i.e. incidental to other attacks) bombing of his metal stores, or of Auer, would be most instructive.

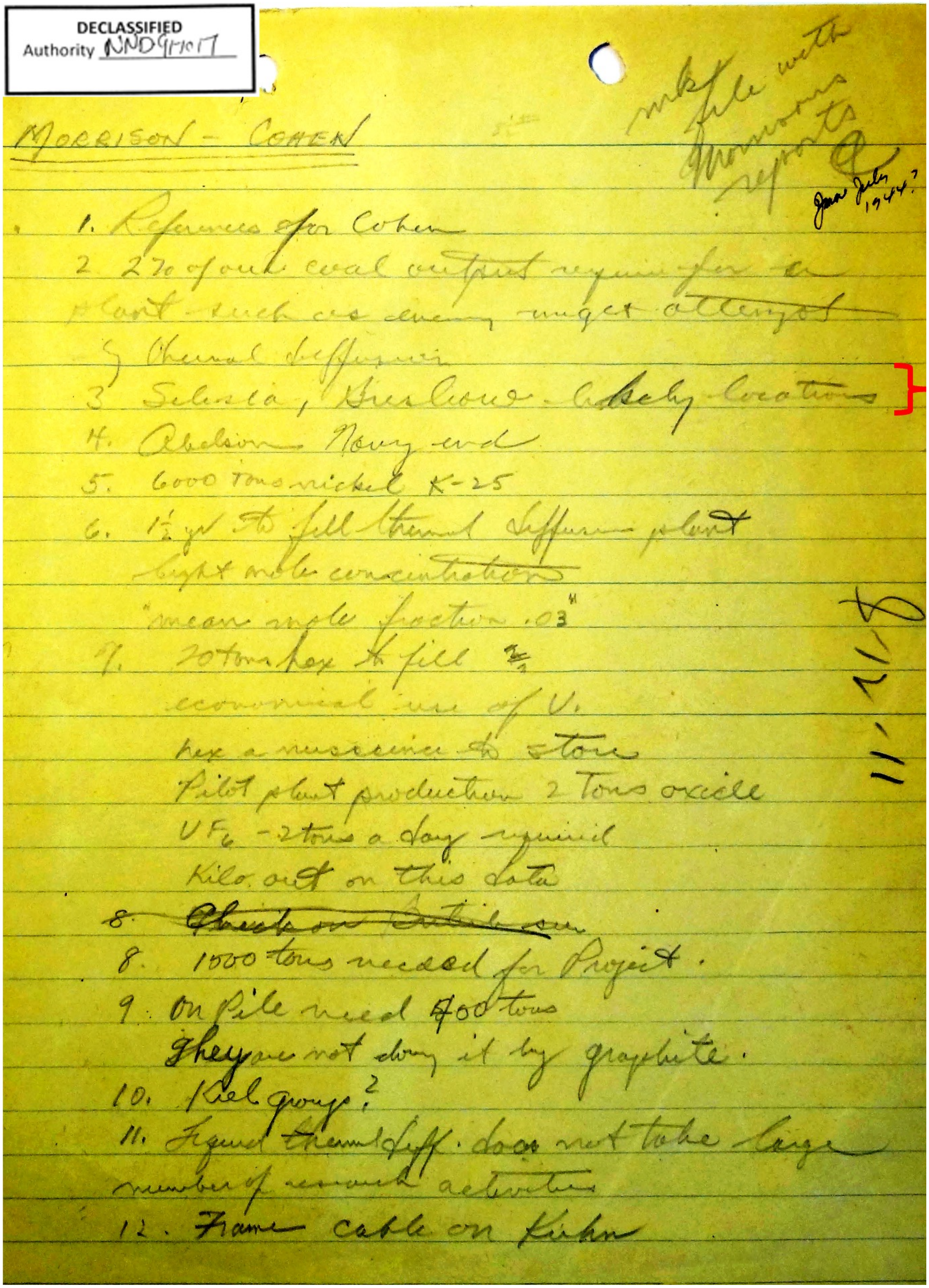
8. We have ample evidence to justify bombing the Auer works on a strategic basis. This firm certainly has a key role in any program of consequence, and should be given special attention. Have we reconnaissance pictures of Auer?

cc: R. Furman
B. Menke
J. King
File

NARA RG 77, Entry UD-22A, Box 168, Folder 203.11 Tech-Countermeasures + RW 1943-1944

Figure D.281: Based on intelligence not specifically described here, Leslie Groves's Foreign Intelligence Unit believed that there were important German nuclear weapons plants in Upper Silesia. They also recommended bombing Auergesellschaft in Oranienburg, which the U.S. ultimately did. Karl Cohen to Philip Morrison. 7 August 1944 [NARA RG 77, Entry UD-22A, Box 168, Folder 203.11 Tech-Countermeasures + RW 1943–1944].

NARA RG 77, Entry UD-22A, Box 171, Folder 32.60-2 GERMANY: Summary Reports (1945-1946)



DECLASSIFIED
Authority NND917017

MORRISON - COHEN

mk file with Morrison's reports

Jan-July 1944?

1. References for Cohen
2. 2% of our coal output required for a plant such as Germany might attempt of thermal diffusion
3. Silesia, Breslau - likely locations
4. Abelson Navy end
5. 6000 tons nickel K-25
6. 1½ yr to fill thermal diffusion plant light mole concentration "mean mole fraction .03"
7. 20 tons hex to fill ¾ economical use of U. hex a nuisance to store Pilot plant production 2 tons oxide UF6 - 2 tons a day required Kilo. out on this data
8. ~~Check on British ..~~
8. 1000 tons needed for Project.
9. On Pile need 400 tons They are not doing it by graphite.
10. Kiel group?
11. Figured thermal diff. does not take large number of research activities
12. Frame cable on Kuhn

11/21/8

Figure D.282: Notes from a meeting with Philip Morrison and Karl Cohen state: "3. Silesia, Breslau likely locations" for uranium enrichment plants, based on intelligence not recorded here [NARA RG 77, Entry UD-22A, Box 171, Folder 32.60-2 GERMANY: Summary Reports (1945–1946)].

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3
GERMANY: US Wartime Positive Int. (Nov. 44–June 45)

OFFICE OF STRATEGIC SERVICES
WASHINGTON 25, D. C.

6 April 1945

AA-172

TO: Major Francis J. Smith,
Washington, D. C.

FROM: Technical Section,
Col. H. W. Dix HWD

SUBJECT: Cable #8127 from Bern, dated 4 April 1945

In a cable from Bern dated 4 April, the following comments are made:

An important laboratory for breaking atoms is located at Wassersau Forschungs Anstalt Walchensee.

Siemens Forschungs Anstalt from Sargan, Silesia was transferred to Thurigen. Most of the equipment was lost enroute.

WASSERAU: ca. 20 mi. SW of Pilsen (Bohemia) 49° 35' N
12° 40' E

WALCHENSEE: ca. 30-35 mi SW of München 47° 35' N
11° 20' E

(Authority: Library of Congress, Map Section)

R., 7/4/45

SECRET

Figure D.283: H. W. Dix to Francis J. Smith. 6 April 1945 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)].

A.D.I. (K) Report No. 113A/1945. Suspected 'V' Weapon Factories—Germany and Poland. [NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL]

UNDERGROUND FACTORY, WIELICZKA, POLAND.
(March 1944).

15. A Polish refugee, who had worked in the Wieliczka area until March 1944, mentioned that towards the ends of 1943 the Germans had installed a plant for secret weapon production in a salt mine to the South-West of the town on the northern side of the Wieliczka-Swoszowice road at 49^o 58' 50" N., 20^o 3' 0" E.

16. The entrances to the site were guarded by black uniformed guards and the workers, who were all interned Jews, were never allowed to go out for air; it was understood that the mortality rate was very high as a result of these restrictions and the unhealthy working conditions.

17. Informant added that many of these workers and some of the machinery had been transferred to Wieliczka from another secret weapon factory situated to the North-East of Debica at approximately 50^o 8' N., 21^o 33' E. The local Poles were fairly sure that Debica was producing V.1's in 1943 as these were tested in the neighborhood and fell in the town of Sandomierz (50^o 30' 40" N., 21^o 46' 00" E.)

[See document photo on p. 3717.

This report described an underground plant in Poland that seemed much more secretive than standard V-1 and V-2 plants. If it was more secretive, was it producing modified missiles, or unusual warheads for missiles, or other advanced weapons?]

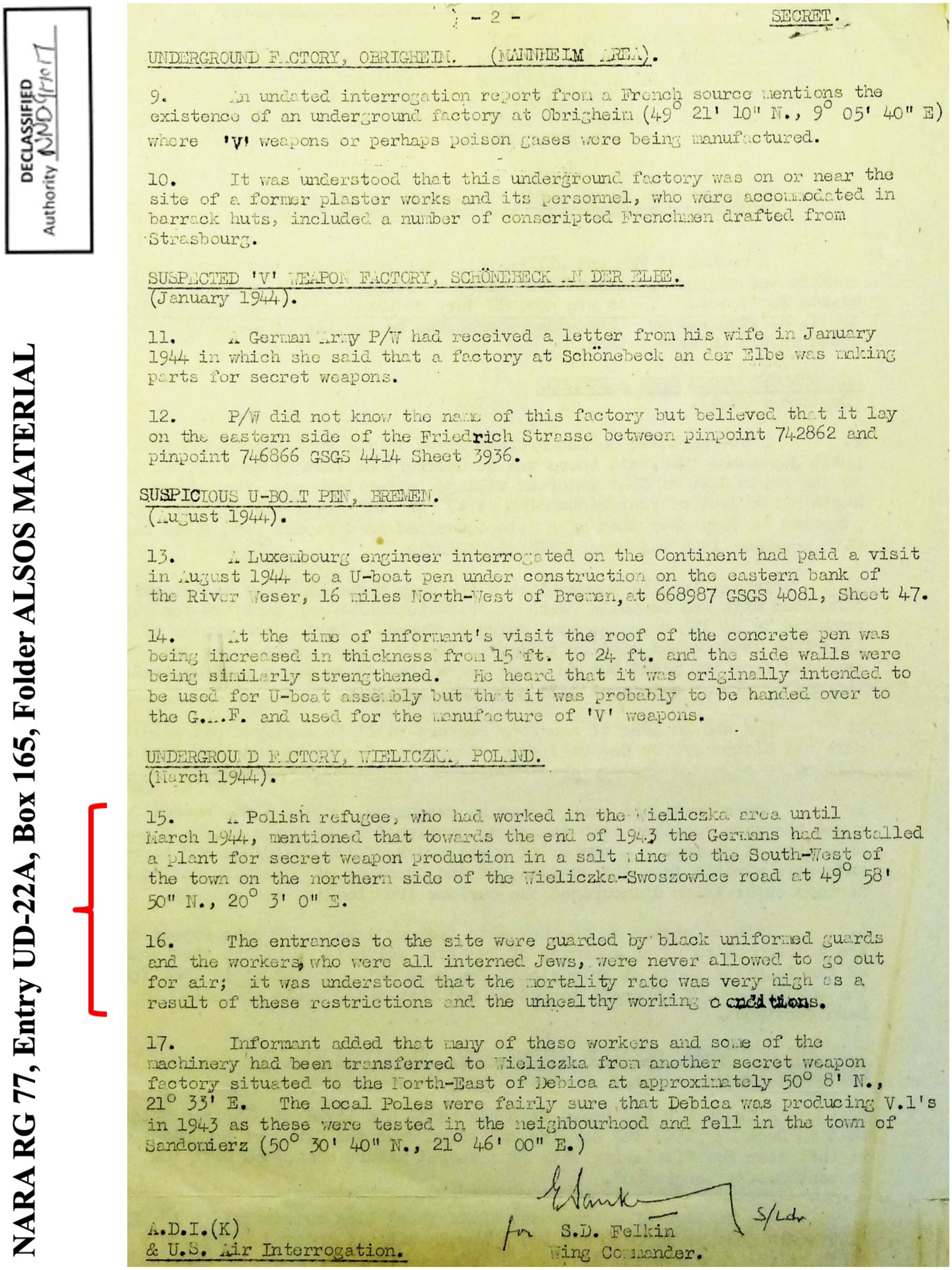
[For some other known or suspected nuclear sites in Poland, see:

pp. 4069–4071

pp. 4440–4477

pp. 4902–4903

See also nearby Kaliningrad, formerly Königsberg, East Prussia: pp. 3928–3933]



DECLASSIFIED Authority NND 917017

NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL

- 2 - SECRET.

UNDERGROUND FACTORY, OBRIGHEIM. (MANNHEIM AREA).

9. An undated interrogation report from a French source mentions the existence of an underground factory at Obrigheim (49° 21' 10" N., 9° 05' 40" E) where 'V' weapons or perhaps poison gases were being manufactured.

10. It was understood that this underground factory was on or near the site of a former plaster works and its personnel, who were accommodated in barrack huts, included a number of conscripted Frenchmen drafted from Strasbourg.

SUSPECTED 'V' WEAPON FACTORY, SCHÖNEBECK AN DER ELBE.
(January 1944).

11. A German Army P/W had received a letter from his wife in January 1944 in which she said that a factory at Schönebeck an der Elbe was making parts for secret weapons.

12. P/W did not know the name of this factory but believed that it lay on the eastern side of the Friedrich Strasse between pinpoint 742862 and pinpoint 746866 GSGS 4414 Sheet 3936.

SUSPICIOUS U-BOAT PEN, BREMEN.
(August 1944).

13. A Luxembourg engineer interrogated on the Continent had paid a visit in August 1944 to a U-boat pen under construction on the eastern bank of the River Weser, 16 miles North-West of Bremen, at 668987 GSGS 4081, Sheet 47.

14. At the time of informant's visit the roof of the concrete pen was being increased in thickness from 15 ft. to 24 ft. and the side walls were being similarly strengthened. He heard that it was originally intended to be used for U-boat assembly but that it was probably to be handed over to the G.A.F. and used for the manufacture of 'V' weapons.

UNDERGROUND FACTORY, WIELICZKA, POLAND.
(March 1944).

15. A Polish refugee, who had worked in the Wieliczka area until March 1944, mentioned that towards the end of 1943 the Germans had installed a plant for secret weapon production in a salt mine to the South-West of the town on the northern side of the Wieliczka-Swoszowice road at 49° 58' 50" N., 20° 3' 0" E.

16. The entrances to the site were guarded by black uniformed guards and the workers, who were all interned Jews, were never allowed to go out for air; it was understood that the mortality rate was very high as a result of these restrictions and the unhealthy working conditions.

17. Informant added that many of these workers and some of the machinery had been transferred to Wieliczka from another secret weapon factory situated to the North-East of Debica at approximately 50° 8' N., 21° 33' E. The local Poles were fairly sure that Debica was producing V.1's in 1943 as these were tested in the neighbourhood and fell in the town of Sandomierz (50° 30' 40" N., 21° 46' 00" E.)

A.D.I.(K)
& U.S. Air Interrogation.

for S.D. Felkin
Wing Commander.

Figure D.284: A.D.I. (K) Report No. 113A/1945. Suspected 'V' Weapon Factories—Germany and Poland. This report described an underground plant in Poland that seemed much more secretive than standard V-1 and V-2 plants [NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL].

Known/Reported Sites Now in Austria

Allen Dulles. 4 March 1944 OSS report. [Allen W. Dulles Papers: Digital Files Series, MC019-09, Public Policy Papers, Department of Special Collections, Princeton University Library. https://findingaids.princeton.edu/catalog/MC019-09_c034 Reports_English_1943-1977_and_undated 19440304_0000033429.pdf]

In the Zipfer Brauerei (brewery) in Zipf, Upper Austria, some secret and important war production is taking place. This production, which might be in connection with the secret weapon, is taking place in the underground parts of the brewery.

From John Lansdale, Jr., to Leslie Groves. Subject: Extract from ASF Intelligence Bulletin No. 10. 1 July 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)]

The following is taken from Part V, paragraph 2, page 11 of ASF Intelligence Bulletin No. 10, dated 28 June 1944:

"When on furlough in December 1943, visiting relatives near Voecklamarkt, Austria, P/W saw a very secret factory at Redl Zipf in a wooded ravine, about 200 meters north of the Redl Zipf RR station on the RR between Voecklamarkt and Voecklabruck. The people living in the vicinity believed poison gas or gas for secret weapons was being manufactured here but no one had definite information because workers were not from the neighborhood and the plant was very closely guarded by Gestapo in uniform and in plain clothes."

SECRET

Report of Interrogation
PW RAAB, Johann
Grenadier, Gren.Regt 305

11 October 1944
IO Captain Campbell

Veracity and estimate of personality: Believed to be reliable. PW is a thirty-year old Austrian, formerly a traffic official (Fahrdienstleiter) for the Deutsche Reichsbahn in Austria. He was inducted into the German Army 12 February 1944. PW is intelligent, observant and cooperative. The information contained herein was gathered by PW as a result of personal observation of the rail traffic between the installations involved and conversations with friends and acquaintances acquainted with the plants.

NOTE: The information contained in this report is only preliminary and as such, incomplete. A full report, together with sketches of installations discussed herein will be submitted 12 or 13 October.

Information obtained: In late September and early October 1943 PW began to notice an unprecedented amount of activity on the rails between Redl Zipf (N 48°02'07") (E 13°04'40"), Stadl-Paura (N 48°04'40") (E 13°52' 40"), Ebensee (N47°48'40") (E13°46'30") and Lenzing (N47°57'30"/E13°39'30"), all in the Salzkammergut. All this activity centered around the former Redl Zipf brewery storage cellars which are cut out of the limestone shale in a nearby hill. The inmates of a nearby concentration camp as well as numerous foreign and native workers were called in to enlarge the working area inside the hill and to lay a road bed for a railroad spur running into the installation. Concrete was poured for the flooring and the whole interior section was remodeled to provide work shops. Power lines were brought in from nearby Timelkam providing a current of 15,000 volts, and vast quantities of special equipment (discussed below) began to arrive even before the place was ready for production. The German engineers in charge as well as their underlings were all informed that the installation had to be ready for full production within a period of four months. While this was going on at Redl Zipf the artificial fiber plant in nearby Lenzing (Zellwolle Fabrik A.G., cf. report 1219, 1 May 1944) was being remodeled for a change over in production. The nature of this remodeling was unknown to PW or any of his acquaintances but in light of its contributions to the Redl Zipf installation it is apparent that the conversion was made to subordinate the activity of Zellwolle A.G. to Redl Zipf.

The engineers in charge of construction and production as well as almost all of the workers were Germans from the Altreich and practically all of them (total number of workers estimated at 2000) were trusted party members wearing the golden party membership insignia. PW became acquainted with the manager, Technischer Ingenieur Helmut Novotny as a result of damage to some of the equipment being shipped to Redl Zipf. Novotny was on the scene from the very beginnings of the construction period and stayed on after it got into production. Another personality whom PW remembers well was a man named Hollstein, also German, but Hollstein's visits became sporadic after the plant was completed. In a

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Figure D.285: Report of Interrogation PW RAAB. 11 October 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)].

SECRET

conversation with Novotny PW learned that there had previously been two similar installations of the same type in Germany itself--one in Sandhofen, north of Mannheim and one in Wiesoppenheim, just west of Ludwigshafen. Both these installations had been destroyed as a result of Allied bombings, but it was felt that this had occured more or less by chance as everything else in the area suffered equally, and the above mentioned installations were above ground, unlike the Redl Zipf plant.

The product of the firm is known to the workers only as "liquid gas" and, based on PW's knowledge of the raw materials delivered to the plant, it would appear to be some kind of explosive. Among the raw materials delivered to the plant were large quantities of coal (not for power, because all power was electric), bauxite, which came in Hungarian R.R. cars, lead, beryllium, tungsten, lye (which came from the Solvay firm in nearby Ebensee (this firm, in turn, was importing large quantities of thorium from Hungary and elsewhere in the Balkans. Lye and cellulose in large sheets came from the Zellwolle A.G. in Lenzing. From Ebensee also came 25 to 30 kilo sacks of a substance described on the bills-of-lading as Chlorzont (an ash-gray colored powder).

The equipment inside the plant consists of circa 200 boilers of unusual construction in that they are completely lined with some argillaceous material and covered over on the outside with some white metal, name of which is unknown to PW, but it is supposed to be a non-magnetic substance. These boilers are situated in different compartments and are connected by a system of pipes and conduits running between the sections and through the concrete walls. PW himself only saw the inside of the plant on one occasion, before completion, when he brought some materials into the installation. His other information comes from his wife's brother who was employed in the plant. The gas, or liquid, prepared was stored in large high-pressure cylinders about 3½ to 4 meters in height and 1½ to 2 meters in diameter. PW believes they were constructed of more than usual strength steel. They too, as well as all connections and valves, were lined with an earthenware type coating.

The product, when ready for shipment, was sent to an already established munitions factory in Stadl Paura (cf. report 1219, 1 May 1944--PW's information on this plant differs substantially from that given in above this report and will be covered fully in final report). Great care had to be exercised in transferring the liquid from the high-pressure containers to the tank cars. The hoses used for making the transfer were made of rubber impregnated fibers reinforced on the outside with flexible bands of the same white and allegedly non-magnetic metal used in the construction of the boilers referred to above. Even the nozzles were lined with an earthenware coating to prevent any contact of the liquid and the metal. The tank cars themselves were extraordinary.They were completely constructed of a clay or heavy earthenware substance and were bedded on thick felt cushioning. They may have been reinforced with metal inside the walls of the tanks, but no metal was visible from the outside. There were 6 of these tank cars, each containing 250 hektoliters and they had been specially built by a firm in Ludwigshafen. They were used only on the Redl Zipf--Stadl Paura run. On one occasion

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NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-Oct. 44)

Figure D.286: Report of Interrogation PW RAAB. 11 October 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)].

SECRET

PW examined the residue clinging to the underside of a tank car lid after it had returned from Stadl Paura. He found a number of lumps of a thick gummy grayish substance with traces of what looked to him like oil on the surface. It was absolutely odorless. He was surprised at the grayish color for he had been told that the gases themselves, when in liquid form, were of a green or yellowish color. He surmised that when pressure was released radical changes took place in the substance.

It is noteworthy that the workers in the plant complained of loss of appetite and one of them, a brother in law of PW, said he could no longer enjoy a regular meal. Peasants in the vicinity were required to make regular delivery of whole milk for the workers. All workers were absolutely forbidden to drink any alcoholic beverage, even beer, whether on or off duty. Brother in law of PW confessed that he had tried a few glasses of beer anyhow, but to his surprise found it distasteful. He felt that the gases or something else in the atmosphere of the installation were responsible for this. Other workers were undergoing the same experience. However, as this brother in law was receiving over 50RM per week for the relatively unskilled work he was performing (transferring the liquids from containers to tank cars) he was not complaining too much about his health.

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Later, before PW was inducted into the army, the RR delivered 4 large dynamoes (marked "Henkel") and 16 to 18 smaller dynamoes (marked "Bosch") to the plant. He wondered what these were for inasmuch as the plant already was getting 15,000 volts from Timelkam. Included with these was a large variety of miscellaneous electrical equipment including transformers and items which PW had never seen before. He knew that electrical furnaces, albeit small ones, had been installed in the plant and felt that perhaps these dynamoes were used to furnished additional power for them .

PW learned from a worker at Stadl Paura that "a new type shell casing " was being turned out. So far as he recalls this shell case was of a size suitable for use in the largest field artillery pieces and was made of some kind of white metal. Whether or not there was any connection between these shell casings and the liquid gases being delivered there PW does not know.

End of preliminary report.

SECRET

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-Oct. 44)

Figure D.287: Report of Interrogation PW RAAB. 11 October 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)].

Report of Interrogation PW RAAB. 11 October 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)]

Report of Interrogation	11 October 1944
PW RAAB, Johann	IO Captain Campbell
Grenadier, Gren. Regt 305	

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Later, before PW was inducted into the army, the RR delivered 4 large dynamos (marked "Henkel") and 16 to 18 smaller dynamoes (marked "Bosch") to the plant. He wondered what these were for inasmuch as the plant already was getting 15,000 volts from Timelkam. Included with these was a large variety of miscellaneous electrical equipment including transformers and items which PW had never seen before. He knew that electrical furnaces, albeit small ones, had been installed in the plant and felt that perhaps these dynamoes were used to furnished additional power for them.

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End of preliminary report.

[See document photos on p. 3719–3721.]

Philip Morrison to Joseph Volpe. Evaluation of Documents in the Washington Office—October 19, 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.60-2 Germany: Summary Reports (1945–1946)]

[...] 7. The long Prisoner of War reports on Redl Zipf have already been discussed by Dr. Tolman. It is reasonably certain that this is not a plant of interest to us [Manhattan Project] but may be of interest to some of the Chemical Warfare officers. [...]

[From this remarkably detailed PW report, it sounds as if something extraordinary was being produced at the Redl Zipf plant, yet there is still not enough information to tell exactly what that product was. It is possible that work conducted at this plant was one (or more) of the following:

- Production of uranium hexafluoride for U-235 enrichment. Uranium hexafluoride is corrosive to most materials except nickel, aluminum to a certain extent (the white metal described in these documents may have been nickel, aluminum, or an alloy containing one or both of those metals), and certain ceramics (such as the earthenware or earthenware-lined containers described in these documents).

- Enrichment of U-235 in uranium hexafluoride via gaseous diffusion, if the "circa 200 boilers of unusual construction" that were "connected by a system of pipes and conduits" were gaseous diffusion cells containing nickel diffusion membranes under high pressure.

- Enrichment of U-235 in uranium hexafluoride via centrifugation, if the "boilers of unusual construction" were uranium gas centrifuges.

- Chemical reprocessing to purify Pu-239 from neutron-irradiated U-238.

- Chemical reprocessing to purify U-233 from neutron-irradiated Th-232.

- Production of a nerve agent. Sarin, cyclosarin, and soman (but not tabun) contained fluorine, which made them corrosive to metals other than nickel or possibly aluminum.

- Production of a blistering agent. Mustard and some other blistering agents contained chlorine, which made them corrosive to most metals.

- Production of a fuel-air explosive, such as a mixture of coal dust and liquid oxygen, or coal dust and a corrosive nitrogen-based oxidizer (nitric acid, nitrogen tetroxide, etc.).

- Production of a corrosive nitrogen-based oxidizer (nitric acid, nitrogen tetroxide, etc.) for rocket propellant.

- Production of a fuel for rocket propellant (hydrazine, etc.).

Any of the above options are possible based on the PW report. Of these options, arguably the best fit might be uranium enrichment via gaseous diffusion or centrifugation of uranium hexafluoride. Manhattan Project personnel certainly seemed to think the Redl Zipf plant could be doing nuclear-related work, which is why they included it in their files and apparently spent some time analyzing it. On what grounds was this PW report ultimately dismissed as not being nuclear-related?

The same information was repeated in the final version of this PW interrogation report, Report 1349, Report from Captured Personnel and Material Branch, 17 October 1944 [AFHRA 25177 electronic version pp. 923–935].

There were many other wartime intelligence reports about very secret, high priority, and extremely mysterious work that was conducted at Redl Zipf [e.g., AFHRA electronic versions A6091 p. 1287l, 25082 pp. 106–108; 25177 pp. 919–951; 25216 pp. 385–386].]

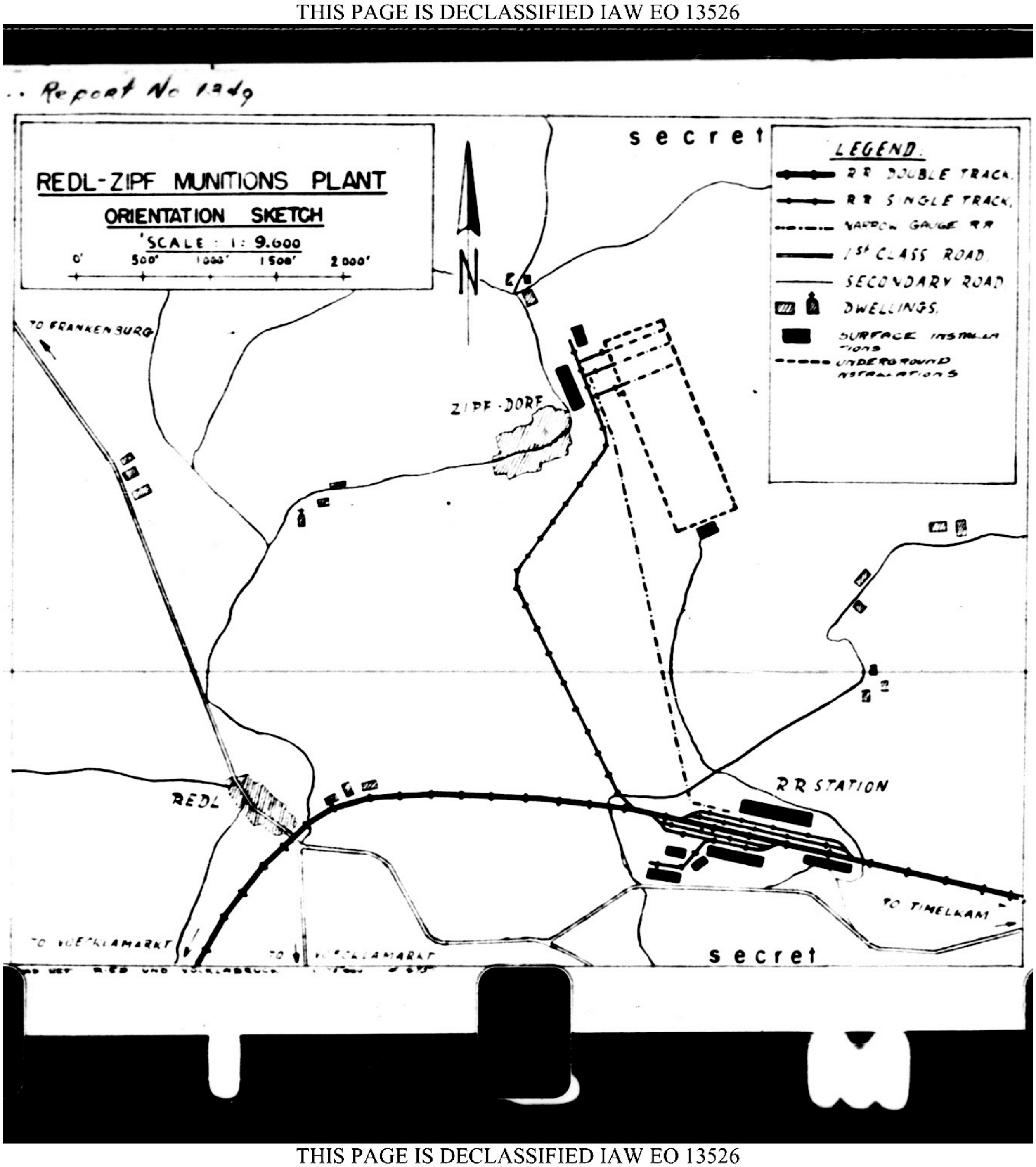


Figure D.288: Map of the Redl Zipf facility from Report 1349, Report from Captured Personnel and Material Branch, 17 October 1944 [AFHRA 25177 p. 932].

Figure D.289: Remains of the Redl Zipf facility on the surface and underground today.

Joseph Volpe to S. D. Brown. 18 October 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)]

18 October 1944

MEMORANDUM to Lt. Col. S. D. Brown, Room 2B677, Pentagon Building.

It is requested that during interrogation of Prisoners of War information be procured concerning the following:

Manufacturing plants at the following locations—

Redl Zipf	Lenzing
Stadl Paura	Timelkam
Ebensee	

Companies—

de Boer, Ems, Germany

Rohstoff Handels Gesellschaft (Roges AG), Berlin

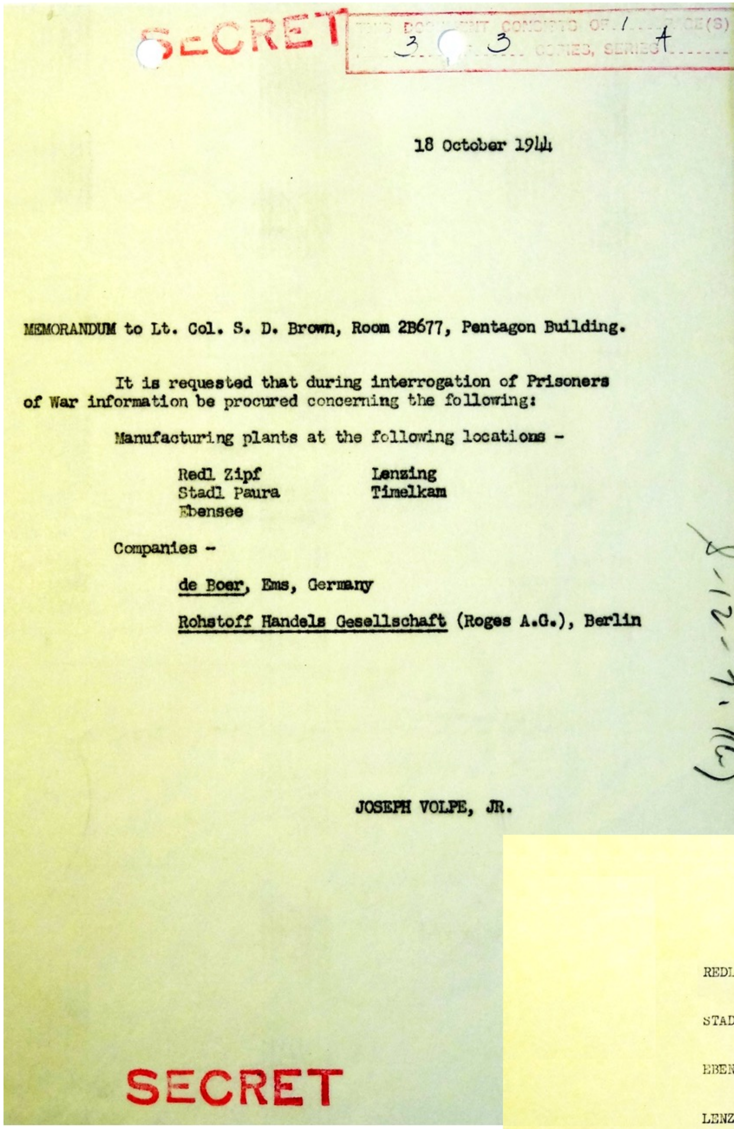
JOSEPH VOLPE, JR.

[See document photo on p. 3729. As shown by this memo, the Manhattan Project's Foreign Intelligence Unit continued to think that Redl Zipf and related facilities might be conducting nuclear weapons work, and they sought further information on those sites.]

PW INTELLIGENCE SECTION, HQ MAAF. 22 December 1944. [AFHRA A6091 frame 1419]

[...] 4. SECRET WEAPONS, REDL ZIPF (A): At REDL ZIPF between VÖCKLAMARKT and VÖCKLABRUCK, experiments are being made in connection with the atomic bomb. (See MAAF S 6686, Intelligence Item 6, Secret Weapons, Austria.) Date of Information: June 1944. [...]

[If this intelligence report was accurate, it confirms that Redl Zipf was indeed conducting work related to nuclear weapons development. What exactly was the information that was received? Can the cited report, "MAAF S 6686, Intelligence Item 6, Secret Weapons, Austria," be located in archives now?]



SECRET THIS DOCUMENT CONSISTS OF 1 PAGE(S) 3 OF 3 COPIES, SERIES A

18 October 1944

MEMORANDUM to Lt. Col. S. D. Brown, Room 2B677, Pentagon Building.

It is requested that during interrogation of Prisoners of War information be procured concerning the following:

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Redl. Zipf	Lenzing
Stadl. Paura	Timelkam
Ebensee	

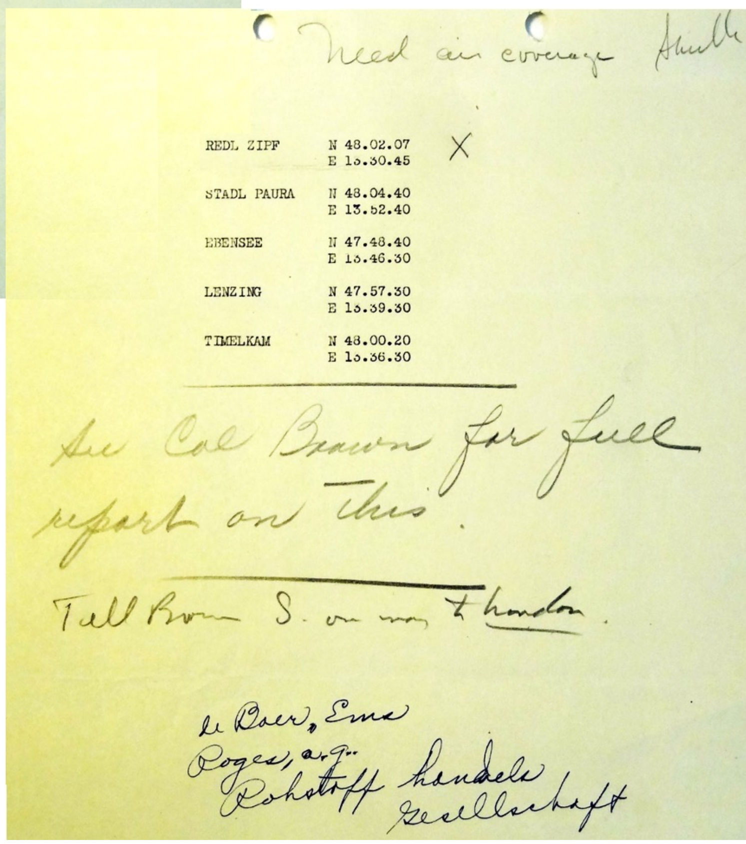
Companies -

de Boer, Ems, Germany

Rohstoff Handels Gesellschaft (Roges A.G.), Berlin

JOSEPH VOLPE, JR.

SECRET



Need air coverage

REDL ZIPF	N 48.02.07 E 13.30.45
STADL PAURA	N 48.04.40 E 13.52.40
EBENSEE	N 47.48.40 E 13.46.30
LENZING	N 47.57.30 E 13.39.30
TIMELKAM	N 48.00.20 E 13.36.30

See Col Brown for full report on this.

Tell Brown S. on way to London.

de Boer, Ems
Roges, a.g.
Rohstoff handels Gesellschaft

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July-Oct. 44)

Figure D.290: Joseph Volpe to S. D. Brown. 18 October 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)].

Report No. 551/158. 13 February 1945. Austria—Economic: Factory Redl-Zipf, district Vöcklabruck. [AFHRA 25177 electronic version pp. 944–947]

Source
LULLABY from Czechoslovak refugee who worked in the factory.

Date of Information
6.2.45

Reliability
Good

Subsource is available for interrogation until 20 Feb. 45. Urgent comments are requested.

1. The secret name of the factory is SCHLIER. All transports for this factory are delivered under this name or "Zentralbauleitung Redl-Zipf". The number of workers employed in this factory is not known exactly to me, but I guess that about 1,000 men are now working there. The camp of these workers is situated in the buildings of the brewery in ZIPF. The brewery works only in a restricted measure. These workers are specialists—German only.

2. The factory has no name. It belongs to the Hermann Göring concern, LINZ (Austria).

3. High-explosive gas is manufactured in the underground tunnels and stored in vertical kettles (20 x 4 m), the pressure being 50–100 atm. These kettles are in the underground tunnels as well.

4. Two entrances lead to this underground factory and, out of these corridors, other corridors were hewn in the rock which lead into working rooms, the number of these being 23. From these rooms are pipe lines leading into the kettles. Some rooms have 2 or 4 (one has even 8) kettles. The total number of kettles I do not know.

5. These kettles, made of steel, are vertical, hewn into the rock under the surface of the corridors and on the top of the kettles is a layer of ash-like material. The whole kettle is cemented into the rock.

6. I have seen machines in 4 rooms only. These 4 rooms were the biggest—12 m width, 100 m length, 5 m high. The firring of these machines, where I helped, lasted one month. In each of these rooms were two machines that looked like huge pumps—dimensions 3 m width, 3 m height, 5 m length. Other installations in these rooms were a steel ball, walls 7 cm thick, 2 m diameter (I know the thickness of this ball as other workers were cleaning the interior of the ball). This ball has not been of one piece, but welded out of several square pieces. Into the ball leads a pipe, the diameter being about 50 cm and another pipe of the same dimension which leads out opposite the first pipe. Two pipes 10 cm diameter lead into a measuring apparatus which has been sufficiently accurate to measure 1/260th of a gramme. This apparatus I suppose has been devised to measure the pressure and probably other qualities of the product.

7. This product has been referred to by German personnel as “Masse”.

8. The ball rested on an iron pedestal and under this pedestal the aforementioned measuring apparatus has been placed. This apparatus has been of a sort of weigh[ing]. During the time of fitting one Russian prisoner left a chisel, probably on purpose, a chisel in this weigh so that the apparatus would not function, the chisel staying upright. He has been shot. This apparatus had several dials which were connected with a camera. This camera has been connected with a “Prüfungsraum” situated on the top of the rock and separated from the working rooms. This ‘Prüfungsraum” was in a pill-box, camouflaged with dry trees painted green. In the same manner has been camouflaged the whole rock on a surface of about 300 m x 300 m. On the rocket has been put a layer of cement, about 30 cm, and in this layer the dry trees stuck in and sprayed with green paint.

9. At the first trial producing the “Masse” an explosion occurred and a fire broke out lasting five minutes. A flame shot out of the tunnels, white in colour (Stichflamme) and a temperature of 3000 ^{o}C—as I heard from the Germans—all the brass, aluminium and copper parts of machines disappeared. The repair lasted for three months (the factory has been built from April 1943–May 1944). All the occupants in the rooms were killed—my party removed 9 bodies, completely unrecognisable, 70 cm long.

10. The other rooms were much smaller, about 3 x 3 x 3 m and some were only enlargements of the corridors. There were a few machines which had been transported there in parts so that I could not guess what sort of machines they were when fitted together. Ten rooms were probably larger, but always behind a curtain. In one of them has been probably a power station, as different electric material has been transported inside. I guess that chemical products were manufactured as cases from the societies: Vereinigte Chemische Fabrik Kreidel & Heller, Wien XXI, Sebastian Kohlgasse (I know the first exactly as near there I have been working—the factory until XII/1944 has not been hit, though the Vacuum Shell Company on the opposite side of the street is completely destroyed).

11. The daily output of the factory is 4 railway-cisterns. These cisterns resist high pressure. At the closing of the cisterns a white snow-like layer forms itself and the so evaporating gas has a slightly green colour, without any smell and when inhaled is harmless.

12. Locating this factory is helped by the brewery in ZIPF which has a high factory chimney painted green. The two corridors leading underground are immediately at the brewery (see sketch) towards North.

13. The rock in ZIPF, where the factory is, is of sandstone and it happened several times during the construction that the corridors broke down. At the entrance the thickness of sandstone is about 1 m, the deepest corridor is 18 m. On that point is a shaft, the Germans said, 18 m deep.

14. The station REDL-ZIPF is on the main railway line LINZ-SALZBURG.

15. Electricity comes from the power station TIMELKAM situated 20 km to the East of the station Redl-Zipf. The tension is 110,000 V. I worked on the fitting of switchboards. From the transformer station (see sketch) electricity comes to the factory with two high tension wires and two underground cables. Here the tension is lowered to 10,000 volts.

Another high tension wire was being erected to the West as I know there is also a power station in STEINDORF, 20 km to the West from REDL-ZIPF.

16. What I heard, and what the workers think, is that gas for the V.1 weapon is being manufactured in this factory.

17. The postal address of this factory is: Attnang-Puchheim, Postschliessfach 26.

I heard about other factories of this sort, but I have not been there. They are:-

1. The factory in ST. GEORGEN, near LINZ. The secret name of this factory is ESCHE. The postal address: LINZ/DONAU 2 Postschliessfach 999/XX.

2. The factory in MELK, near Vienna. The secret name is QUARZ, the postal address is not known to me.

We were told by the Germans that, upon being asked by relatives etc we have to say that we are in Esche, Quarz etc. Where is this unknown place? At Attnang-Puchheim. Of course, what is being done there, we were forbidden to tell.

3. Another factory of this sort in WIENER NEUSTADT has been destroyed by bombing. Work not resumed.

NO. 1391

ZIPF

GN 5061

SOURCE SHEET SECRET

Subject : AUSTRIA : ECONOMIC

Report No.: 551/158

Date: 13.2.45

Distribution : G-2 CIO MAAF MAAF TARGETS EAB

Source	Date of Information	Reliability
LULLABY from Czechoslovak refugee who worked in the factory.	6.2.45	Good

Subsource is available for interrogation until 20 Feb. 45. Urgent comments are requested.

FLYING BOMB or ROCKET FACTORY
at
Z I P F
(AUSTRIA)

G.S.G.S. (AIR) 5005. SHEET 4751.

48° 02' 22" N.
13° 30' 12" E.

SORTIE: 60PR/636.
PRINTS: 3023 to 3025.
4043 to 4049.
5011.
SCALE : 1/8,500 (36")
1/51,000 (6")
DATE : 7 August 1944.

Reports have stated that:

(a) Flying bombs are produced in a former brewery 15 miles from SALZBURG in the direction of VIENNA.
(b) A bomb-filling factory is situated in a brewery which lies at the foot of a hill known as ZIPF; the factory being partly underground.
(c) Rockets 10m. long and 4m. broad, were seen in a salt mine at REDELZIPF.

Photographs which cover the village of ZIPF, which is situated 27 miles N.E. of SALZBURG, show a large brewery adjacent to the hillside. From the well-defined tracks at the foot of the hill and the existence of dumps of spoil, it is evident that some excavation has been made in the hillside; furthermore a newly constructed siding leads from the main line to what are probably the entrances to the excavation. Judging by th[e] well defined roads and tracks it seems that not only is the brewery closely allied to t[he] underground shops, but that the whole village has been taken over for administration, billeting and perhaps part production.

As it is to be expected there are no external indications as to what the finished product is other than the presence of three dumps of curious unidentified objects, "egg like" in shape, and measuring approx. 10 ft. by 6 ft. The most significant feature in [the] complex, however, is the presence on the siding near the entrances to the underground wor[ks] of a special type of tankcar identical with those seen at PEENEMUNDE, also at least 5, probably 7, similar tank cars are situated on the works siding where it leaves the main [line].
The plant is obviously active for in addition to the indications mentioned previou[sly] smoke is issuing from the brewery chimney, numerous M.T. are parked near a large buildi[ng] two M.T., and some personnel are in motion.

Figure D.291: [AFHRA Mediterranean Allied Air Forces Reel 189, No. 1391 Zipf GN 5061]

SECRET

YO 400
8th February 1945

AUSTRIA - ECONOMIC
Factory Redl-Zipf, district Vöklabruck

1. The secret name of the factory is SCHLIER. All transports for this factory are delivered under this name or "Zentralbauleitung Redl-Zipf". The number of workers employed in this factory is not known exactly to me, but I guess that about 1,000 men are now working there. The camp of these workers is situated in the buildings of the brewery in ZIPF. The brewery works only in a restricted measure. These workers are specialists - Germans only.

2. The factory has no name. It belongs to the Hermann Göring concern, LINZ (Austria).

3. High-explosive gas is manufactured in the underground tunnels and stored in vertical kettels (20 x 4m), the pressure being 50 - 100 atm). These kettels are in the underground tunnels as well.

4. Two entrances lead to this underground factory and, out of these corridors, other corridors were hewn in the rock which lead into working rooms, the number of these being 23. From these rooms are pipe lines leading into the kettels. Some rooms have 2 or 4 (one has even 8) kettels. The total number of kettels I donot know.

5. These kettels, made of steel, are vertical, hewn into the rock under the surface of the corridors and on the top of the kettels is a layer of ash-like material. The whole kettel is cemented into the rock.

6. I have seen machines in 4 rooms only. These 4 rooms were the biggest - 12m width, 100m length, 5m high. The firring of these machines, where I helped, lasted one month. In each of these rooms were two machines which looked like huge pumps - dimensions 3m width, 3m height, 5m length. Other installations in these rooms were a steel ball, walls 7cm thick, 2m diameter (I know the thickness of this ball as other workers were cleaning the interior of the ball). This ball has not been of one piece, but welded out of several square pieces. Into the ball leads a pipe, the diameter being about 50cm and another pipe of the same dimension which leads out opposite the first pipe. Two pipes 10cm diameter lead into a measuring apparatus which has been sufficiently accurate to measure 1/260th of a gramme. This apparatus I suppose has been devised to measure the pressure and probably other qualities of the product.

7. This product has been referred to by German personnel as "Masse".

8; The ball rested on an iron pedestal and under this pedestal the afore-mentioned measuring apparatus has been placed. This apparatus has been of a sort of weigh. During the time of fitting one Russian prisoner left a chisel, probably on purpose, a chisel in this weigh so that the apparatus would not function, the chisel staying upright. He has been shot.

Figure D.292: [AFHRA Mediterranean Allied Air Forces Reel 189, No. 1391 Zipf GN 5061]

This apparatus had several dials which were connected with a camera. This camera has been connected with a "Prufungsraum" situated on the top of the rock and separated from the working rooms. This "Prufungsraum" was in a pill-box, camouflaged with dry trees painted green. In the same manner has been camouflaged the whole rock on a surface of about 300m x 300m. On the rock has been put a layer of cement, about 30cm, and in this layer the dry trees stuck in and sprayed with green paint.

9. At the first trial producing the "Masse" an explosion occurred and a fire broke out lasting five minutes. A flame shot out of the tunnels, white in colour (Stichflamme) and a temperature of 3000° C - as I heard from the Germans - all the brass, aluminium and copper parts of machines disappeared. The repair lasted for three months (the factory has been built from April 1943 - May 1944). All the occupants in the rooms were killed - my party removed 9 bodies, completely unrecognisable, 70 cm long.

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11. The daily output of the factory is 4 railway-cisterns. These cisterns resist high pressure. At the closing of the cisterns a white snow-like layer forms itself and the so evaporating gas has a slightly green colour, without any smell and when inhallated is harmless.

12. Locating this factory is helped by the brewery in ZIPF which has a high factory chimney painted green. The two corridors leading underground are immediately at the brewery (see sketch) towards North.

13. The rock in ZIPF, where the factory is, is of sandstone and it happened several times during the construction that the corridors broke down. At the entrance the thickness of sandstone is about 1m, the deepest corridor is 18m. On that point is a shaft, the Germans said, 18m deep.

14. The station REDL-ZIPF is on the main railway line LINZ - SALZBURG.

15. Electricity comes from the power station TIMMELKAM situated 20 km to the East of the station Redl-Zipf. The tension is 110,000 V. I worked on the fitting of switchboards. From the transformer station (see sketch) electricity comes to the factory with two high tension wires and two underground cables. Here the tension is lowered to 10,000 volts.

Figure D.293: [AFHRA Mediterranean Allied Air Forces Reel 189, No. 1391 Zipf GN 5061]

- 3 - YO 400

Another high tension wire was being erected to the West as I know there is also a power station in STEINDOF, 20km to the West from REDL-ZIPF.

16. What I heard, and what the workers think, is that gas for the V.1 weapon is being manufactured in this factory.

17. The postal address of this factory is: Attnang-Puchheim, Postschliessfach 26.

- o -

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1. The factory in ST. GEORGEN, near LINZ. The secret name of this factory is ESCHEN. The postal address: LINZ/DONAU 2 Postschliessfach 999/XX.

2. The factory in MELK, near Vienna. The secret name is QUARZ, the postal address is not known to me.

We were told by the Germans that, upon being asked by relatives etc we have to say that we are in Eschen, Quarz etc. Where is this unknown place? At Attnang-Puchheim. Of course, what is being done there, we were forbidden to tell.

3. Another factory of this sort is WIENER NEUSTADT has been destroyed by bombing. Work not resumed.

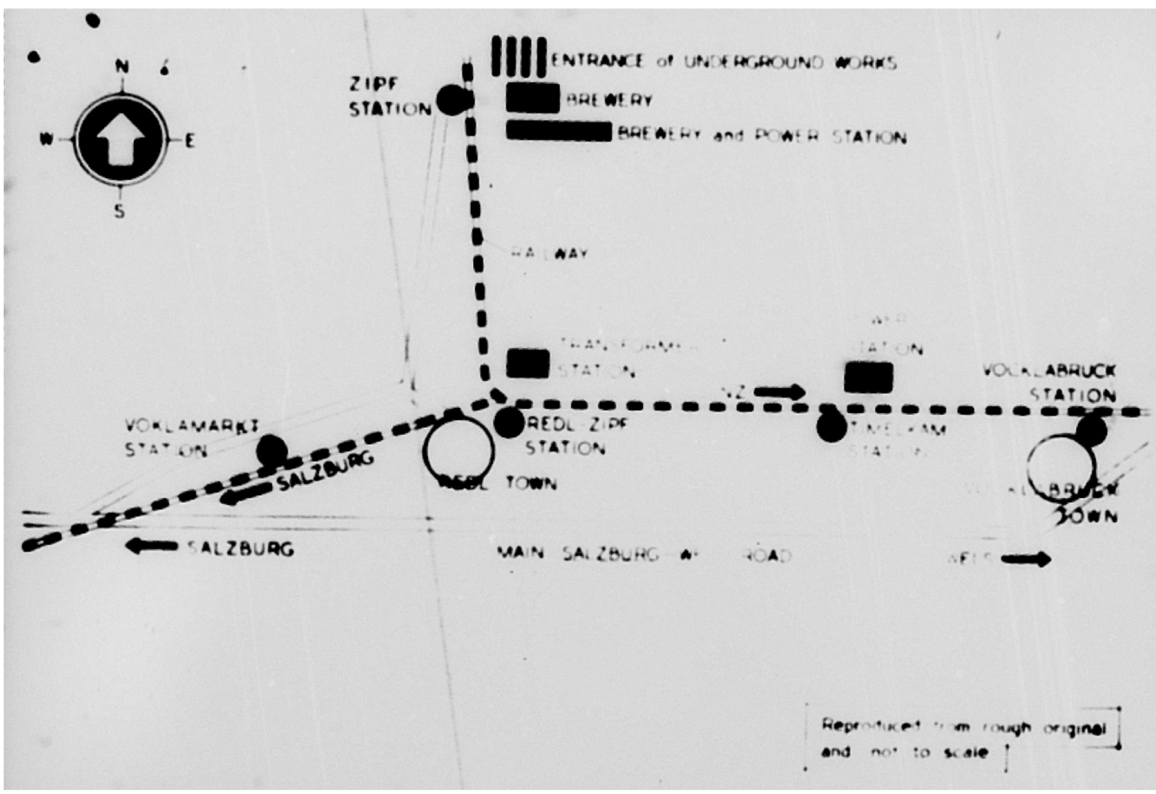


Figure D.294: [AFHRA Mediterranean Allied Air Forces Reel 189, No. 1391 Zipf GN 5061]

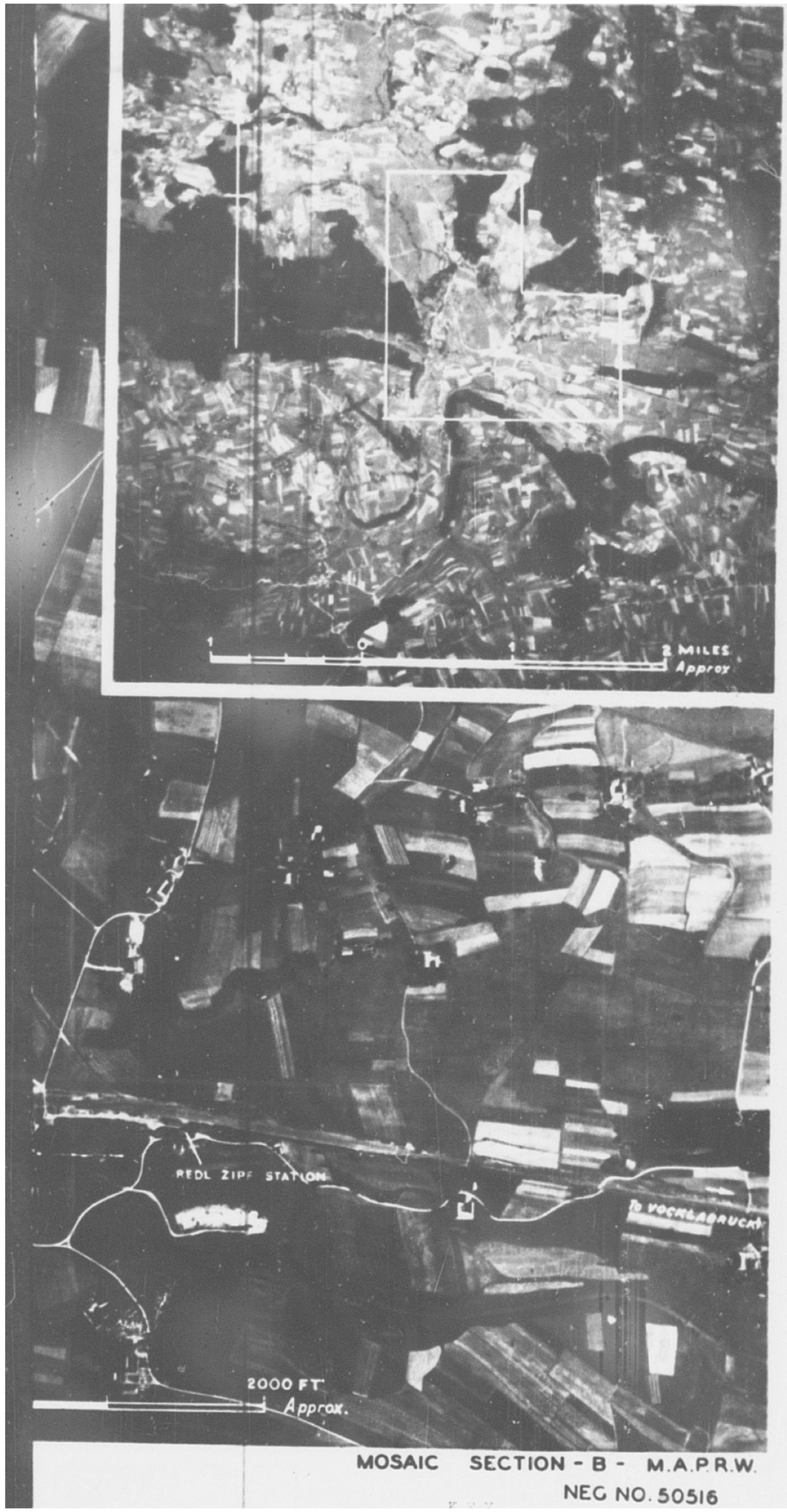


Figure D.295: [AFHRA Mediterranean Allied Air Forces Reel 189, No. 1391 Zipf GN 5061]

AFHRA MAAF Reel 189 No. 1391 Zipf GN 5061

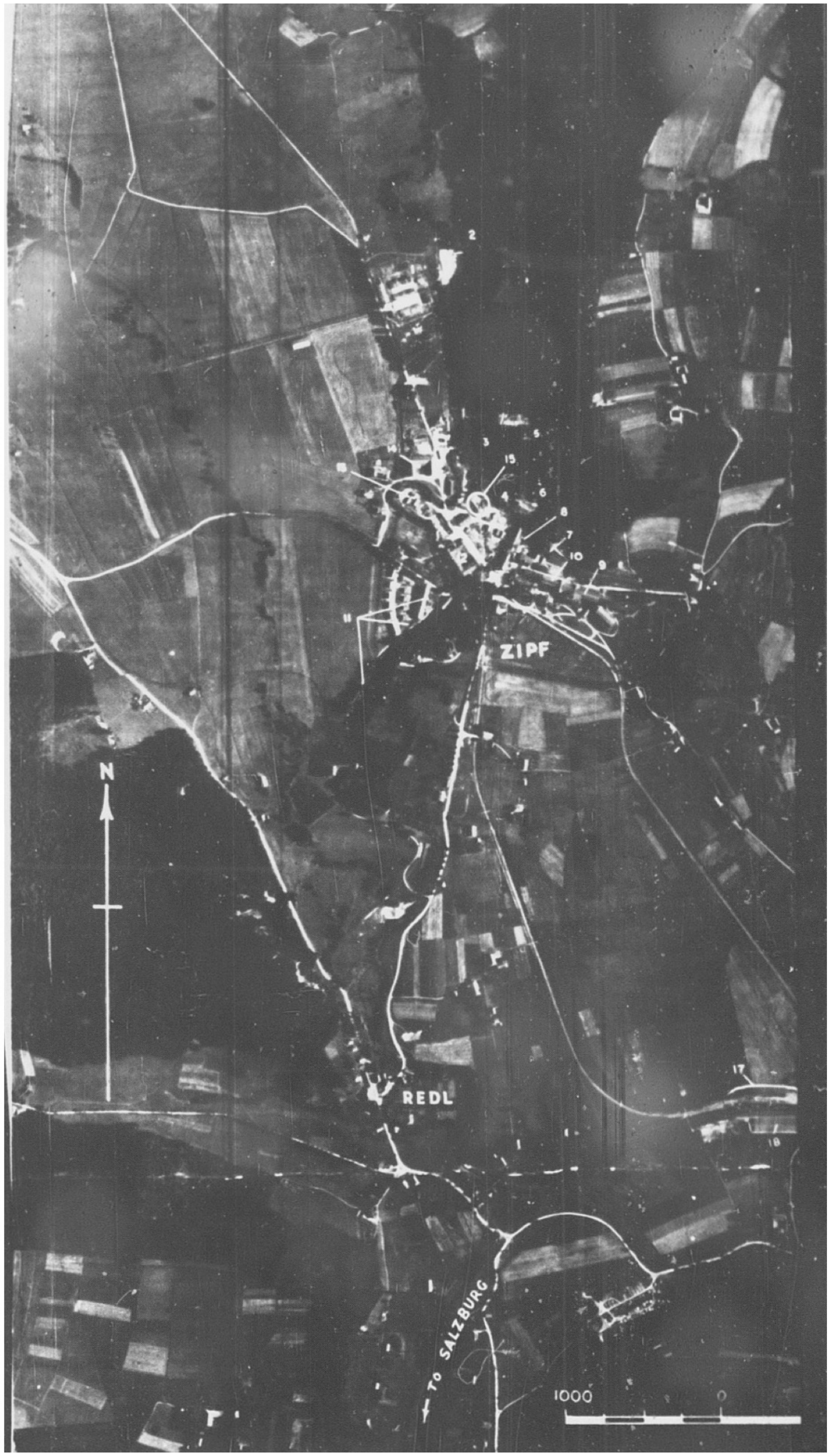


Figure D.296: [AFHRA Mediterranean Allied Air Forces Reel 189, No. 1391 Zipf GN 5061]

AFHRA MAAF Reel 189 No. 1391 Zipf GN 5061

THIS PAGE DECLASSIFIED IAW EO 13526

NEG NO. 50516

KEY

1. Concentration camp.
2. Spoil dump from excavations.

3.)
4.) Entrances to underground workshops.

5.)
6.) Unidentified structures.

7. Ventilation or smoke stack.
8. Entrance to underground workshop.
9. Brewery buildings.
10. Power Plant or Boiler House.
11. Three groups of unidentified objects.
12. Village building possibly used as offices or billets.

13.)
14.) Workshops (probably only maintenance)

15. Special type of tank car on works sidings.
16. Building connected by pipe line or underground cable to the works area
17. Group of special type tank cars on the siding.
18. Despatch or storage shed.

M.A.P.R.W. 11 August 1944. Report No: MI.511

CONFIDENTIAL

Figure D.297: [AFHRA Mediterranean Allied Air Forces Reel 189, No. 1391 Zipf GN 5061]

BIOS 31. *Rocket Developments in South Germany and Austria.* pp. 35–37.

Target:	Steinbruchverwertungs G.m.b.H. Betrieb Schlier
Location:	Brauerei Zipf, Redl. N.49 XV2954 (U.S. zone)
Nature of Target:	Underground liquid oxygen plant and firing station for static proof of A.4 rocket motors.
Date visited:	24.8.45.
Personnel interviewed:	Dr. Kretz, (E), the owner of the brewery. Available at the brewery.

1. The brewery's storage vaults, which were constructed in the side of a hill, had been used by the above-named organisation for the erection in 1943 of an underground liquid oxygen plant.

This plant consisted of seven units, operating on the Linde principle, capable of producing 80 tons of liquid oxygen per day.

Each unit comprised a compressor, alkali absorption towers for removal of CO_2, and a still for separation of liquid oxygen and nitrogen.

The compressor, built by Borsig, operated in five stages and developed 600 Kw. Compression to 160 atms. was attained.

The nitrogen was expanded after separation from the oxygen, giving a recovery of 10 per cent. of the power input. After running off the liquid, residual gaseous oxygen was bottled.

The liquid oxygen was pumped from the plant's storage tanks into specially constructed railway wagons, each holding 30 tons. It was stated that the loss by evaporation from these wagons was one ton per day.

Production had been continuous until April 1945, when transportation became impossible on account of disruption of railway services.

The plant had not been attacked by air and was completely undamaged although provision had been made by the S.S. for blowing up the entrances. This plan was frustrated by the early arrival of U.S. ground forces.

Dr. Kretz stated that a similar plant consisting of 15 units had been operating at Saalfield. (Russian occupied zone).

Maintenance of the plant is at present being carried out, pending a decision as to its utilisation. (Redl is in Austria).

2. A static firing station, for testing A. 4 rocket motors, had been constructed on top of the hill. This was directly accessible by a lift from the underground factory, in which the motors awaiting test were stored. (Nine motors, mounted on trolleys running on a narrow gauge railway, were seen). [...]

The whole station was of massive dimensions and solid construction.

Two bursts during firings had occurred since tests commenced in October, 1943. The first of these occurred in February, 1944, and the second which partially destroyed the firing bay, in August 1944, since when no firings had been done.

After the first of these bursts, all iron pipe lines for liquid oxygen were replaced by aluminium, which does not become so brittle at extremely low temperatures.

It was stated by Dr. Kretz that no other rocket work was carried out at the factory. No rocket materials, other than those mentioned above, were discovered by this team.

It is of interest to record that the underground factory contained one "secret room", open to S.S. officials only, in which counterfeit Bank of England notes, from L1 to L50 denomination, were printed.

Visits by other rocket teams to this target are not considered necessary.

[This is one of several Allied reports that described Redl Zipf as just an oxygen production plant (e.g., see p. 4965).

It is possible that part of the Redl Zipf facility did produce oxygen, but if that were the only product of Redl Zipf, that would not be consistent with many of the details provided by PW Johann Raab (p. 3722): (1) long-term toxicity to the workers; (2) extreme corrosivity to all materials except a white metal (nickel, aluminum, or an alloy containing one or both of those metals?) and ceramics; and (3) consumption of large quantities of nuclear-related materials such as lead, beryllium, thorium, etc.

If Redl Zipf were only an oxygen plant, it would also contradict the intelligence report that specifically stated that Redl Zipf was doing work related to nuclear weapons (p. 3728), as well as other intelligence reports that indicated that Redl Zipf had far greater secrecy and security than one would expect of a simple oxygen plant [e.g., AFHRA electronic versions A6091 p. 1287l, 25082 pp. 106–108, 25177 pp. 919–951, 25216 pp. 385–386].

Was the Redl Zipf plant really only producing oxygen the whole time, or was it converted to that later, or only using oxygen production as a cover story? For example, at the end of the war, German industrial plants that had been producing nerve gas were stripped of all evidence and even completely overhauled to appear to have been nothing more than harmless soap factories throughout the war [Jacobsen 2014, pp. 24–29, 73–75].

BIOS 31 was a British report. U.S. officials also personally inspected the Redl Zipf plant after the war (p. 4965). What exactly did they find there? Where are their reports?]

English translation of French intelligence report. 10 June 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)]

1. With reference to conversation which Hitler is supposed to have had in a factory in Vienna. Accordingly there are supposed to have been successful in making tractable the disintegration of matter—with a possibility of using it as an explosive—they will only make use of it as a desperate measure (tested during the attack on Kovel?) because when the transformation has begun they do not know how to stop it.

2. On the road from Vienna Neustadt to Neuburg [Neuberg?]—on the side of a small hill a factory or an underground laboratory is located surrounded by barbed wire—guarded by SS troops—workmen are not allowed to enter. [...]

[See document photos on pp. 3743–3744.]

1177
extra

OFFICE OF STRATEGIC SERVICES
TECHNICAL INTELLIGENCE

CONFIDENTIAL

SF 23625

ARG 1/20300

date (of information – 22 May 1944
(reception – 3 June 1944
(dissemination – 10 June 1944

SECRET.

Number of pages: 1

TRANSLATION

GERMANY – WAR ECONOMY

FACTORIES: ACTIVITIES

Germany 22 May 1944

1. With reference to conversation which Hitler is supposed to have had in a factory in Vienna. Accordingly they are supposed to have been successful in making tractable the disintegration of matter – with a possibility of using it as an explosive – they will only make use of it as a desperate measure (tested during the attack on Kovel?) because when the transformation has begun they do not know how to stop it.

2. On the road from Vienna Neustadt to Neubourg – on the side of a small hill a factory or an underground laboratory is located surrounded by barbed wire – guarded by the SS Troops – workmen are not allowed to enter.

3. In three (3) months a new fighter plane should be ready equipped with a 3,400 H.P. Mercedes-Benz engine, 24 cylinder radio engine with a speed of 800 Klm., armed with 4 cannons of 25 mm. calibre.

4. The manufacture of bombers has recently been cut down in favor of pursuit planes.

5. The factories of Vienna Neustadt have only sustained slight damages from bombing and are working at 90 per cent capacity.

CONFIDENTIAL

Figure D.298: English translation of French intelligence report. 10 June 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)].

NARA RG 77, Entry UD-22A, Box 171, Folder
32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)

23625

1177
extra

CONFIDENTIAL

ARG 1/20300

date (de l'information - 22.5.44.
(reception - 3.6.44.
(diffusion - 10.6.44.

SECRET.
Nombre de feuillets: 1

ALLEMAGNE - ECONOMIE DE GUERRE.

USINES : ACTIVITE.

Allemagne 22.5.44.

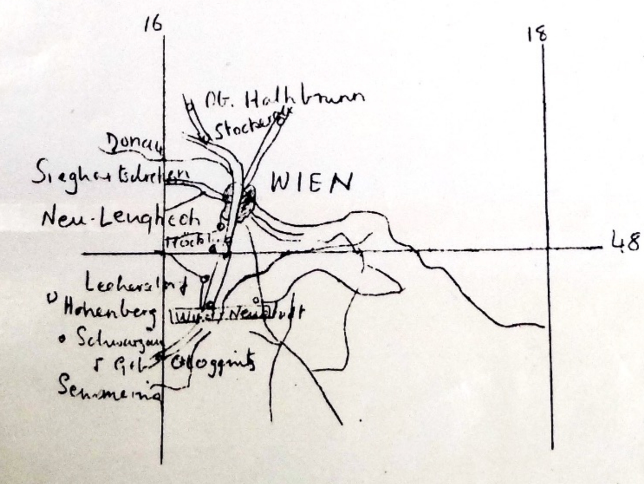
1. References conversations qu'aurait tenu HITLER dans une usine de Vienne. Ils auraient reussi a domestiquer la desintegration de la matiere - avec possibilite de s'en servir comme explosifs- ils ne s'en serviraient que comme moyen desespere (essaye lors de l'attaque de Kovel ?) car si la reaction peut debuter, ils ne savent pas comment l'arreter.

2. Sur la route de Wiener Neustadt a Neubourg - au flanc d'une colline existe une usine ou un laboratoire souterrain entoure de barbeles- garde par des SS - les ouvriers n'on aucune permission.

3. Dans trois mois doit sortir un nouveau chasseur 3.400 HP (Mercedes-Benz) 24 cylindres en etoile 800 km arme de 4 canons de 25 mm.

4. La fabrication des bombardiers est a peu pres supprimee au profit des chasseurs .

5. Les Usines de Wiener Neustadt ont ete peu atteintes et marchent a 90%



ENMA

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37

Figure D.299: French intelligence report. 10 June 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–October 1944)].

[For some other known or suspected nuclear sites in Austria, see:

pp. 3874–3920

pp. 4072–4081

pp. 4328–4341

pp. 4611–4624

pp. 4790–4800

pp. 4962–4974]

Known/Reported Sites Now in Hungary

Cable IN 1788 from Caserta, Italy to Office of Strategic Services Director. 19 January 1945 [NARA RG 226, Entry A1-134, Box 219, Folder IN AZUSA Nov. '43 Sept. '45]

#27074. AZUSA. 154 and Dix from 148.

Octopus cables 18 January that partisans report experiments being conducted on atomic bombs at Sopron, Hungary and west of Vienna. We are asking that further inquiries be made discreetly. Meanwhile cable me whether you have had other indications on these localities. Ask Major Furman if Major Ham is still his representative in this Theater.

[See document photo on p. 3747.

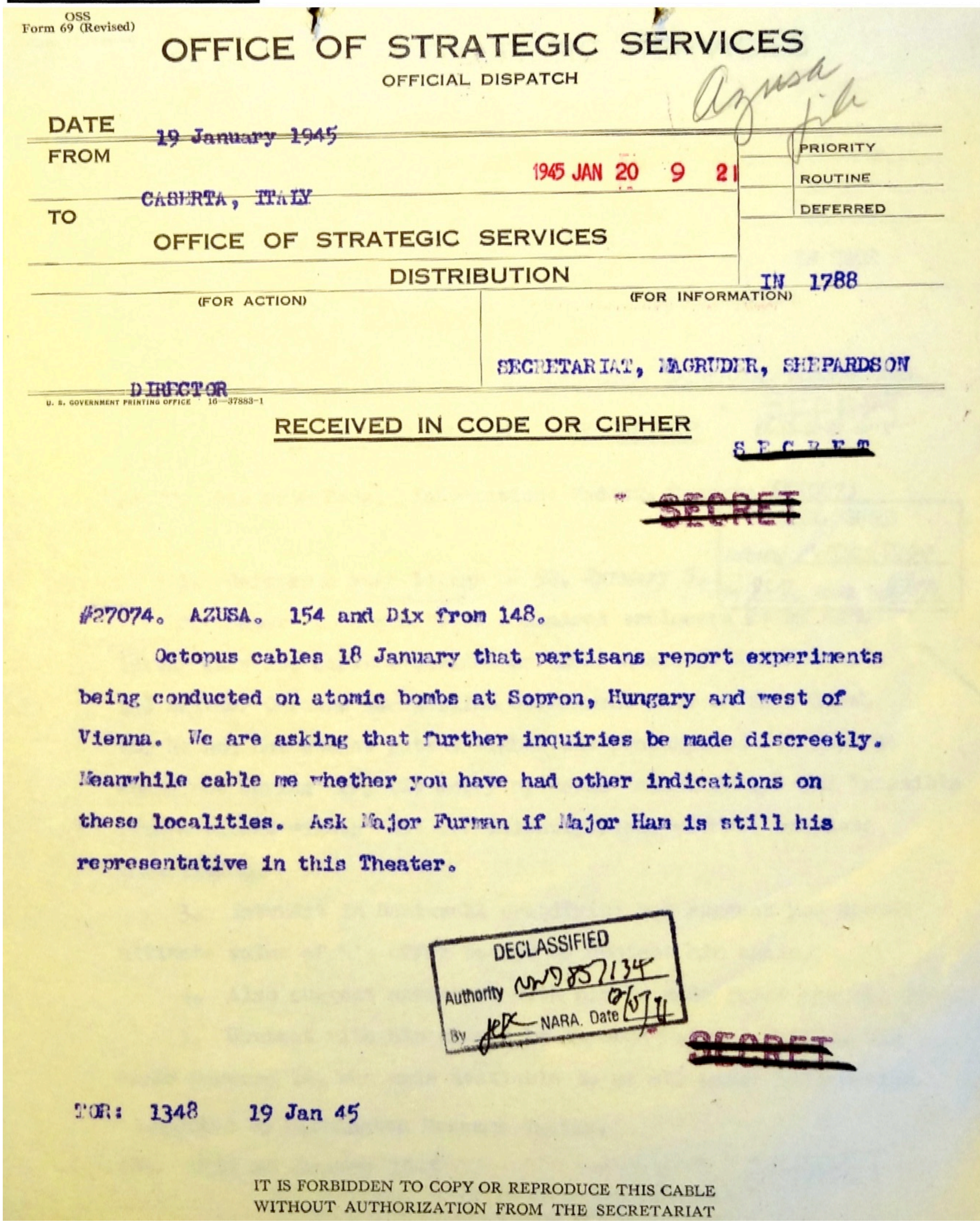
This intelligence report may or may not have been talking about Redl Zipf specifically, but it is further confirmation that nuclear weapons development was being conducted in that area.

Experiments "west of Vienna" might refer to research installations at Redl Zipf, Gusen/Bergkristall, Zell-am-See, Lofer, Melk/Quarz, and/or other locations.

What was going on at Sopron (Ödenburg), Hungary? Sopron is approximately 65 km south of Vienna, just across the border into Hungary. Can any other documents concerning wartime nuclear research there be located? It sounds as if the OSS was going to write follow-up reports.]

DECLASSIFIED
Authority NND 857134

NARA RG 226, Entry A1-134, Box 219, Folder IN AZUSA Nov. '43 Sept. '45



OSS
Form 69 (Revised)

OFFICE OF STRATEGIC SERVICES

OFFICIAL DISPATCH

Azusa file

DATE 19 January 1945

FROM CASERTA, ITALY

1945 JAN 20 9 21

PRIORITY
ROUTINE
DEFERRED

TO OFFICE OF STRATEGIC SERVICES

DISTRIBUTION

IN 1788

(FOR ACTION) DIRECTOR

(FOR INFORMATION) SECRETARIAT, MAGRUDER, SHEPARDSON

U. S. GOVERNMENT PRINTING OFFICE 16—37883-1

RECEIVED IN CODE OR CIPHER

SECRET

SECRET

#27074. AZUSA. 154 and Dix from 148.

Octopus cables 18 January that partisans report experiments being conducted on atomic bombs at Sopron, Hungary and west of Vienna. We are asking that further inquiries be made discreetly. Meanwhile cable me whether you have had other indications on these localities. Ask Major Furman if Major Ham is still his representative in this Theater.

DECLASSIFIED
Authority NND 857134
By JEK NARA. Date 6/6/74

SECRET

TOR: 1348 19 Jan 45

IT IS FORBIDDEN TO COPY OR REPRODUCE THIS CABLE
WITHOUT AUTHORIZATION FROM THE SECRETARIAT

Figure D.300: This 19 January 1945 OSS cable reported “experiments being conducted on atomic bombs at Sopron, Hungary and west of Vienna” [NARA RG 226, Entry A1-134, Box 219, Folder IN AZUSA Nov. ’43 Sept. ’45].

Known/Reported Sites Now in Czechia

Cable IN-9026 from MacFarland Istanbul to Office of Strategic Services Shepardson. 4 May 1944 [NARA RG 226, Entry A1-134, Box 219, Folder IN AZUSA Nov. '43 Sept. '45] See document photo on p. 3749.

#332. AZUSA. From Javelin to Shepardson and Cecil only.

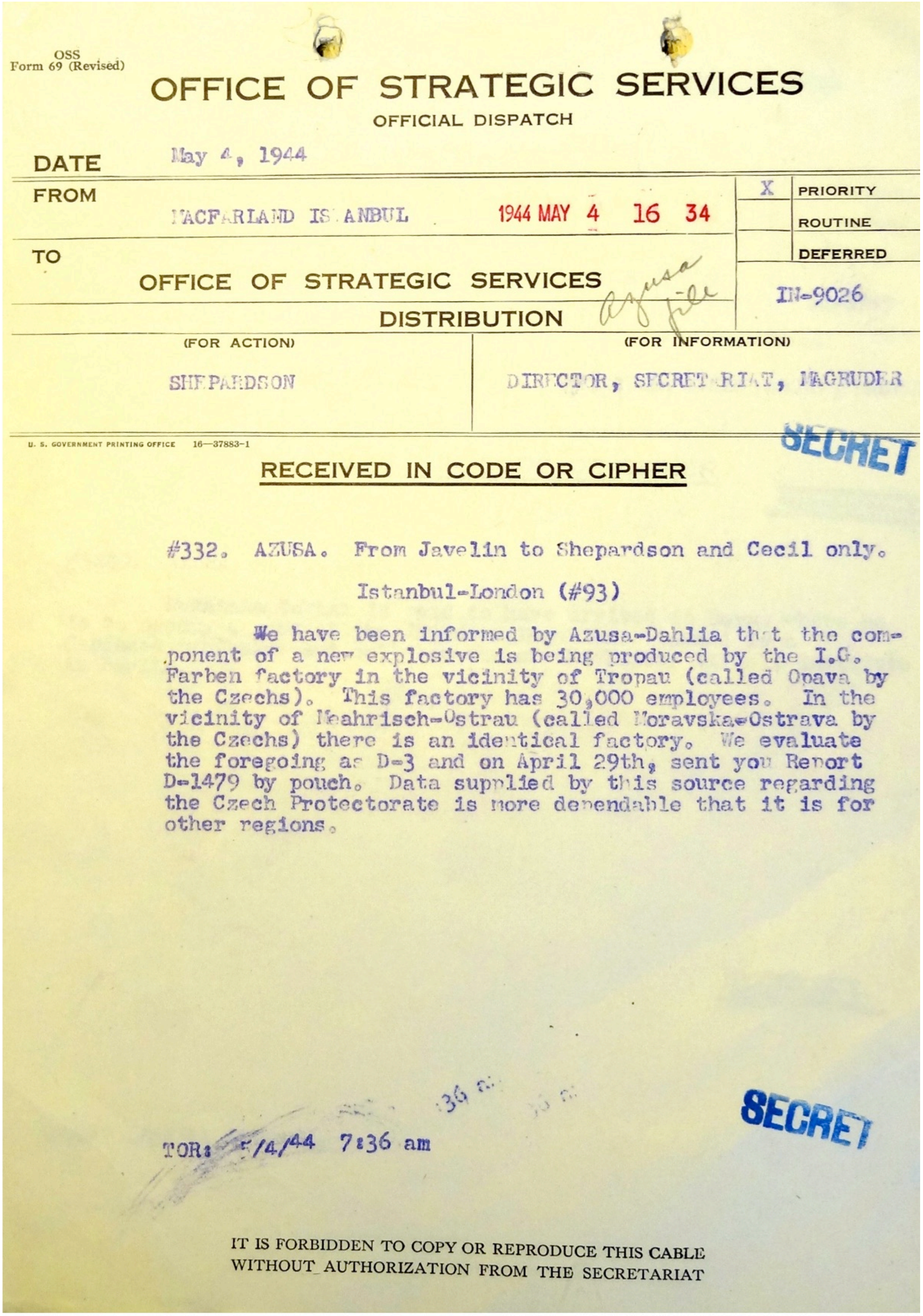
Istanbul–London (#93)

We have been informed by Azusa-Dahlia that the component of a new explosive is being produced by the I.G. Farben factory in the vicinity of Tropau (called Opava by the Czechs). This factory has 30,000 employees. In the vicinity of Maehrisch-Ostrau (called Moravska-Ostrava by the Czechs) there is an identical factory. We evaluate the foregoing as D-3 and on April 29th, sent you Report D-1479 by pouch. Data supplied by this source regarding the Czech Protectorate is more dependable than it is for other regions.

[See document photo on p. 3749. These sound like two massive uranium enrichment facilities, similar to Oak Ridge. Azusa was the OSS codename for German nuclear matters, so clearly the OSS thought the same.

For train logbooks that appear to show repeated shipments between these factories and other suspected nuclear sites, see pp. 3882–3883. See also p. 3784.]

DECLASSIFIED
Authority NND 857134



OSS
Form 69 (Revised)

OFFICE OF STRATEGIC SERVICES
OFFICIAL DISPATCH

DATE May 4, 1944

FROM MACFARLAND ISTANBUL 1944 MAY 4 16 34

X PRIORITY
ROUTINE
DEFERRED

TO
OFFICE OF STRATEGIC SERVICES Azusa file

IN-9026

DISTRIBUTION

(FOR ACTION) SHEPARDSON

(FOR INFORMATION) DIRECTOR, SECRETARIAT, MAGRUDER

U. S. GOVERNMENT PRINTING OFFICE 16—37883-1

SECRET

RECEIVED IN CODE OR CIPHER

#332. AZUSA. From Javelin to Shepardson and Cecil only.

Istanbul-London (#93)

We have been informed by Azusa-Dahlia that the component of a new explosive is being produced by the I.G. Farben factory in the vicinity of Tropau (called Opava by the Czechs). This factory has 30,000 employees. In the vicinity of Maehrisch-Ostrau (called Moravska-Ostrava by the Czechs) there is an identical factory. We evaluate the foregoing as D-3 and on April 29th, sent you Report D-1479 by pouch. Data supplied by this source regarding the Czech Protectorate is more dependable that it is for other regions.

SECRET

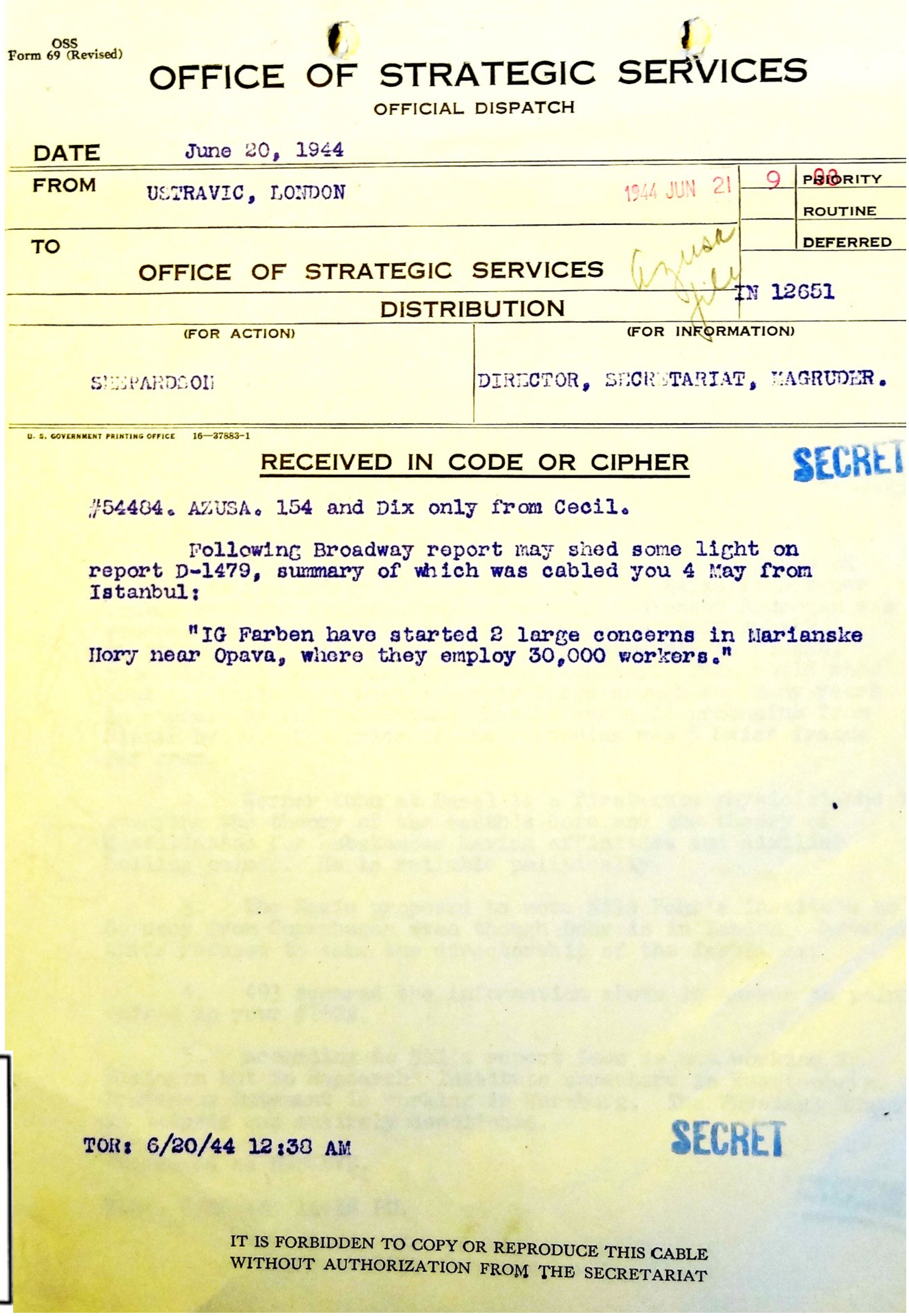
TOR: 5/4/44 7:36 am

IT IS FORBIDDEN TO COPY OR REPRODUCE THIS CABLE WITHOUT AUTHORIZATION FROM THE SECRETARIAT

NARA RG 226, Entry A1-134, Box 219, Folder IN AZUSA Nov. '43 Sept. '45

Figure D.301: This May 1944 OSS intelligence report described what sound like two massive uranium enrichment facilities, each with 30,000 workers, run by I.G. Farben in Opava and Ostrava in eastern Czech territory [NARA RG 226, Entry A1-134, Box 219, Folder IN AZUSA Nov. '43 Sept. '45]. For train logbooks that appear to show repeated shipments between these factories and other suspected nuclear sites, see pp. 3882–3883. See also p. 3784.

NARA RG 226, Entry A1-134, Box 219, Folder IN AZUSA Nov. '43 Sept. '45



OSS Form 69 (Revised)

OFFICE OF STRATEGIC SERVICES

OFFICIAL DISPATCH

DATE June 20, 1944

FROM USTRAVIC, LONDON 1944 JUN 21 9 00 PRIORITY ROUTINE DEFERRED

TO OFFICE OF STRATEGIC SERVICES

Azusa file

IN 12651

DISTRIBUTION

(FOR ACTION) SHEPARDSON

(FOR INFORMATION) DIRECTOR, SECRETARIAT, MAGRUDER.

U. S. GOVERNMENT PRINTING OFFICE 16—37883-1

RECEIVED IN CODE OR CIPHER

SECRET

#54484. AZUSA. 154 and Dix only from Cecil.

Following Broadway report may shed some light on report D-1479, summary of which was cabled you 4 May from Istanbul:

"IG Farben have started 2 large concerns in Marianske Hory near Opava, where they employ 30,000 workers."

TOR: 6/20/44 12:38 AM

SECRET

IT IS FORBIDDEN TO COPY OR REPRODUCE THIS CABLE WITHOUT AUTHORIZATION FROM THE SECRETARIAT

DECLASSIFIED Authority NND 857134

Figure D.302: A June 1944 OSS intelligence report mentioning the same two massive facilities that were run by I.G. Farben in Opava and Ostrava in eastern Czech territory [NARA RG 226, Entry A1-134, Box 219, Folder IN AZUSA Nov. '43 Sept. '45]. For train logbooks that appear to show repeated shipments between these factories and other suspected nuclear sites, see pp. 3882–3883.

Zbynek Zeman and Rainer Karlsch. 2008. *Uranium Matters: Central European Uranium in International Politics 1900-1960.* p. 73.

While the uranium treaty was being considered, Bakulin reminded Fierlinger that he had agreed to hand over 38,516 kilograms of radioactive material available on Czechoslovakian territory to the Soviets. Fierlinger immediately gave orders for the transfer of the materials to the Soviet foreign trade organization, Torgpredstvo, and requested that the ministries of industry and foreign trade take care of the transfer. On 14 October [1945], 37,012 kilograms of uranium paints, (containing up to 58.4% uranium oxide [U_3O_8]), were taken away from the Příbram smelting works. On 29 and 30 October, barrels and boxes containing 9,725 kg of 58% uranium concentrate followed. Additional pitchblende from the slagheaps was collected, and the amount of uranium the Soviet Union received from these sources has been calculated at 30.838 tons; only 0.919 tons of uranium was actually mined in 1945.

[Ivan Bakulin was a Soviet official. Zdeněk Fierlinger was the Soviet-installed prime minister of Czechoslovakia after the war.

It seems highly unlikely that over 30 tons of valuable refined uranium was simply being used for paint. Presumably that was just a cover story given by the Germans, Czechs, and/or Soviets.

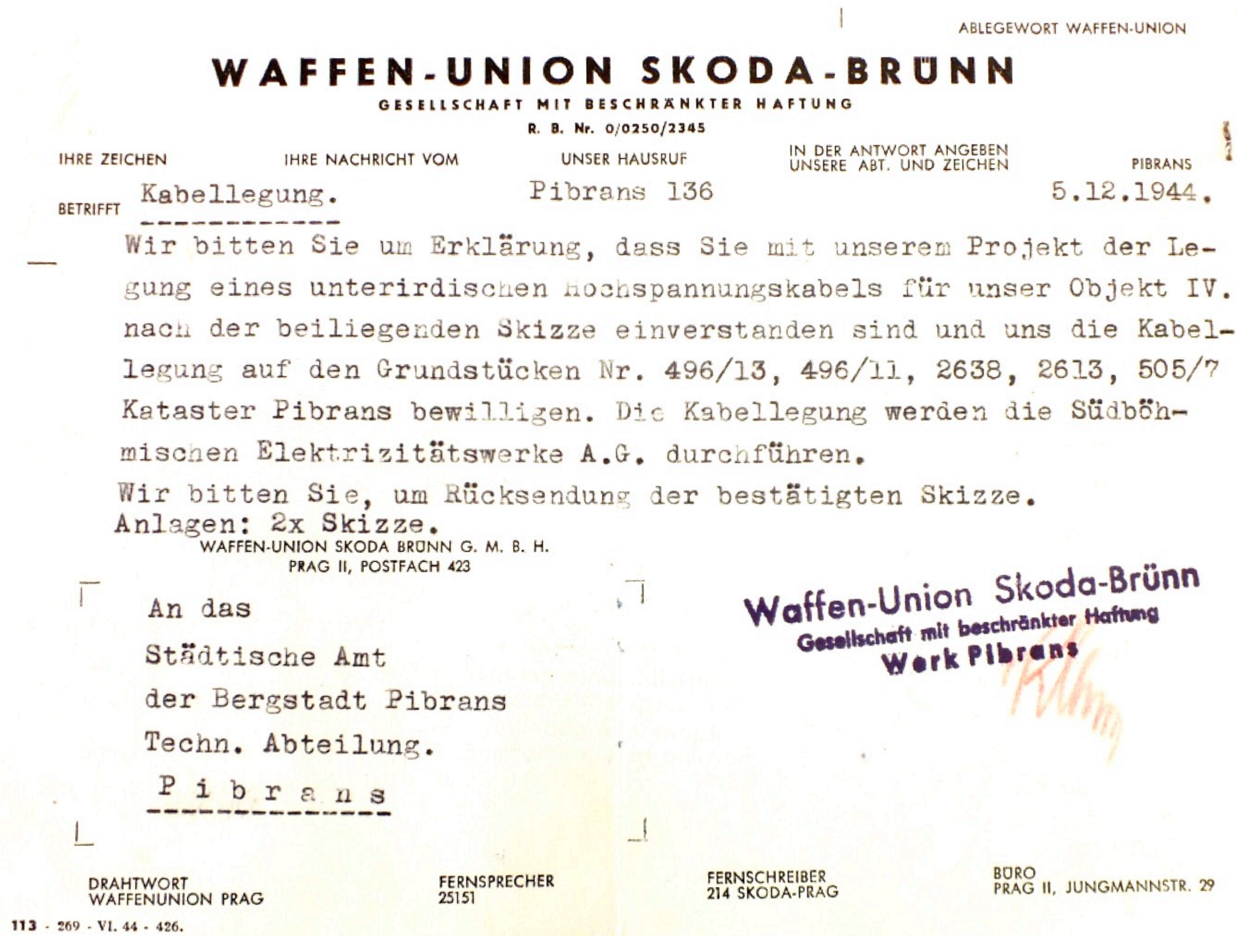
What exactly was the uranium being used for during the war? Was it for enrichment or for use in a fission reactor? Or had it already been enriched or irradiated in a reactor?

Why was the uranium at Příbram? Among other things, Příbram was home to a large wartime research installation run by the SS and Skoda and directed by Rolf Engel, who was an expert on explosives, implosion bombs, rockets, and related subjects (pp. 4921, 5696).

See the documents on pp. 3752–3754.]

1944 German plans for high-voltage power cables from Štěchovice to "Objekt IV," a facility built by Skoda in Příbram

SOkA Příbram, Elektrifikace - 1944, AM Příbram - S, inv. č. 1001



ABLEGEWORT WAFFEN-UNION

WAFFEN-UNION SKODA-BRÜNN

GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG

R. B. Nr. 0/0250/2345

IHRE ZEICHEN	IHRE NACHRICHT VOM	UNSER HAUSRUF	IN DER ANTWORT ANGEBEN UNSERE ABT. UND ZEICHEN	PIBRANS
		Pibrans 136		5.12.1944.

BETRIFFT Kabellegung.

Wir bitten Sie um Erklärung, dass Sie mit unserem Projekt der Legung eines unterirdischen Hochspannungskabels für unser Objekt IV. nach der beiliegenden Skizze einverstanden sind und uns die Kabellegung auf den Grundstücken Nr. 496/13, 496/11, 2638, 2613, 505/7 Kataster Pibrans bewilligen. Die Kabellegung werden die Südböhmischen Elektrizitätswerke A.G. durchführen.

Wir bitten Sie, um Rücksendung der bestätigten Skizze.

Anlagen: 2x Skizze.

WAFFEN-UNION SKODA BRÜNN G. M. B. H.
PRAG II, POSTFACH 423

An das
Städtische Amt
der Bergstadt Pibrans
Techn. Abteilung.
P i b r a n s

Waffen-Union Skoda-Brünn
Gesellschaft mit beschränkter Haftung
Werk Pibrans

DRAHTWORT WAFFENUNION PRAG — FERNSPRECHER 25151 — FERNSCHREIBER 214 SKODA-PRAG — BÜRO PRAG II, JUNGMANNSTR. 29

113 - 269 - VI. 44 - 426.

Figure D.303: 1944 German plans for high-voltage power cables from Štěchovice to "Objekt IV," a facility built by Skoda in Příbram [SOkA Příbram, Elektrifikace—1944, AM Příbram—S, inv. č. 1001, courtesy of Jaroslav Mareš].

1944 German plans for high-voltage power cables from Štěchovice to "Objekt IV," a facility built by Skoda in Příbram
SOkA Příbram, Elektrifikace - 1944, AM Příbram - S, inv. č. 1001

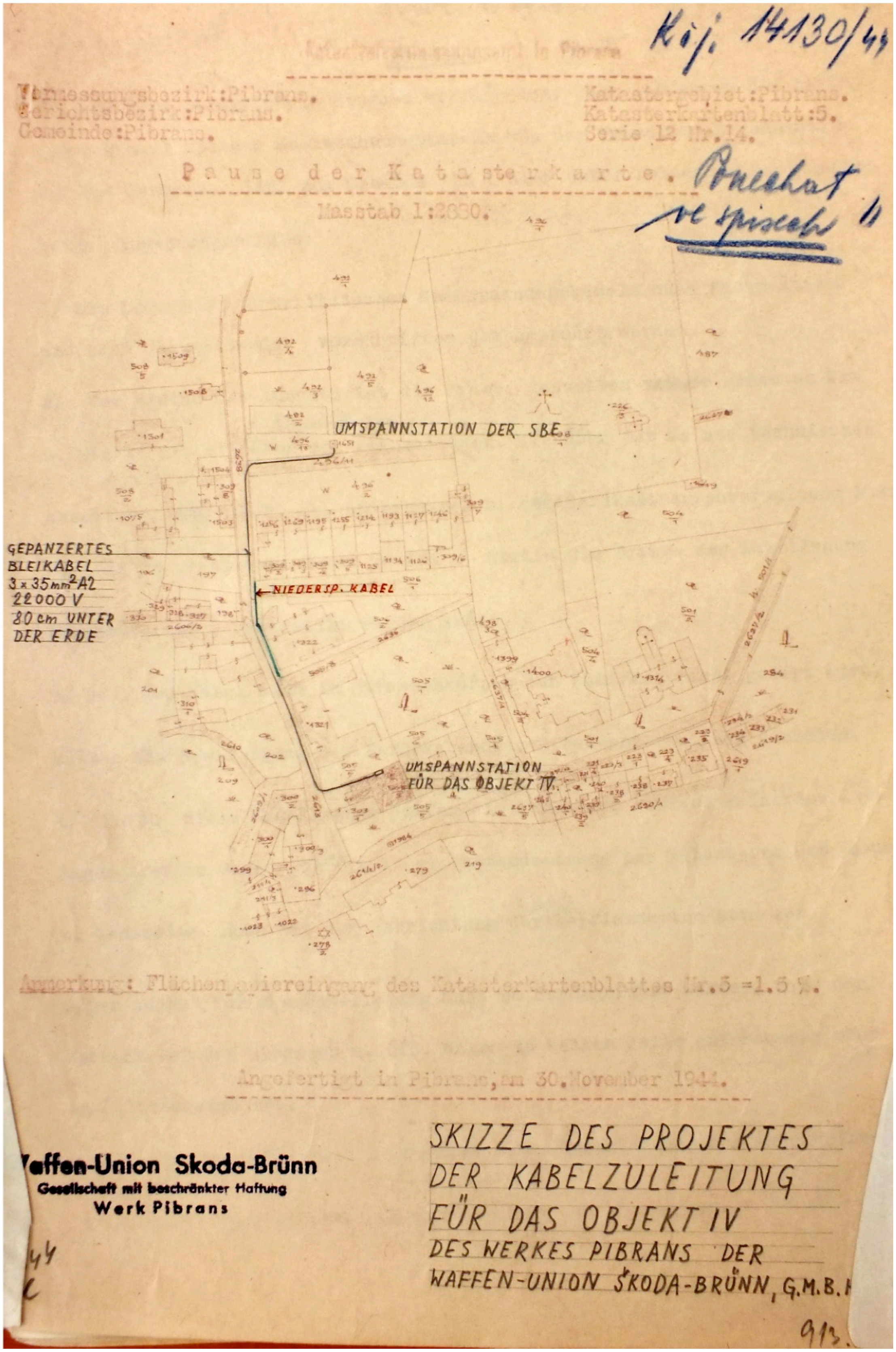
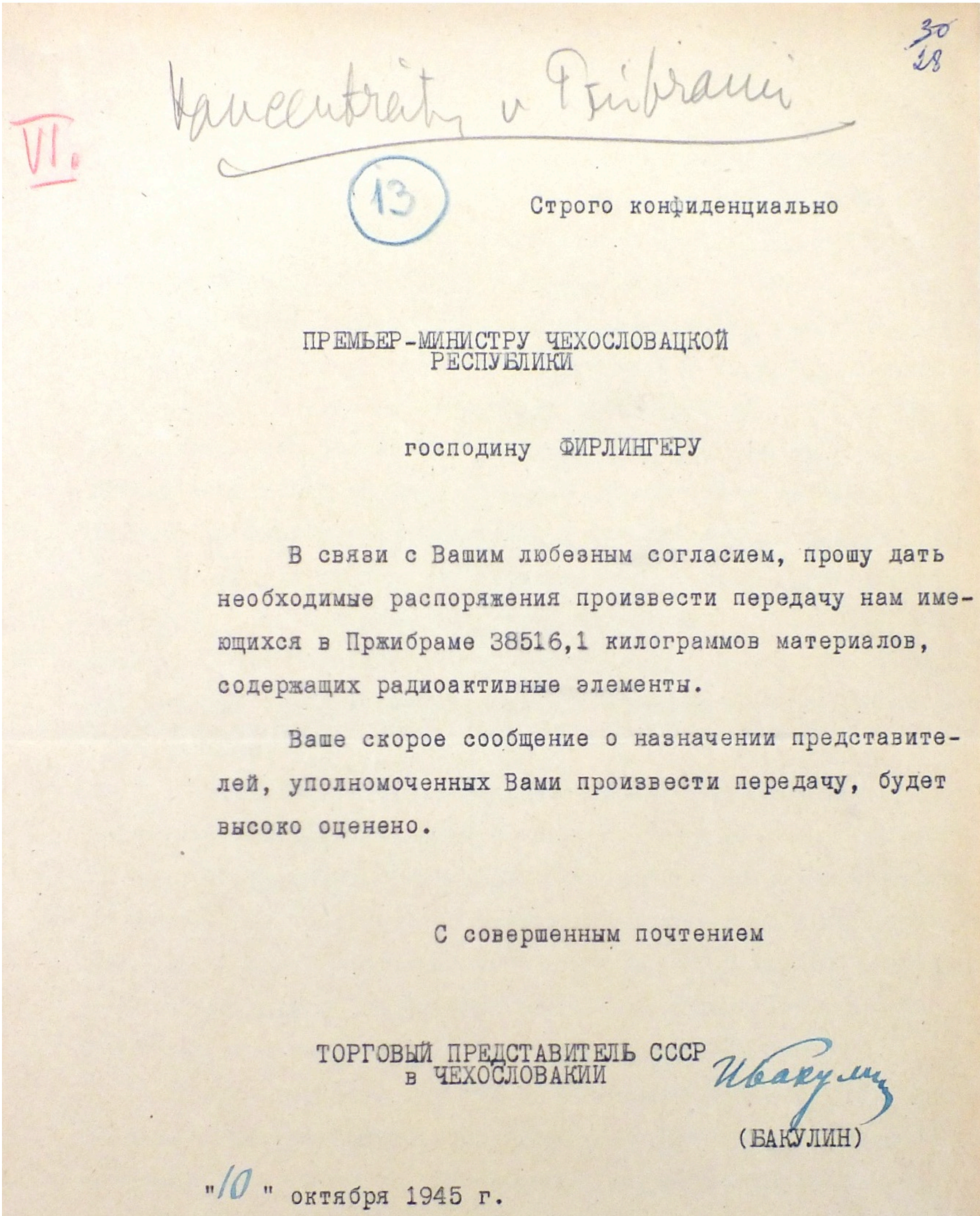


Figure D.304: 1944 German plans for high-voltage power cables from Štěchovice to "Objekt IV," a facility built by Skoda in Příbram [SOkA Příbram, Elektrifikace—1944, AM Příbram—S, inv. č. 1001, courtesy of Jaroslav Mareš].

10 October 1945 letter from Ivan Bakulin to Zdeněk Fierlinger, Národní archiv, Ústřední výbor KSČ, Klement Gottwald, sv. 81, aj. 1031



30
28

Koncentráty v Příbrami

VI.

13

Строго конфиденциально

ПРЕМЬЕР-МИНИСТРУ ЧЕХОСЛОВАЦКОЙ
РЕСПУБЛИКИ

господину ФИРЛИНГЕРУ

В связи с Вашим любезным согласием, прошу дать необходимые распоряжения произвести передачу нам имеющихся в Пржибраме 38516,1 килограммов материалов, содержащих радиоактивные элементы.

Ваше скорое сообщение о назначении представителей, уполномоченных Вами произвести передачу, будет высоко оценено.

С совершенным почтением

ТОРГОВЫЙ ПРЕДСТАВИТЕЛЬ СССР
в ЧЕХОСЛОВАКИИ

(БАКУЛИН)

"10" октября 1945 г.

Figure D.305: 10 October 1945 letter from Ivan Bakulin to Zdeněk Fierlinger requesting 38,516.1 kilograms of radioactive material that had been left by German forces in Czechoslovakia at the end of the war [Národní archiv, Ústřední výbor KSČ, Klement Gottwald, sv. 81, aj. 1031, courtesy of Jaroslav Mareš].

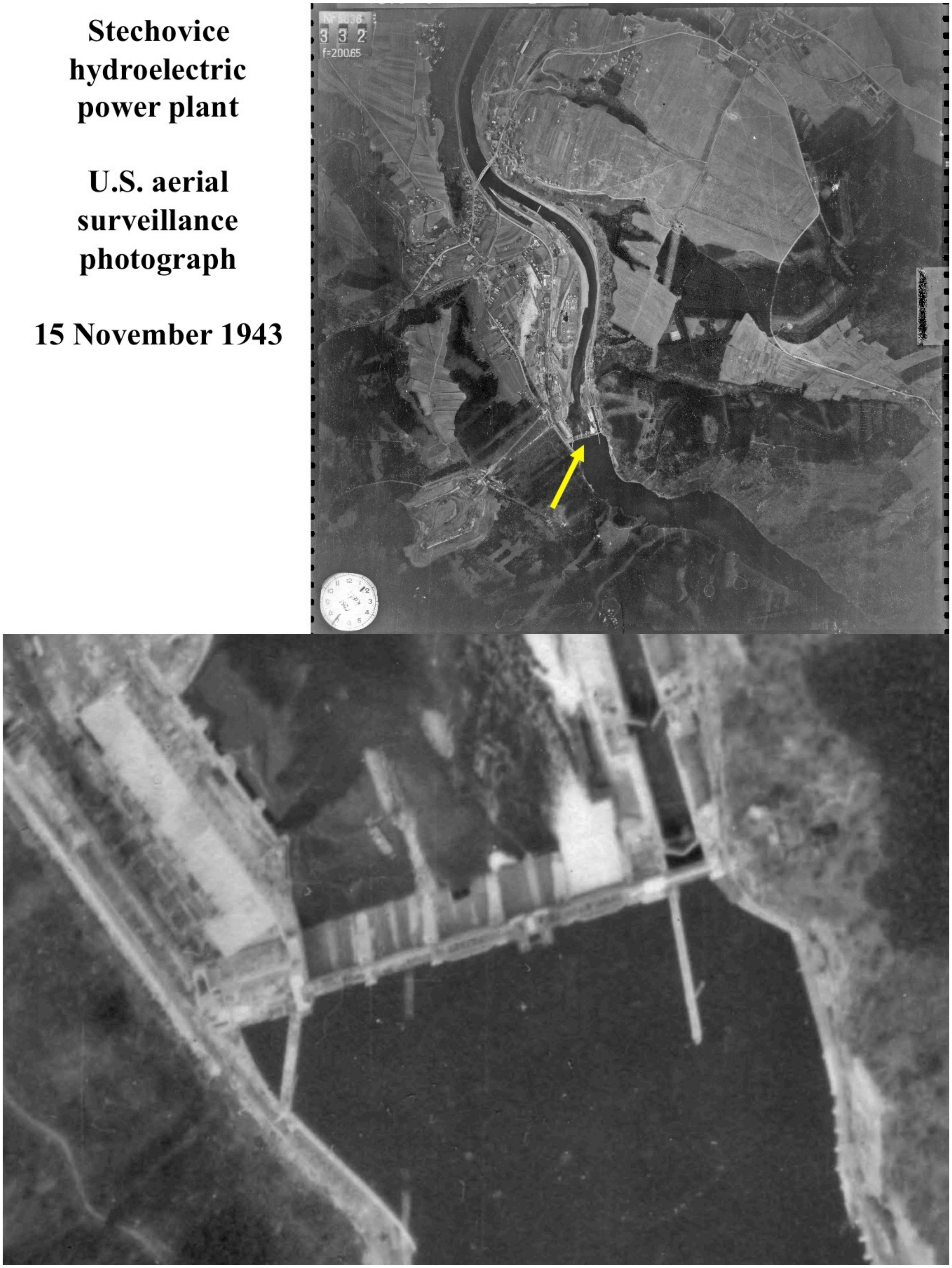


Figure D.306: At Štěchovice, German forces built a large dam, hydroelectric power plant, and associated facilities that became operational in 1943. Nearby were large, secret underground facilities such as Blaumeise I–III. The installations may have been conducting nuclear-related work such as uranium enrichment [AFHRA, courtesy of Gunther Hebestreit].

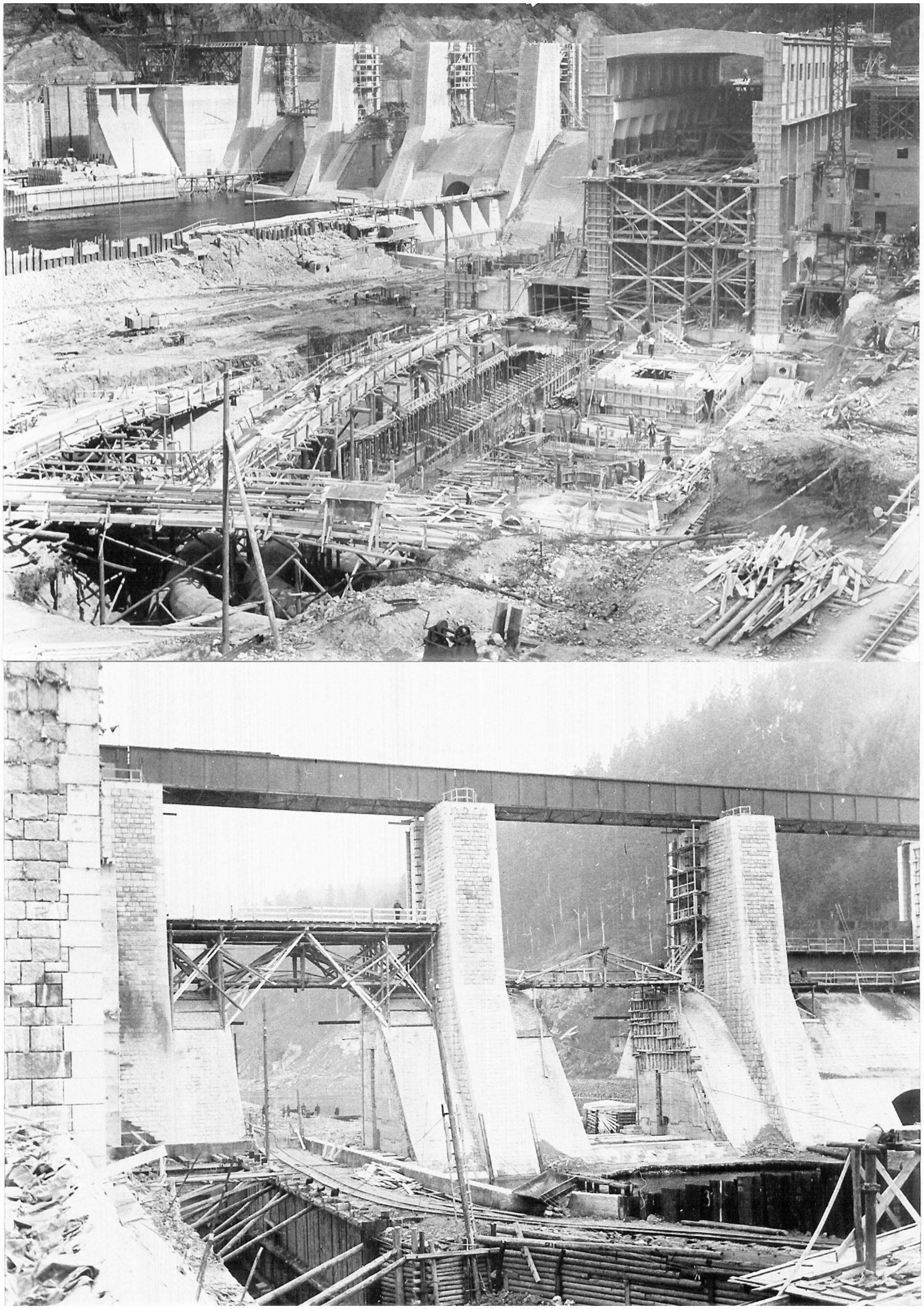


Figure D.307: The Štěchovice dam and hydroelectric power plant under construction in 1942.

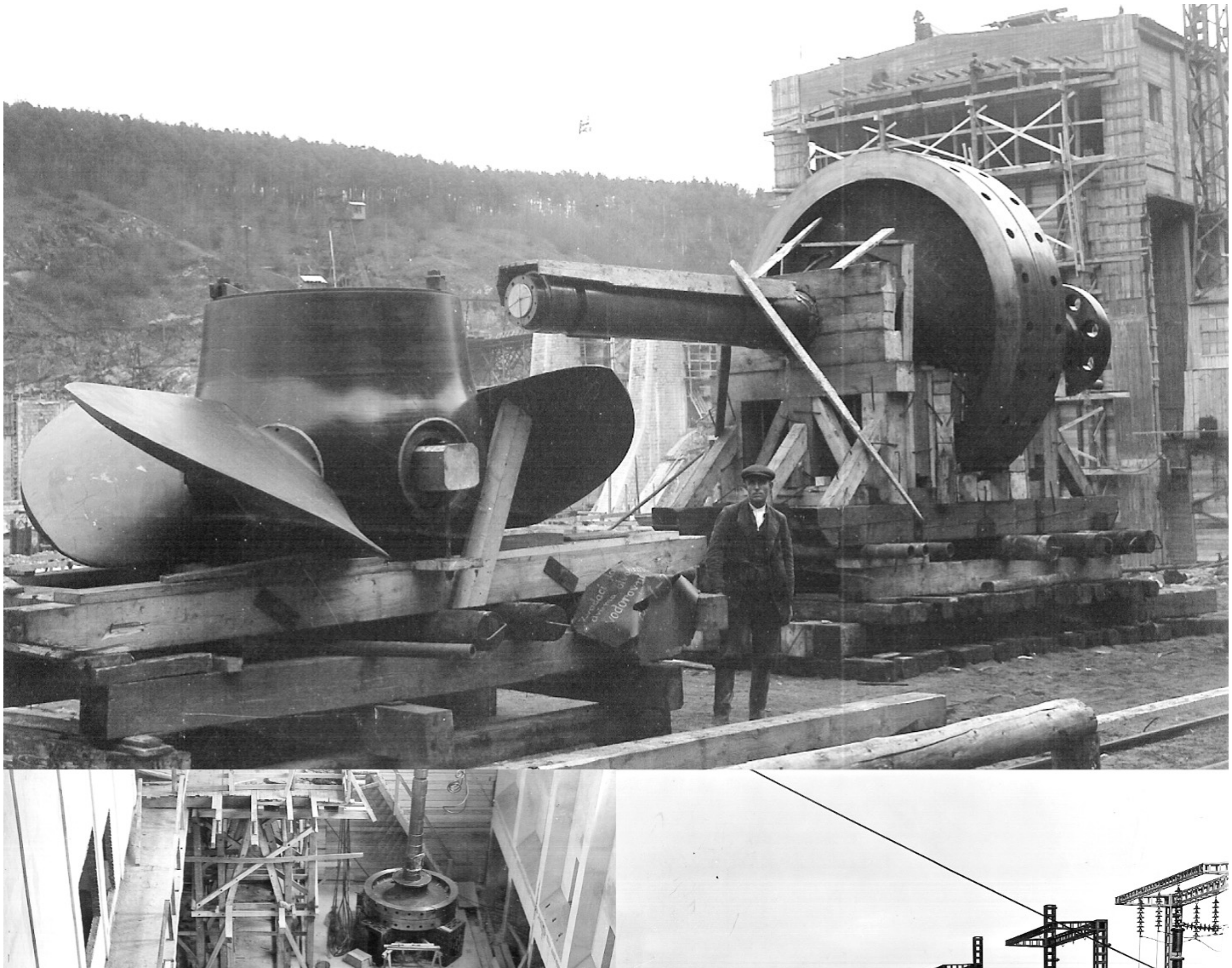


Figure D.308: Installation of the Kaplan turbines (p. 1495) and high-voltage transformers at Štěchovice during 1942–1943.

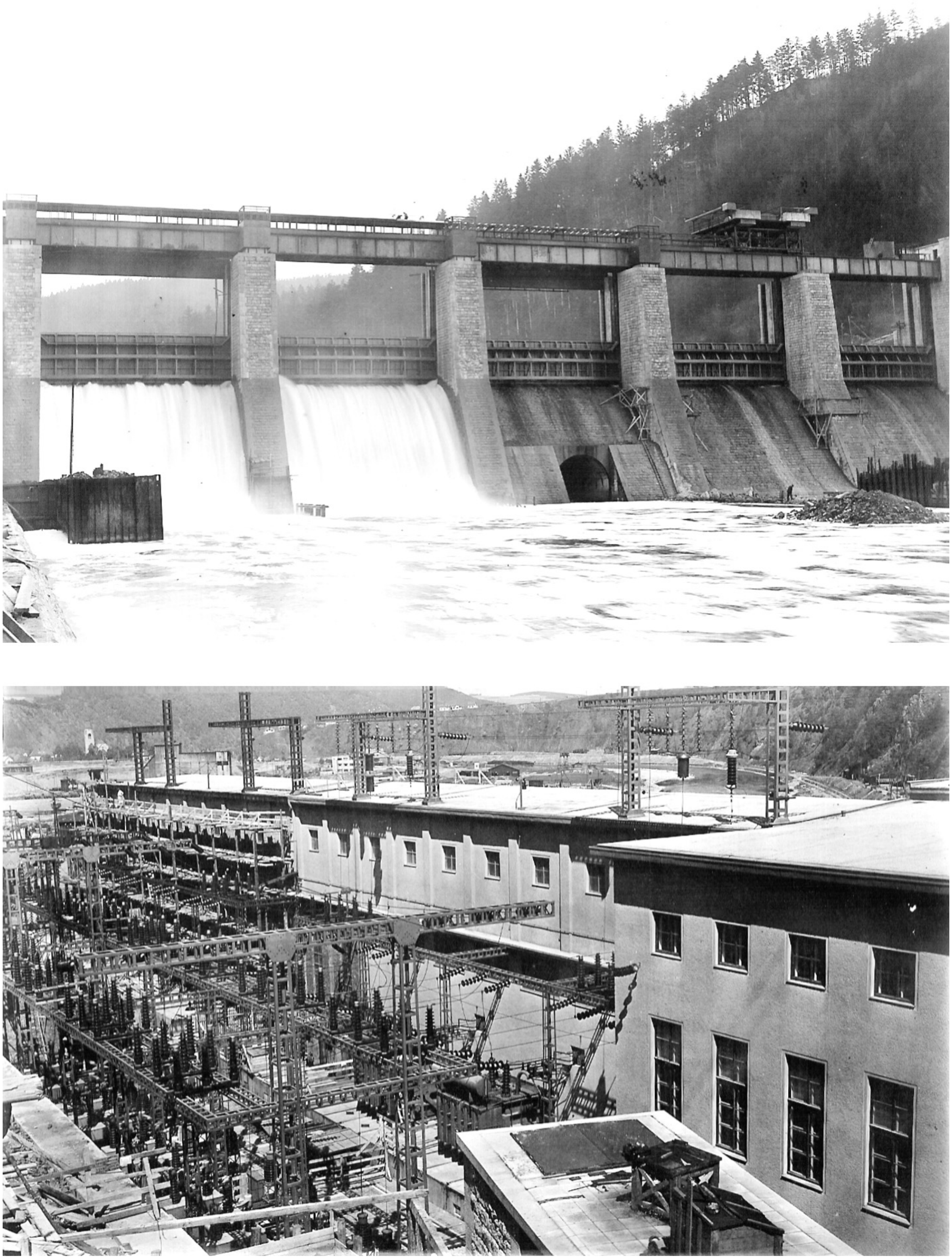
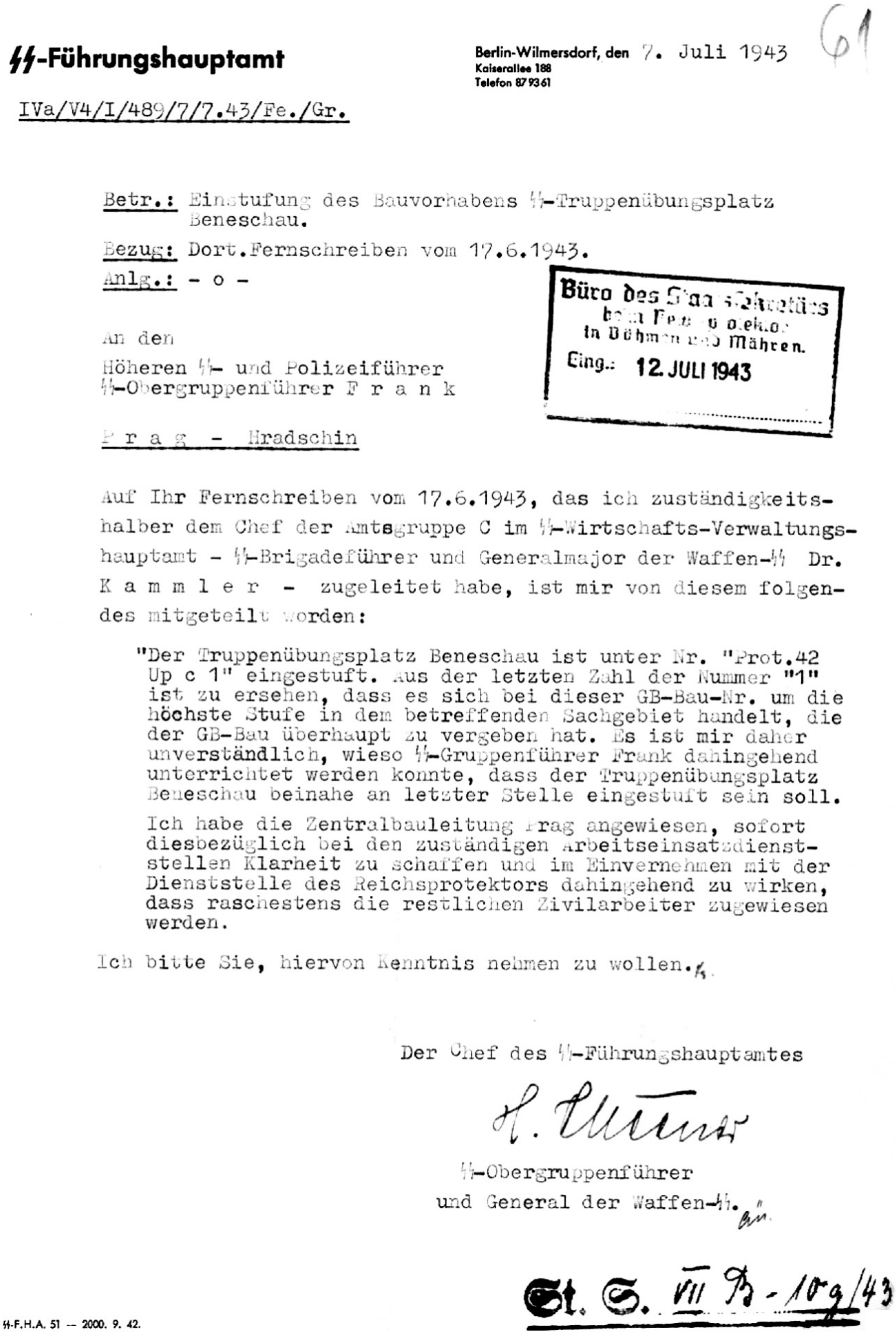


Figure D.309: The Štěchovice dam and hydroelectric power plant operational in 1943.

Figure D.310: The Štěchovice dam and hydroelectric power plant today.



ϟϟ-Führungshauptamt

Berlin-Wilmersdorf, den 7. Juli 1943
Kaiserallee 188
Telefon 87 93 61

IVa/V4/I/489/7/7.43/Fe./Gr.

Betr.: Einstufung des Bauvorhabens ϟϟ-Truppenübungsplatz Beneschau.

Bezug: Dort.Fernschreiben vom 17.6.1943.

Anlg.: – o –

Büro des …
in Böhmen … Mähren.
Eing.: 12. JULI 1943

An den
Höheren ϟϟ- und Polizeiführer
ϟϟ-Obergruppenführer F r a n k

P r a g – Hradschin

Auf Ihr Fernschreiben vom 17.6.1943, das ich zuständigkeitshalber dem Chef der Amtsgruppe C im ϟϟ-Wirtschafts-Verwaltungshauptamt – ϟϟ-Brigadeführer und Generalmajor der Waffen-ϟϟ Dr. K a m m l e r – zugeleitet habe, ist mir von diesem folgendes mitgeteilt worden:

"Der Truppenübungsplatz Beneschau ist unter Nr. "Prot.42 Up c 1" eingestuft. Aus der letzten Zahl der Nummer "1" ist zu ersehen, dass es sich bei dieser GB-Bau-Nr. um die höchste Stufe in dem betreffenden Sachgebiet handelt, die der GB-Bau überhaupt zu vergeben hat. Es ist mir daher unverständlich, wieso ϟϟ-Gruppenführer Frank dahingehend unterrichtet werden konnte, dass der Truppenübungsplatz Beneschau beinahe an letzter Stelle eingestuft sein soll.

Ich habe die Zentralbauleitung Prag angewiesen, sofort diesbezüglich bei den zuständigen Arbeitseinsatzdienststellen Klarheit zu schaffen und im Einvernehmen mit der Dienststelle des Reichsprotektors dahingehend zu wirken, dass raschestens die restlichen Zivilarbeiter zugewiesen werden.

Ich bitte Sie, hiervon Kenntnis nehmen zu wollen.

Der Chef des ϟϟ-Führungshauptamtes

ϟϟ-Obergruppenführer
und General der Waffen-ϟϟ.

St. S. VII P - 109/43

ϟϟ-F.H.A. 51 — 2000. 9. 42.

Figure D.311: In June 1943, Hans Kammler issued an order that the Beneschau (Benešov) military base near Štěchovice was classified as the highest priority: "The Beneschau military training area is classified under No. 'Prot. 42 Up c 1.' From the last number of the number '1' it can be seen that this GB-Bau-No. is the highest level in the relevant subject area, which the GB-Bau has to assign at all." What work was conducted there?

Figure D.312: In February 1946, a U.S. military team made an unannounced incursion deep into Czechoslovakia to recover important German papers buried at Štěchovice. The contents of most of the papers have never been publicly revealed [https://www.archives.gov/publications/prologue/2007/winter/stechovice.html]. This (in)famous incident was actually just one of many U.S. military incursions into Czechoslovakia in 1946 to collect mysterious cargo from multiple sites (pp. 3765–3772).

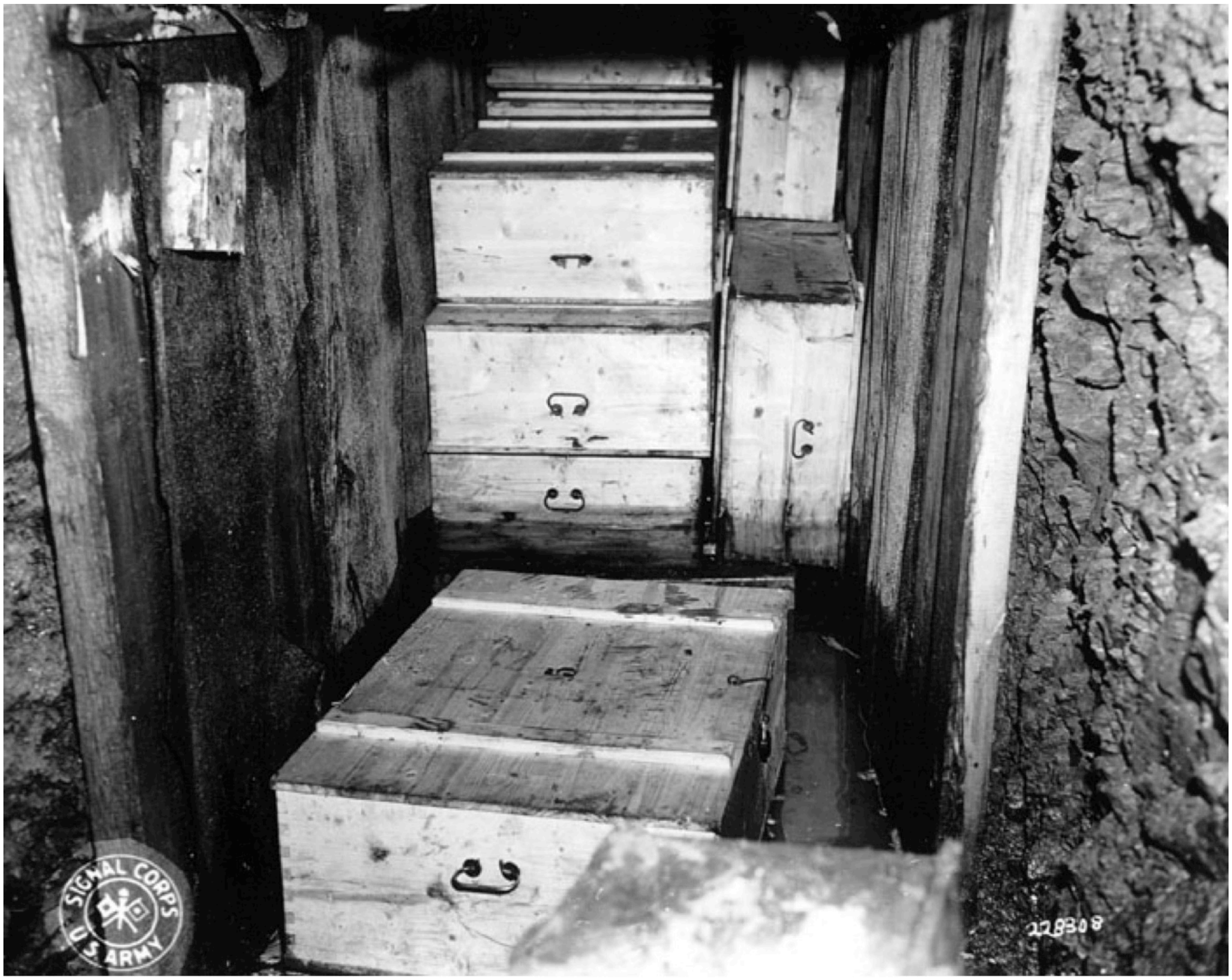
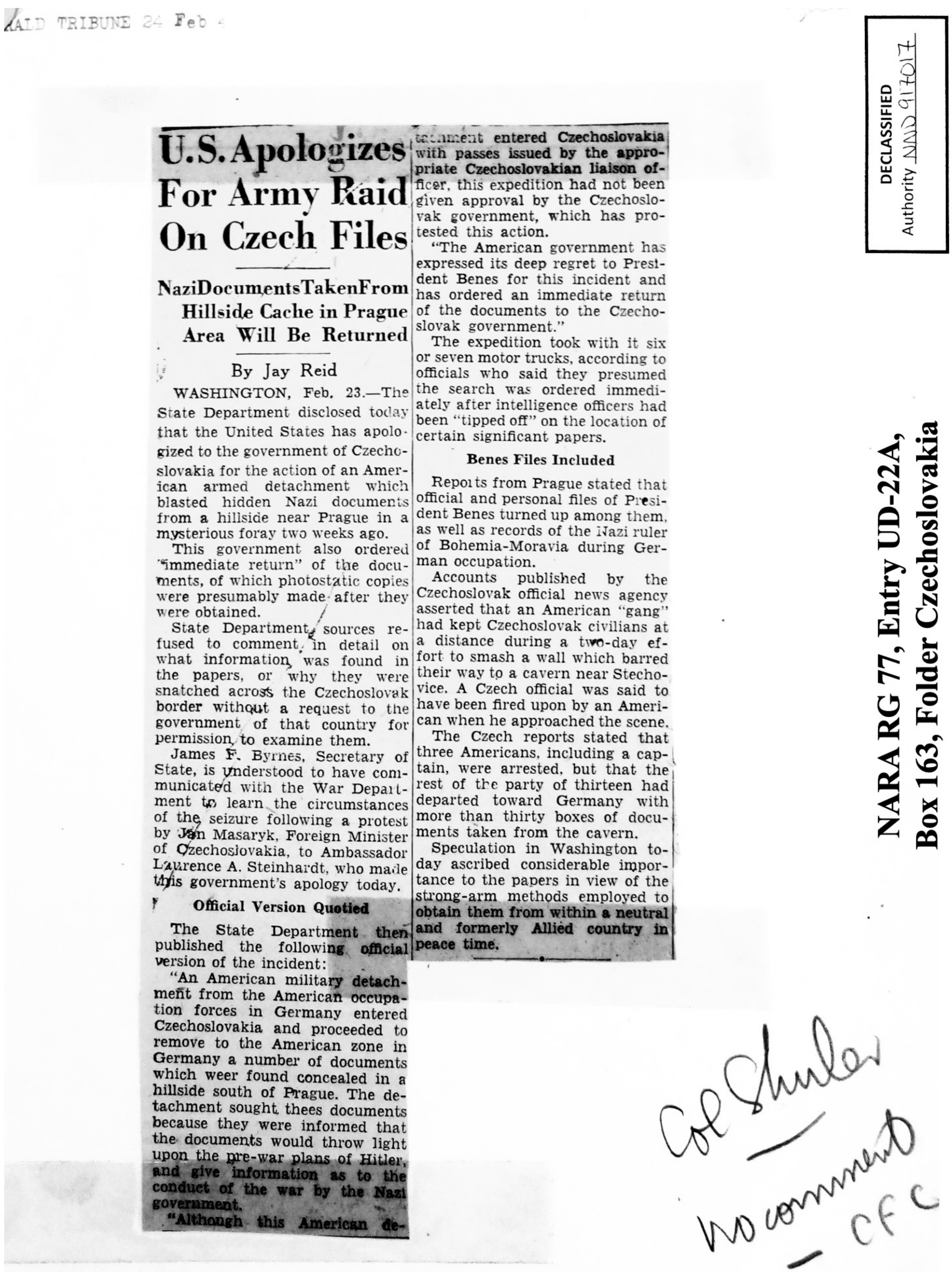


Figure D.313: In February 1946, a U.S. military team made an unannounced incursion deep into Czechoslovakia to recover important German papers buried at Štěchovice. The contents of most of the papers have never been publicly revealed [https://www.archives.gov/publications/prologue/2007/winter/stechovice.html]. This (in)famous incident was actually just one of many U.S. military incursions into Czechoslovakia in 1946 to collect mysterious cargo from multiple sites (pp. 3765–3772).

Figure D.314: In February 1946, a U.S. military team made an unannounced incursion deep into Czechoslovakia to recover important German papers buried at Štěchovice. The contents of most of the papers have never been publicly revealed [https://www.archives.gov/publications/prologue/2007/winter/stechovice.html]. This (in)famous incident was actually just one of many U.S. military incursions into Czechoslovakia in 1946 to collect mysterious cargo from multiple sites (pp. 3765–3772).



ALD TRIBUNE 24 Feb 4

DECLASSIFIED
Authority NND 917017

U.S. Apologizes For Army Raid On Czech Files

Nazi Documents Taken From Hillside Cache in Prague Area Will Be Returned

By Jay Reid

WASHINGTON, Feb. 23.—The State Department disclosed today that the United States has apologized to the government of Czechoslovakia for the action of an American armed detachment which blasted hidden Nazi documents from a hillside near Prague in a mysterious foray two weeks ago.

This government also ordered "immediate return" of the documents, of which photostatic copies were presumably made after they were obtained.

State Department sources refused to comment in detail on what information was found in the papers, or why they were snatched across the Czechoslovak border without a request to the government of that country for permission to examine them.

James F. Byrnes, Secretary of State, is understood to have communicated with the War Department to learn the circumstances of the seizure following a protest by Jan Masaryk, Foreign Minister of Czechoslovakia, to Ambassador Laurence A. Steinhardt, who made this government's apology today.

Official Version Quoted

The State Department then published the following official version of the incident:

"An American military detachment from the American occupation forces in Germany entered Czechoslovakia and proceeded to remove to the American zone in Germany a number of documents which weer found concealed in a hillside south of Prague. The detachment sought thees documents because they were informed that the documents would throw light upon the pre-war plans of Hitler, and give information as to the conduct of the war by the Nazi government.

"Although this American detachment entered Czechoslovakia with passes issued by the appropriate Czechoslovakian liaison officer, this expedition had not been given approval by the Czechoslovak government, which has protested this action.

"The American government has expressed its deep regret to President Benes for this incident and has ordered an immediate return of the documents to the Czechoslovak government."

The expedition took with it six or seven motor trucks, according to officials who said they presumed the search was ordered immediately after intelligence officers had been "tipped off" on the location of certain significant papers.

Benes Files Included

Reports from Prague stated that official and personal files of President Benes turned up among them, as well as records of the Nazi ruler of Bohemia-Moravia during German occupation.

Accounts published by the Czechoslovak official news agency asserted that an American "gang" had kept Czechoslovak civilians at a distance during a two-day effort to smash a wall which barred their way to a cavern near Stechovice. A Czech official was said to have been fired upon by an American when he approached the scene.

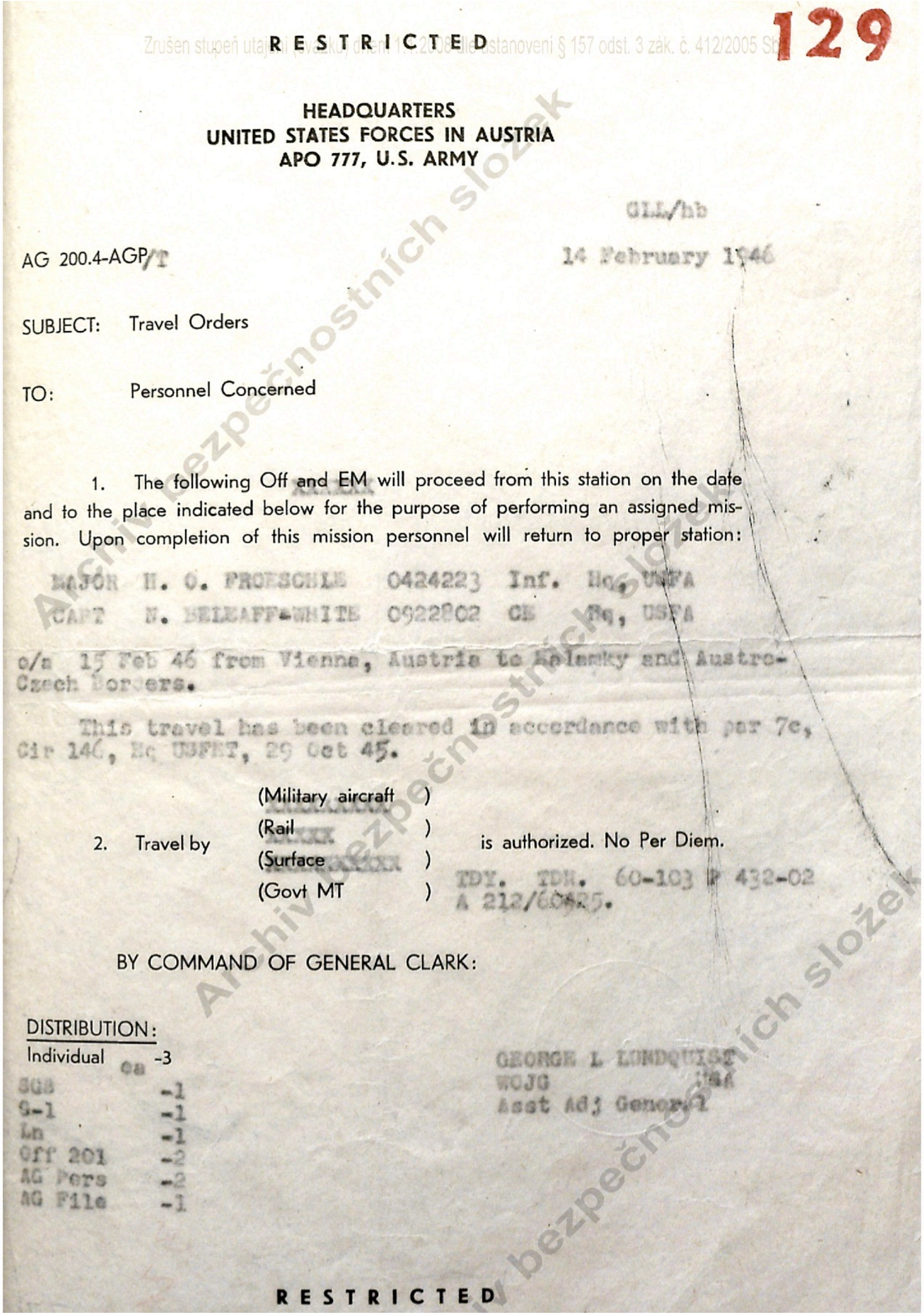
The Czech reports stated that three Americans, including a captain, were arrested, but that the rest of the party of thirteen had departed toward Germany with more than thirty boxes of documents taken from the cavern.

Speculation in Washington today ascribed considerable importance to the papers in view of the strong-arm methods employed to obtain them from within a neutral and formerly Allied country in peace time.

NARA RG 77, Entry UD-22A, Box 163, Folder Czechoslovakia

Col Shuler — no comment — CFC

Figure D.315: [NARA RG 77, Entry UD-22A, Box 163, Folder Czechoslovakia].



RESTRICTED

129

HEADQUARTERS
UNITED STATES FORCES IN AUSTRIA
APO 777, U.S. ARMY

GLL/hb

AG 200.4-AGP/T 14 February 1946

SUBJECT: Travel Orders

TO: Personnel Concerned

1. The following Off and EM will proceed from this station on the date and to the place indicated below for the purpose of performing an assigned mission. Upon completion of this mission personnel will return to proper station:

MAJOR H. O. FROESCHLE 0424223 Inf. Hq, USFA
CAPT N. BELEAFF-WHITE 0922802 CE Hq, USFA

o/a 15 Feb 46 from Vienna, Austria to Halamky and Austro-Czech Borders.

This travel has been cleared in accordance with par 7e, Cir 146, Hq USFET, 29 Oct 45.

2. Travel by (Military aircraft) (Rail) (Surface) (Govt MT) is authorized. No Per Diem. TDY. TDN. 60-103 P 432-02 A 212/60425.

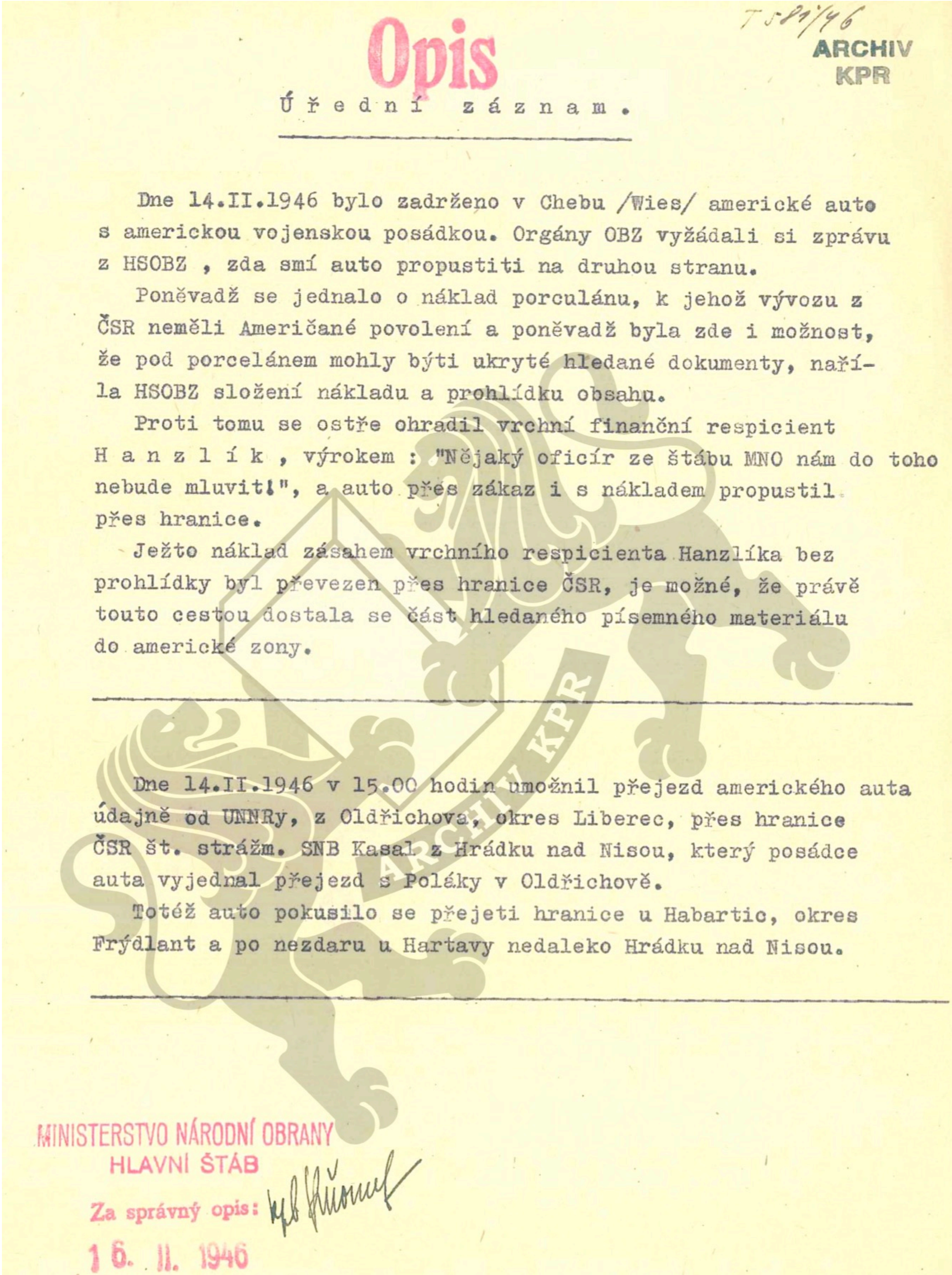
BY COMMAND OF GENERAL CLARK:

DISTRIBUTION:
Individual ea -3
SGS -1
G-1 -1
Ln -1
Off 201 -2
AG Pers -2
AG File -1

GEORGE L LUNDQUIST
WOJG USA
Asst Adj General

RESTRICTED

Figure D.316: Other U.S. Army soldiers made an incursion into Czechoslovakia on 14 February 1946 and left this travel order behind at a checkpoint near Halámky-Rapšach on the Czech/Austrian border. [Archiv Bezpečnostních Složek. H-544 Akce Úkryty. Courtesy of Jaroslav Mareš.]



T 5-81/46

Opis

ARCHIV KPR

Ú ř e d n í   z á z n a m .

Dne 14.II.1946 bylo zadrženo v Chebu /Wies/ americké auto s americkou vojenskou posádkou. Orgány OBZ vyžádali si zprávu z HSOBZ , zda smí auto propustiti na druhou stranu.

Poněvadž se jednalo o náklad porculánu, k jehož vývozu z ČSR neměli Američané povolení a poněvadž byla zde i možnost, že pod porcelánem mohly býti ukryté hledané dokumenty, nařídla HSOBZ složení nákladu a prohlídku obsahu.

Proti tomu se ostře ohradil vrchní finanční respicient H a n z l í k , výrokem : "Nějaký oficír ze štábu MNO nám do toho nebude mluvit!", a auto přes zákaz i s nákladem propustil přes hranice.

Ježto náklad zásahem vrchního respicienta Hanzlíka bez prohlídky byl převezen přes hranice ČSR, je možné, že právě touto cestou dostala se část hledaného písemného materiálu do americké zony.

Dne 14.II.1946 v 15.00 hodin umožnil přejezd amerického auta údajně od UNNRy, z Oldřichova, okres Liberec, přes hranice ČSR št. strážm. SNB Kasal z Hrádku nad Nisou, který posádce auta vyjednal přejezd s Poláky v Oldřichově.

Totéž auto pokusilo se přejeti hranice u Habartic, okres Frýdlant a po nezdaru u Hartavy nedaleko Hrádku nad Nisou.

MINISTERSTVO NÁRODNÍ OBRANY
HLAVNÍ ŠTÁB
Za správný opis:
16. II. 1946

Figure D.317: A report of two successful U.S. incursions into Czechoslovakia on 14 February 1946. [Archiv Kanceláře Prezidenta Republiky. Courtesy of Jaroslav Mareš. https://www.prazskyhradarchiv.cz/file/edee/archivalie_mesice/2016/1602.pdf]

A report of two successful U.S. incursions into Czechoslovakia on 14 February 1946. [Archiv Kanceláře Prezidenta Republiky. Courtesy of Jaroslav Mareš. https://www.prazskyhradarchiv.cz/file/edee/archivalie_mesice/2016/1602.pdf]

Official record.

On 14 February 1946, an American car with an American military crew was intercepted in Cheb. OBZ [Defense Intelligence Agency] authorities requested a report from HSOBZ [Main Administration of Defense Intelligence Agency] as to whether the car could be released to the other side.

Since it was a cargo of porcelain, which the Americans had no permission to export from Czechoslovakia, and since there was also the possibility that the wanted documents might be hidden under the porcelain, HSOBZ ordered the cargo to be gathered together and the contents to be searched.

The chief financial officer Hanzlik strongly objected to this, saying: "Some officer from the MNO staff will not interfere with us!" and despite the ban, he let the car and its cargo cross the border.

Since the cargo was transported across the Czechoslovak border without inspection by the intervention of chief financial officer Hanzlik, it is possible that it was through this route that some of the wanted written material reached the American zone.

On 14 February 1946, an American car, allegedly from the UNNRy in Oldřichov, Liberec district, was allowed to cross the border of Czechoslovakia by staff guard Kasal from Hrádek nad Nisou, who negotiated the crossing with the Poles in Oldřichov.

The same car tried to cross the border at Habartice, Frýdlant district, and after failure at Hartava near Hrádek nad Nisou.

[This document reports:

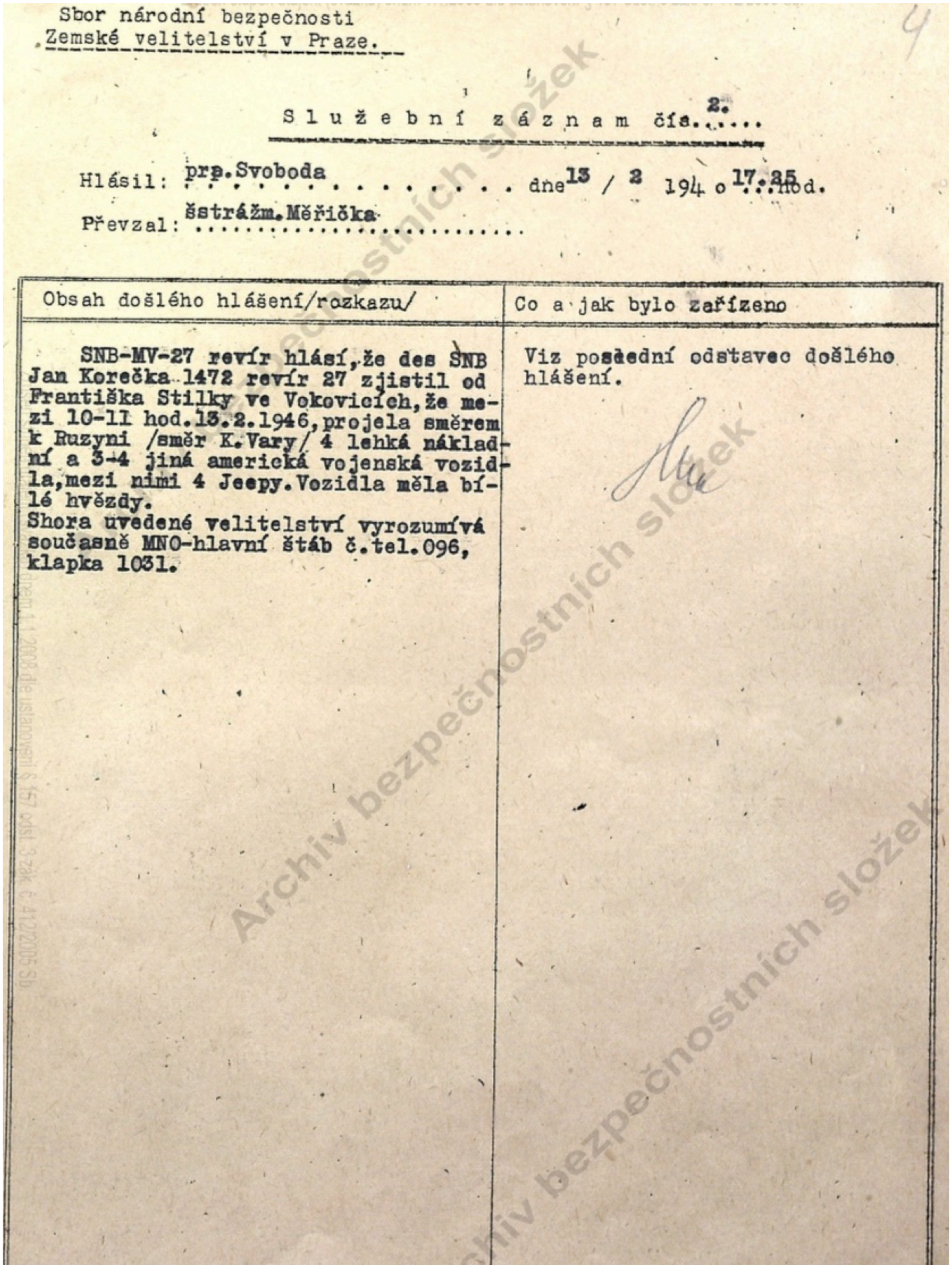
- An American military vehicle with an unknown cargo (concealed in or under porcelain) left Czechoslovakia for Germany at Cheb (due west of Prague).
- An American military vehicle with an unknown cargo left Czechoslovakia for Poland near Liberec (northeast of Prague), after trying unsuccessfully to leave Czechoslovakia at two other border checkpoints in that general area. The vehicle probably just cut across the extreme southwestern corner of Poland before returning to Germany.

These two U.S. military incursions were in addition to those at Štěchovice (pp. 3761–3763), Halámky-Rapšach (p. 3765), Prague-Vokovice to Karlovy Vary (p. 3768), Prague area (p. 3769), and apparently many others (p. 3772).

What exactly triggered all of these U.S. incursions into Czechoslovakia? Perhaps recently obtained information from interrogations, or fears that Czech or Soviet officials were about to seize or block access to certain sites or materials?

What did all of these U.S. incursions into Czechoslovakia retrieve?

Where are all of the retrieved materials and U.S. records about these incursions now?]



Sbor národní bezpečnosti
Zemské velitelství v Praze.

4

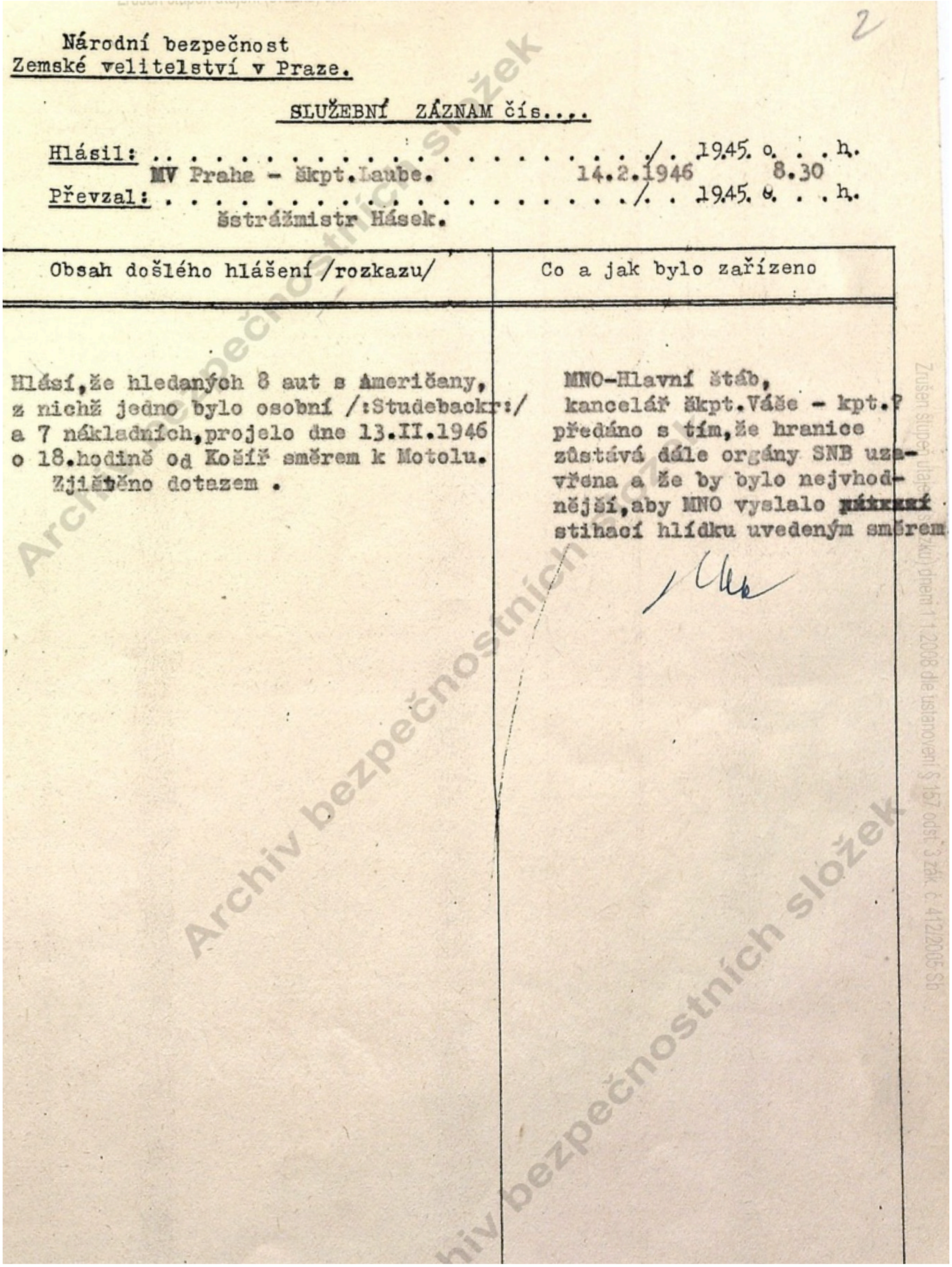
Služební záznam čís. 2.

Hlásil: prp. Svoboda dne 13 / 2 194 o 17.35 hod.

Převzal: šstrážm. Měřička

Obsah došlého hlášení/rozkazu/	Co a jak bylo zařízeno
SNB-MV-27 revír hlásí, že des SNB Jan Korečka 1472 revír 27 zjistil od Františka Stilky ve Vokovicích, že mezi 10-11 hod. 13.2.1946, projela směrem k Ruzyni /směr K. Vary/ 4 lehká nákladní a 3-4 jiná americká vojenská vozidla, mezi nimi 4 Jeepy. Vozidla měla bílé hvězdy. Shora uvedené velitelství vyrozumívá současně MNO-hlavní štáb č.tel. 096, klapka 1031.	Viz posledni odstavec došlého hlášení.

Figure D.318: A report of another successful U.S. incursion into Czechoslovakia on 13 February 1946, describing a U.S. convoy of four trucks and four Jeeps traveling from Prague-Vokovice to Karlovy Vary. [Archiv Bezpečnostních Složek. File 304_81_5. Courtesy of Jaroslav Mareš.]



2

Národní bezpečnost
Zemské velitelství v Praze.

SLUŽEBNÍ ZÁZNAM čís....

Hlásil: ..../. 1945. o . . h.
MV Praha - škpt. Laube. 14.2.1946 8.30
Převzal: ..../. . 1945. o . . h.
šstrážmistr Hásek.

Obsah došlého hlášení /rozkazu/	Co a jak bylo zařízeno
Hlásí, že hledaných 8 aut s Američany, z nichž jedno bylo osobní /:Studebacker:/ a 7 nákladních, projelo dne 13.II.1946 o 18. hodině od Košíř směrem k Motolu. Zjištěno dotazem.	MNO-Hlavní štáb, kancelář škpt. Váše - kpt.? předáno s tím, že hranice zůstává dále orgány SNB uzavřena a že by bylo nejvhodnější, aby MNO vyslalo xxxxxxx stihací hlídku uvedeným směrem.

Figure D.319: A report of another successful U.S. incursion into Czechoslovakia on 13 February 1946, describing a U.S. convoy of seven trucks and one passenger car traveling from Prague-Košíře to Prague-Motol. [Archiv Bezpečnostních Složek. File 304_81_5. Courtesy of Jaroslav Mareš.]

Leslie Groves to U.S. Military Attaché London. 10 September 1946. Top Secret cable WAR 99912 [NARA RG 77, Entry UD-22A, Box 160, Folder 205.4 Cables Outgoing, Top Secret]. See document photo on p. 3771.

10 September 1946

MILATTACHÉ AMEMBASSY London England

Number: WAR 99912

Loco Personal for Dean from Shuler signed Groves

Mr P. C. Keith will be in Czechoslovakia from approximately 15 September to 28 September. The name of the Military Attaché at Prague, Colonel Egmont F. Koenig, has been given to Keith. It is important that Koenig be notified of visit of Keith into Czechoslovakia so that Koenig may extend to him every courtesy possible should the occasion arise.

Wire Koenig immediately in Prague—Top Secret-priority—as follows and sign name of Dean: Mr P. C. Keith, President of U.S. Industrial Corporation, will be in Czechoslovakia on September 15th and may contact you personally. Important that every courtesy possible be shown him if occasion arises.

End

ORIGINATOR: Gen Groves

[Percival C. Keith, a chemical engineering graduate from MIT, was the chief designer and engineer of the Oak Ridge K-25 gaseous diffusion uranium enrichment facility. See for example:

> https://www.nytimes.com/1976/07/12/archives/percival-c-keith-scientist-75-dies-worked-on-abomb-project-and-in.html
>
> https://www.nae.edu/30698/Mr-Percival-C-Keith-Jr
>
> https://ahf.nuclearmuseum.org/ahf/profile/percival-dobie-keith/

In September 1946, Leslie Groves sent Keith on a two-week Top Secret mission to Czechoslovakia. Groves also ordered Colonel Egmont Koenig (pp. 5541–5544) at the U.S. embassy in Prague to do anything possible to bail out Keith if he ran into trouble during his visit ("Important that every courtesy possible be shown him if occasion arises"). As the designer of Oak Ridge, Keith would have been an invaluable prize to the Czechs or Soviets if he had been captured.

Since this mission was ordered by Groves and led by Keith, it must have focused on nuclear issues. Since the mission was Top Secret and Keith was sent despite the great risk if he had been captured, it must have been extremely high priority.

The logical target for such a mission would be former wartime German nuclear resources in Czechoslovakia that were now being used or in danger of being used by Czech/Soviet forces. There was considerable wartime German and postwar Soviet mining of uranium ore in Czechoslovakia, but that was already being addressed by other U.S./U.K. investigators with much more expertise with mining and/or espionage and much less risk if captured than Keith (e.g., pp. 4980–4984).

It seems as if the only target that would require the specific expertise of Keith and justify the great risk of sending him would be a former German uranium enrichment facility in Czechoslovakia. Was Keith's mission to help inspect/remove/destroy key components at an enrichment facility? Can anyone locate more archival documents regarding the information that prompted Keith's mission, what he did during his mission, and the resulting reports or other impacts after his mission?

For examples of similar incidents, see pp. 3761–3769, 3772, 4613–4615, 4853, 4980–4981, 5050.]

WAR DEPARTMENT
CLASSIFIED MESSAGE CENTER
OUTGOING CLASSIFIED MESSAGE

Shuler

TOP SECRET

TOP SECRET

PARAPHRASE NOT REQUIRED. HANDLE AS TOP SECRET CORRESPONDENCE
PER PARAS 51i and 60a. AR 380-5

Maj Gen. L. R. Groves' Office
Room 4166 78333 Major John C.
Mattina

10 September 1946

MILATTACHE AMEMBASSY London England

Number: WAR 99912

Loco Personal for Dean from Shuler signed Groves

Mr P. C. Keith will be in Czechoslovakia from approximately 15 September to 28 September. The name of the Military Attache at Prague, Colonel Egmont F. Koenig, has been given to Keith . It is important that Koenig be notified of visit of Keith into Czechoslovakia so that Koenig may extend to him every courtesy possible should the occasion arise.

Wire Koenig immediately in Prague-Top Secret-priority-as follows and sign name of Dean: Mr P. C. Keith, President of U. S. Industrial Corporation, will be in Czechoslovakia on September 15th and may contact you personally. Important that every courtesy possible be shown him if occasion arises.

End

ORIGINATOR : Gen Groves

CM-OUT-99912 (Sep 46) DTG 101959Z se

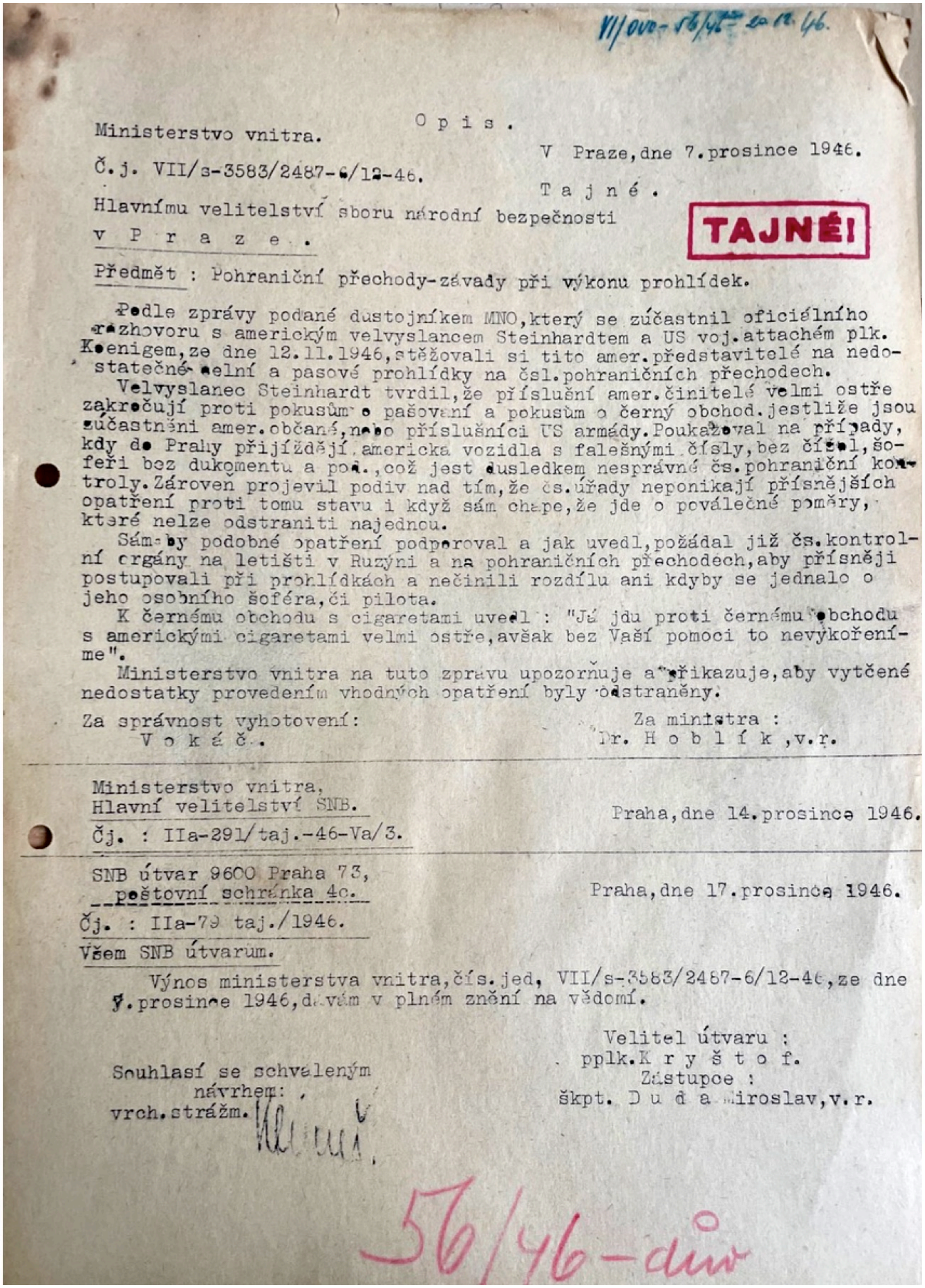
TOP SECRET

COPY NO. 1

THE MAKING OF AN EXACT COPY OF THIS MESSAGE IS FORBIDDEN

NARA RG 77, Entry UD-22A, Box 160,
Folder 205.4 Cables Outgoing, Top Secret

Figure D.320: In September 1946, Leslie Groves sent Percival C. Keith, the construction chief of Oak Ridge, on a two-week Top Secret mission to Czechoslovakia. Leslie Groves to U.S. Military Attaché London. 10 September 1946. Top Secret cable WAR 99912 [NARA RG 77, Entry UD-22A, Box 160, Folder 205.4 Cables Outgoing, Top Secret].



VII/ovo-56/46 - 20.12.46.

Ministerstvo vnitra.

O p i s .

V Praze, dne 7. prosince 1946.

Č. j. VII/s-3583/2487-6/12-46.

T a j n é .

TAJNÉ!

Hlavnímu velitelství sboru národní bezpečnosti

v P r a z e .

Předmět : Pohraniční přechody-závady při výkonu prohlídek.

Podle zprávy podané dustojníkem MNO, který se zúčastnil oficiálního rozhovoru s americkým velvyslancem Steinhardtem a US voj. attachém plk. Koenigem, ze dne 12.11.1946, stěžovali si tito amer. představitelé na nedostatečné celní a pasové prohlídky na čsl. pohraničních přechodech.

Velvyslanec Steinhardt tvrdil, že příslušní amer. činitelé velmi ostře zakročují proti pokusům o pašování a pokusům o černý obchod, jestliže jsou zúčastněni amer. občané, nebo příslušníci US armády. Poukazoval na případy, kdy do Prahy přijíždějí americká vozidla s falešnými čísly, bez čísel, šoféři bez dukomentu a pod., což jest dusledkem nesprávné čs. pohraniční kontroly. Zároveň projevil podiv nad tím, že čs. úřady neponikají přísnějších opatření proti tomu stavu i když sám chápe, že jde o poválečné poměry, které nelze odstraniti najednou.

Sám by podobné opatření podporoval a jak uvedl, požádal již čs. kontrolní orgány na letišti v Ruzyni a na pohraničních přechodech, aby přísněji postupovali při prohlídkách a nečinili rozdílu ani kdyby se jednalo o jeho osobního šoféra, či pilota.

K černému obchodu s cigaretami uvedl : "Já jdu proti černému obchodu s americkými cigaretami velmi ostře, avšak bez Vaší pomoci to nevykořeníme".

Ministerstvo vnitra na tuto zprávu upozorňuje a přikazuje, aby vytčené nedostatky provedením vhodných opatření byly odstraněny.

Za správnost vyhotovení:
V o k á č .

Za ministra :
Dr. H o b l í k , v.r.

Ministerstvo vnitra,
Hlavní velitelství SNB.
Čj. : IIa-291/taj.-46-Va/3.

Praha, dne 14. prosince 1946.

SNB útvar 9600 Praha 73,
poštovní schránka 40.
Čj. : IIa-79 taj./1946.
Všem SNB útvarum.

Praha, dne 17. prosince 1946.

Výnos ministerstva vnitra, čís. jed, VII/s-3583/2487-6/12-46, ze dne 7. prosince 1946, dávám v plném znění na vědomí.

Souhlasí se schváleným návrhem:
vrch. strážm.

Velitel útvaru :
pplk. K r y š t o f.
Zástupce :
škpt. D u d a Miroslav, v. r.

56/46-dův

Figure D.321: According to this December 1946 report from the Czechoslovakian Ministry of Defense, even the U.S. ambassador in Prague, Laurence Steinhardt (1892–1950, who had a fascinating career that deserves greater study!), complained about the large numbers of U.S. vehicles making unauthorized incursions into Czechoslovakia. [Pohraniční útvary SNB 1946–1947. Courtesy of Jaroslav Mareš.]

R ze dne 4.6.1986 p.č. 2168 4
R

Rybín Jaroslav
nar. 25.4.1923
K Závěrce 2752/34
Praha 5

Praha dne 3. června 1986

Vážený soudruhu generální tajemníku a presidente ČSSR.

Předem prosím, abyste přijal odemne srdečný soudružský pozdrav a prominul mi, že se snažím Vás připravit o cenný čas, kterého jistě při své odpovědné funkci nemáte nikdy nazbyt.

Napsat Vám dopis mne nutí mé svědomí, které inspirovaly události kolem havarie atomové elektrárny v Černobylu. Nikdy jsem si předtím neuvědomoval, že i v " celku nevelká " havarie může mít tak veliké následky s tak namáhavými a nebezpečnými úkoly s jejich odstraňováním.

Píši proto, že i my máme nedaleko Prahy docela ještě strašnější hrozbu, - dědictví po německé okupaci. Jedná se o sklad cca 1.200 tun velmi brisantní trhaviny spolu s cca 200 sudy obohaceného uranu, které Němci ukryli před postupující Sovětskou armádou v prostoru Štěchovice, Hradištko, Závist, Krňany, Benešov až Sedlčany.

V poslední době se hodně psalo o tektonických poruchách, které z části zasahovaly i Středočeský kraj. Jímá mne hrůza při pomyšlení, že v souhrnu náhod by došlo tektonickým pohybem půdy ke vznícení trhavin, které by při výbuchu a vzniklým žárem roztavily sudy s uranem. Tím by z podkritických hodnot jednotlivých sudů najednou vznikla silná nadkritická hodnota štěpného materiálu a výbuch by se stal výbuchem atomové pumy, která by ohrozila nejen hlavní město Prahu, ale ochromila by možná celé Čechy i sousední státy.

Tyto poznatky nejsou jen mojí fantasií, ale jsou co do ukrytí materiálu doloženy poznatky v archivu ministerstva vnitra ČSSR.

Figure D.322: 3 June 1986 letter from Rybín Jaroslav [Czech National Archive, courtesy of Adam Kretschmer].

2

Jako býv. příslušník ministerstva vnitra jsem se již v letech k952 - 56 podílel jako vyšetřovatel válečných zločinů a později jako operativní pracovník na rekonstrukci nacistických tajných sítí. Přitom bylo též pátráno po tajných materiálech tehdejší III. Říše, údajně ukrytých ke konci války v hlubokých štolách v uváděném prostoru.

Po odchodu do důchodu jsem na popud tehdejšího ministra vnitra ČSSR s Obziny v r. 1982 pracoval a pomáhal v hledání materiálů tehdy žijícímu s. gen. Josefu Riplovi. Zjistil jsem mimo jiné, že v pátrání proti r. 1956 nebylo vůbec pokročeno a záhady kolem ukrytých materiálů nebyly rozptýleny, neboť se prakticky na problému nepracovalo. Bylo to zejména proto, že po odhalení tzv. " Frankova archivu ", který nám byl v r. 1946 Američany odcizen, byla šířena nedůvěra v další nálezy, vyhledávací skupiny skupiny měly malou operativnost a skoro žádnou pravomoc, byly nedostatečně vybaveny pracovními silami a v neposlední řadě i nedostečnou technikou. S přihlédnutím, že oblast v rozloze cca 500 km^2, kde materiály podle protokolů zajatých Němců a dalších různých nezávislých svědků z řad čs. občanů byly zakopány nebo ukryty do různých štol a studní, bylo vyhledávání naprosto nedostatečné a pokud je mi v současné době známo, vůbec se v něm nepokračuje.

Dostupné materiály archivů uvádějí, že to vše bylo v prostoru býv. cvičiště " SS Truppenübungsplatz BÖHMEN " se sídlem v Benešově (Konopiště - velitel SS generál KARASEH) a v Hradištku, kde byla škola pro ženisty SS (velitel SS plk. KLEIN).

Dle různých poznatků, včetně přátel, jedná se souhrnně asi o:

1, nebezpečnou munici a trhaviny (údajně 1.200 tun uváděných třeskavin a 200 sudů s uranovým materiálem),

2, historické materiály ČSR,

3, 52 dřevěných beden s neznámými písemnými materiály a dalšími 5 bednami ukrytých z příkazu K.H.Franka koncem dubna 1945),

4, neznámé materiály, které byly přiváženy ze západního a středního Německa pod ochranou pancéřových vozidel v době mezi 24.12.1944 do konce ledna 1945 v prostoru Krňan,

5, cca 3 vagony maďarského pokladu,

Figure D.323: 3 June 1986 letter from Rybín Jaroslav [Czech National Archive, courtesy of Adam Kretschmer].

3

6, cca 3 vagony materiálů RSHA,

7, Kijevskou a Charkovskou biblioteku, která byla proka - zatelně v Benešově, na zámku Konopiště,

8, tzv. Jantarovou komnatu,

9, kolem 30 tun zlata a zlatých věcí (údajně poklad Belgie),

10, kolem 3 tun stříbra v cihlách,

11, archiv NSDAP - údajně u Karlových Var na ABERKU,

12, a jiných věcí, jako jsou archivy prokuratury SS a sou - du SS v Nalžovicích apod.

Ještě před dvěma a půl léty jsem měl osobně zájem pomoci uváděné věci nalézt (ještě jsem si tehdy neuvědomoval nebezpečí výbuchu trhavin). Podal jsem pětistránkový návrh na způsob vyhledávání tehdejšímu I. náměstku ministra vnitra ČSSR s. gen. Kováčovi a i když jsem se zříkal jakékoliv finanční odměny za práci spojenou s vyhledáváním, nebylo mi na můj návrh ani odpovězeno.

Nyní jsem již 7 roků v důchodu, po třech infarktech a s lehčí cukrovkou nikde nepracuji. Nemohu však přenést přes srdce, že by hrozba katastrofy nad námi visela stále jako Damoklův meč.

Obracím se proto vážený soudruhu generální tajemníku a presidente ČSSR na Vás s prosbou jako na nejodpovědnější osobu v naší republice, abyste si ověřil tyto poznatky a hlavně zabránil tomu nejhoršímu, co by nás mimo atomové války mohlo potkat.

Se soudružskými pozdravy

Rybín Jaroslav

býv. pplk. S N B a
nositel medailí

Za obětavou práci pro socialismus
Za upevňování přátelství ve zbrani
I. stupně
a další.

Figure D.324: 3 June 1986 letter from Rybín Jaroslav [Czech National Archive, courtesy of Adam Kretschmer].

Rybín Jaroslav
25.4.1923
K Závěrce 2752/34
Prague 5

Prague 3 June 1986

Dear comrade Secretary General and President of the ČSSR [Czecho-Slovak Socialist Republic],

First of all please accept my comradely greeting, and excuse me that I deprive you of precious time, which you surely do not have much to spare.

I am compelled to write you this letter spurred by the events around the Chernobyl nuclear accident. I had not realized before that even "not really major" accidents could have such serious consequences requiring difficult and dangerous clean-up operations.

I am writing you because there is near Prague an even more dangerous threat that we inherited from the German occupation. There is a deposit of approximately 1200 tons of high explosives together with approximately 200 barrels of enriched uranium that were hidden in the area of Štěchovice, Hradišt'ko, Závist, Krňany, Benešov, and Sedlčany, by the German forces retreating before the victorious Soviet Army.

There have been news recently about tectonic disturbances affecting partially Central Bohemia District. I am terrified to think what could happen if tectonic movements would by coincidence lead to ignition of the explosives and the subsequent blast that would melt the barrels with the uranium. This would lead from subcritical mass contained in each of the barrels to the fusion of critical mass and the explosion would thus in effect be the explosion of an atomic bomb that would endanger not only the capital city of Prague, but most probably the whole Bohemia and neighbouring states.

These findings are not mere fantasy of mine, but are based on the findings in the Archive of the Interior Ministry of the ČSSR.

As a former officer of the Interior Ministry I was working in 1952–56 as war crimes investigator and later as operational officer on the reconstruction of the Nazi secret services activities. One of the things that were investigated were secret materials of the Third Reich apparently hidden by the end of the war in deep tunnels in the area I mentioned above.

After my retirement on the orders of the then Minister of the Interior comrade Obzina I was working and helping comrade General Josef Ripl with locating those materials. I have found out, among other, that the search did not advance compared to 1956 and that the secrets surrounding hidden materials were not solved because there was practically no activity in this regard. It was primarily because after the affair with the so called "Frank's Archive" there was suspicion regarding other findings, search parties had very low operatibility and almost no authority, they were understaffed and also underequipped. If we take into consideration the fact that the area in question, where according to the interrogation protocols of captured Germans and according to testimonials of various Czechoslovak witnesses these materials were hidden into various tunnels and water wells, has approximately 500 km^2, the search efforts were totally inadequate and as far as I am aware no further efforts are being made.

The accessible archival materials attest that the area in question is former military training ground "SS Truppenübungsplatz BÖHMEN" with the command in Benešov (Konopiště – commander SS General KARASCH) and in Hradištko where a school for SS sappers was located (commander SS Colonel KLEIN).

According to various sources, including those from my acquaintances, we are dealing with:

1. Dangerous ammunition and explosives (allegedly including above mentioned 1200 tons high explosives and 200 barrels of uranium).
2. Historical materials belonging to Č[S]SR.
3. 52 wooden boxes with unidentified written materials and other 5 boxes hidden by the order of K.H. Frank at the end of April 1945.
4. Unidentified materials that were transported from western and central Germany under the protection of armored vehicles between 24.12.1944–end of January 1945 to the area of Krňany.
5. Approximately 3 wagons of Hungarian treasure.
6. 3 wagons of RSHA materials.
7. Kiev and Kharkiv libraries that were arguably located in Benešov, at Konopiště Chateau.
8. So called Amber Room [Bernsteinzimmer].
9. Around 30 tons of gold and golden treasure (presumably incl. Belgian treasure).
10. Around 3 tons of silver bars.
11. Archive of the NSDAP, presumably near Karlovy Vary at ABERK.
12. Miscellanea, including archives of the SS Prosecution Office and Tribunal at Nelžovice etc.

Two years ago I was personally disposed to assist in locating the above mentioned (back then I did not yet realize the danger posed by the explosives). I submitted a 5-page draft regarding means of locating the stuff mentioned above to the then First Deputy Minister of Interior, comrade General Kováč, and even though I explicitly renounced any financial recompense connected with the search, I never even received an answer back.

I have been 7 years in retirement, and after three heart attacks and light diabetes I am not working anywhere. I can not ignore though the danger of the catastrophe looming above us like the Sword of Damocles.

I therefore turn to you, dear comrade Secretary General and President of the ČSSR as the most responsible person in our republic, to confirm these findings and especially to prevent the worse that can happen to us, save for atomic war.

With comradely greetings,

Rybín Jaroslav
SNB [National Security Corps] Lieutenant Colonel (ret.)
Awardee of the medals: For Selfless Work for Socialism,
For Securing Friendship in Arms, First Class, and others.

[If this information is correct, "approximately 200 barrels of enriched uranium" would be the product of an industrial-scale nuclear weapons program, not small-scale laboratory experiments. And that is only the enriched uranium that this particular person knew about in this particular location. How much enriched uranium had been produced throughout German-controlled territory by the end of the war, to what degrees was it enriched, and by which enrichment methods?]

R ze dne 1.9.1986 p.č. 4857.

R y b í n Jaroslav
nar. 25.4.1923
K Závěrce 2752/34
P r a h a 5

Praha dne 1. září 1986

Vážený soudruhu generální tajemníku ÚV KSČ a presidente ČSSR.

Dovlte mi, abych se předem omluvil, že znovu obtěžuji pro - blémem, který jsem Vám již sdělil dopisem ze dne 3.6.1986.

V červnu tr. jsem byl navštíven dvěma pracovníky Federální správy VB (mjr. Urban Jan aspol.). Pochopil jsem z pohovoru, že jde o upřesňování poznatků a názorů, které jsem Vám zaslal. Po vy- světlení některých bodů jsem jim ještě zapůjčil i dvě kopie dopi - sů, které jsem napsal v minulosti a které údajně na MV ČSSR nenaš- li (býv. ministru vnitra ČSSR s. Obzinovi a býv. 1. náměstku MV - ČSSR s. gen. Kovačovi, které mě dosud nebyly vráceny). Nabyl jsem z tohoto jednání dojem, že pracovníci FS VB nechápou veliké nebez- pečí, které zde je (třebas jen pouhý únik radioaktivity v případě i náhodného poškození kontejneru apod.) a zaměřují se jen na pro - blém hledání uloupených cenností, nebo písemných dokumentů tzv. III. Říše.

Nyní po návratu z delšího letního pobytu v Lučenci jsem na - vštívil lokality býv. cvičiště SS na Hradištsku. Zjistil jsem, že podezřelá místa úleže ukrytých nebezpečných trhavin a uranu nikdo neprověřuje a nebezpečí pro okolí stále přetrvává.

Z pohovoru s pracovníky FS VB a vlastním ohledáním jsem nabyl přesvědčení, že Federální ministerstvo vnitra a jeho složky podce- ňují nebezpečí, nebo na druhé straně nejsou vůbec schopni zabránit možné katastrofě.

Proto jako komunista se znovu obracím na Vás, abyste posou- dil nebo nechal prověřit stav šetření. Jako býv. konzultant mini- stra vnitra ČSSR mám zato, že není těžké ani organizačně nemožné urychleně zahájit vyhledávání a zneškodnění trhavin, jakož i bez- pečně zajistit výskyt uranu, jak jsem již uváděl v prvním dopise.

Figure D.325: 1 September 1986 letter from Rybín Jaroslav [Czech National Archive, courtesy of Adam Kretschmer].

Dále mám zato, že není-li vnitro schopno ujmout se tohoto úkolu, bylo by dobře tím pověřit MNO a ČSLA, kteří mají v tomto oboru dostatek zkušeností, odborníků, techniky i fundovaných lidí. Mohou proto také odpovědněji posoudit stávající nebezpečí a podle toho naplánovat příslušná opatření.

Jsem si vědom toho, že od ukrytí materiálu uplynulo již více jak 41 let, že vyhledávání je značně ztíženo nově vzrostlou vegetací, erozí půdy apod. Přesto jsou jen podle dostupných materiálů , výpovědí apod. hned nejméně tři lokality, kde Němci mohli nebezpečné výbušniny ukrývat. Jsou to pro informaci (píši a uvádím to proto, že mne zase v poslední době po prodělaných třech infarktech zlobí srdce a nerad bych odnášel tyto poznatky do hrobu) :

1,Tzv, kóta"V lese". Nachází se těsně nad obcí Hradištko. Pro tuto variantu hovoří okolnost, že prostory štol měly mít obsah cca 275 m^3 a hned poblíž, asi 300 m vzdáleno bylo velké skladiště munice, trhavin apod. pro celé seskupení SS v té době na Hradištsku, z nichž jedno oddělení v dubnu 1945 vyletělo do vzduchu.

2,Kopec Medník. V tomto kopci bylo dolováno již asi od r. 1942 a vytěžený kámen byl používán při budování cest a silnice směrem na Závist a dále. Dle výpovědí má být v kopci celá síť chodeb a uprostřed jedna štola cca 500 m hluboká (asi důlní šachta). Fotografie neznámého fotografa z r. 1942-3 ukazuje dva vchody z místa dnešní střelnice MV ČSR. Další dva vchody mají být ve stráni nad obcí Závist a jeden asi 1 km východněji v kopci za Závistí.

3,Posledním mě známým možným úkrytem je tzv. Bobkův kopec, kde údajně byl vybudován vjezd tak velký, že do něho mohli vjet dva jezdci na koních vedle sebe. Rovněž tam byli zastřeleni ke konci dubna 1945 vězňové v počtu 250 - 300 osob. Pro tuto okolnost svědčí i fakt, že hned vedle byla kasárna SS (nyní jsou tam kasárna ČSLA), odkud bylo možno řídit důlní práce i ukrytí tolika trhavin.

Pokud se týká cenností a písemných materiálů, asi o to dnes již není valný zájem. Jistě se na to přijde možná náhodou, až geologové, nebo hledači zlata a pokladů o to " zakopnou ". Bylo by

Figure D.326: 1 September 1986 letter from Rybín Jaroslav [Czech National Archive, courtesy of Adam Kretschmer].

však smutné, kdyby kopli nejdříve do zabezpečovací miny. Je známo, že Němci i v jiných případech vše takto zajišťovali (viz tzv. Štěchovický archiv).

Vážený soudruhu generální tajemníku ÚV KSČ a presidente ČSSR.

Prosím ještě jednou o omluvu, že Vás tolik zaneprazdňuji. Neznám však už jinou možnost, jak na toto veliké nebezpečí upozornit.

Závěrem přijměte mé srdečné soudružské pozdravy a přání, abyste ještě dlouhá léta ve zdraví a svěžesti mohl vykonávat nejvyšší stranické a státní funkce.

Se soudružskými pozdravy

býv. pplk. SNB a
nositel medailí

Za obětavou práci pro socialismus,
Za upevňování přátelství ve zbrani
I. stupně a další.

Figure D.327: 1 September 1986 letter from Rybín Jaroslav [Czech National Archive, courtesy of Adam Kretschmer].

Rybín Jaroslav
25.4.1923
K Závěrce 2752/34
Praha 5 Praha 1 September 1986

Dear comrade Secretary General and President of the ČSSR,

First of all, please accept my apology for contacting you again regarding the matters I presented in my letter to you of 3 June 1986.

In June of this year I was visited by two officers of Federal Service of VB (Public Security /Police/) (Major Jan Urban and a colleague). I understood from the interview that they visited me to clarify some points regarding the matters I wrote you about. After providing clarification I gave them two copies of the letter that I wrote previously to the then Minister of the Interior comrade Obzina and to the then First Deputy Minister of the Interior comrade General Kovač. No copy of the letter was ever returned to me, and even so the Ministry of Interior claims they have been unable to find them in their archive. I got the impression from the interview that the VB Federal Service officers don't understand the magnitude of the danger present (even including a mere radioactive leak in case of accidental damage to a barrel etc.) and that they focused only on issues of finding the lost valuables or written documents of the Third Reich.

After I had returned from a longer summer stay at Lučenec, I visited the area of the former SS training grounds at Hradištsko. I found out that suspected places where dangerous explosives and the uranium may be located were not being searched and thus the danger for local environment persists.

From the interview with the officers of the VB Federal Service and by checking personally the locality, I got the impression that the Federal Ministry of the Interior and its departments underestimate the danger or perhaps they don't even have the means to avert a possible catastrophe.

Therefore I turn to you as a communist to have this reviewed and examined. As a former specialist of the Ministry of the Interior of the ČSSR I hold that it is neither hard nor impossible from an organizational point of view to start locating and disarming the explosives, as well as safely deal with the uranium, that I mentioned in my first letter.

It is my belief that if the Interior Ministry is not able to deal with this task, it could be delegated to the Defence Ministry and the ČSLA (Army) that have in this regard lot of experiences, specialists, technical means and personal capabilities. They can best evaluate the present danger and plan accordingly how to deal with it.

I am aware that 41 years have passed since the materials were hidden, and that the search is more difficult due to grown vegetation, soil erosion, etc. Nonetheless, according to available evidence, testimonies, etc., there are at least three possible locations where the Germans could have hidden dangerous explosives. These are for your information (I write it here since after three heart attacks my heart is starting to act up again and I don't want to take my knowledge with me to the grave) the following locations:

1. The so called "V lese" spot. It is located directly above Hradištko. The factors favoring this location are that the volume of the tunnels is supposed to be approximately $275m^3$ and that nearby, around 300 m away, there was an ammunition and explosives depot for the SS unit stationed at Hradištko, a part of which exploded in April 1945.

2. The Medník hill spot. This hill was mined since 1942 and the mined stone was used to build communications to Závist and beyond. According to testimonies there is supposed to be a network of passages and one tunnel approximately 500 m deep (mining tunnel) located in the hill. Photos made by an unidentified photographer in 1942–43 show two entrances located at the area of a current shooting training ground of the Interior Ministry of the ČSSR. Another two entrances should be located in the hillside above Závist and one about 1 km east of Závist.

3. The last possible hiding place location known to me is so called Bobkův kopec hill spot, where allegedly an entrance was constructed of sufficient dimensions that two horse riders could enter riding side by side. It is also a place where around the end of April 1945 250–300 prisoners were shot. A factor favouring this location is that right next to it there were SS barracks (now ČSLA barracks) from where it was possible to direct the hiding of such an amount of explosives.

Regarding the valuables and written materials, these are not of such an interest today. They may be found by accident when geologists or treasure seekers would "trip over them" by accident.

It would be sad though if they would first trip over the safety explosives. It is well known that the Germans used to secure valuables in this way (see the so-called Štěchovice Archive).

Dear comrade Secretary General and President of the ČSSR, please accept once more my apology for keeping you busy. But I don't know what else to do to point out this grave danger.

Finally, please accept my heartfelt comradely greetings and best wishes for you to serve in the highest Party and State capacities for many coming years full of health and vigor.

With comradely greetings,

Rybín Jaroslav

SNB (National Security Corps) Lieutenant Colonel (ret.)

Awardee of medals For selfless work for socialism and

For securing friendship in arms I. degree and others

[See also:

Czech information on World War II sites (including Štěchovice) that appear to have radioactive contamination: https://www.sekm.cz and https://kontaminace.cenia.cz

Evidence for underground structures and previous excavations at Štěchovice: Jaroslav Sveceny. 2005. *The Search for Nazi Treasures III. Proposal for an Exploration Project and TV Documentary Series.* Prague. pp. 12–14. https://issuu.com/ptouge/docs/nazi_treasures_iii_qxp

It is difficult to find much information about the Blaumeise I–III underground facilities at Štěchovice [Wichert 1999].

Much more archival and archaeological research should be conducted for this site.]

[For some other known or suspected nuclear sites in Czechia, see:

p. 3446

p. 3936

pp. 3979–4025

pp. 4082–4083

pp. 4914–4984]

Known/Reported Sites Now in Slovakia

Philip Morrison to Francis J. Smith. 17 February 1945. Subject: Evaluation of Air Photos [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)].

1. Leverkusen [...]

2. Dubnica (Czechoslovakia) — This plant has been carefully studied by the Crossbow Committee in interpretation report #U17. It is an excellent factory for making anything. More specifically, the underground facilities, which include quite sizeable steam installations, would make possible the location of a plant of LTD [Liquid Thermal Diffusion, i.e. uranium enrichment], or similar style in fractional scale, at this site. The absence of visible handling facilities for large equipment, etc., is not conclusive, but it is a bit strange if this is really a normal factory for producing ordnance. No specific features except the steel and water facilities would imply a plant of special interest to us, but on the other hand, one cannot exclude that it is such a plant. Here I would like to keep watching this installation and would especially like to see the Crossbow report H(1)131, which was an earlier report on the same site.

3. Hechingen [...]

[See document photo on p. 3785.]

R. V. Shepherd. BIOS 313. *Report on Visit to Czechoslovakia by Armament Design Department. 16th November to 9th December, 1945.* p. 11.

Black List
Number Target

[...]

2/462 Dubnica—An underground factory built before the war by Skoda. It was taken over by the Germans and operated by them. It was completely destroyed by the Germans when the Russians advanced into Slovakia. [...]

C2/788 Vitkovice—Skoda had no works here but probably owned coal mines for which this area is noted. The main works are the Vitkovice Steel Works which were in the Herman Goering Trust in the steel making section. The firm is NOT linked with Skoda. Head of the Firm is von Ringhoffer—German. Also a Director of Skoda.

[This Vitkovice (Czechia) plant is either the same as or at least in close proximity to the Ostrava nuclear facility reported in the documents on pp. 3748–3750, 3882–3883.]

SECRET

This document consists of 2 pages,
No. 1 of 3 copies, series A

P. O. Box 1663
Santa Fe, New Mexico

17 February 1945

Subject: Evaluation of Air Photos.

To: Major Frank J. Smith, P. O. Box 2610, Washington, D. C.

1. Leverkusen - the PW report mentioning heavy concrete structures at this plant (Calvert - 29 January 1945) is an evident lead in our direction. Such structures imply either the operation of a 49 pile or a chemical operations plant for active material from such a pile. It does not seem likely that these operations, which are not on a heavy chemical scale, would be carried out in the crowded site at Leverkusen. I have looked over the whole plant and I do not find any such structures except for a line of dubious objects across the river which I have circled on prints #4009 and #4114. I would like to show these objects to one of the Interpretation Officers in the Pentagon. It is unlikely, however, that this is a tip to operations of our interests.

I note with enthusiasm in the latest coverage, a direct hit on the power house which edges the buildings number 31 through 36. This is made to order for us, since it is this area which represents the best enemy installation for the processing of fluorine compounds and, therefore, probably of hex. This area was closed tight in November 1944. If it is not too difficult for the operational crews, I should like to see another coverage of Leverkusen to examine repair on this particular area.

2. Dubnica (Czechoslovakia) -- This plant has been carefully studied by the Crossbow Committee in interpretation report #U17. It is an excellent factory for making anything. More specifically, the underground facilities, which include quite sizeable steam installations, would make possible the location of a plant of LTD, or similar style in fractional scale, at this site. The absence of visible handling facilities for large equipment, etc., is not conclusive, but is a bit strange if this is really a normal factory for producing ordnance. No specific features except the steel and water facilities would imply a plant of special interest to us, but on the other hand, one cannot exclude that it is such a plant. Here I would like to keep watching this installation and would especially like to see the Crossbow report H(1)131, which was an earlier report on the same site.

3. Hechingen - I received no text at all with these pictures, but I studied the pictures at length. There are very many remarkable features about this plant, which is in the stage of active construction. I do not know what this plant is doing. The very large pipe or pressure vessels visible everywhere indicate a chemical process involving handling large amounts of gas. The strip mining, or possibly just dirt moving, which is going on, the presence of many cranes and other elevated structure, the possible large concrete structure, which I have circled on the prints, do not combine to indicate conventional kind of operation. Taken with our information that this region is, in fact, a seat of special work on our Project, the pictures are of great interest. I do not believe that a 49 plant is being constructed here, but I would not at all be surprised if some sort of isotope separation in a gas phase is being contemplated on a rather small scale. There are no data to make this "yes" probable, and the plant may very well be for some other chemical purpose (rocket fuel, etc.), but it is a most unconventional kind of operation.

The quality of the photos leaves a great deal to be desired. I would strongly recommend improved coverage of this plant.

P. Morrison

P. Morrison

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3
GERMANY: US Wartime Positive Int. (Nov. 44-June 45)

Figure D.328: Philip Morrison to Francis J. Smith. 17 February 1945. Subject: Evaluation of Air Photos [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)].

Known/Reported Sites Now in Denmark

[Many 1945–1948 newspaper articles alleged that there was some sort of German nuclear work on the Danish island of Bornholm during the war, and that Soviet forces occupying the island after the war removed material from that work:

> Clearing of Bornholm: Germans Who Refused to Surrender. *The Times* (London, 15 May 1945).
>
> Danes Seek Restoration of Communications. *The Times* (London, 18 May 1945).
>
> Russians Believed Near Atom Secret. *New York Times* (15 October 1945 p. 4).
>
> Russia Will Have Secret Soon. *News Chronicle* (15 October 1945 p. 1).
>
> Russia Confident on Bomb. *New York Times* (31 October 1945 p. 6).
>
> Atomic Energy May Be Behind Bornholm Mystery. *Sydney Morning Herald* (20 April 1946 p. 2).
>
> Rich Uranium Ore on Danish Island Russia Evacuated. *Spokane Daily Chronicle* (16 March 1948 p. 6).

With advanced rockets under development at Peenemünde East, advanced aircraft under development at Peenemünde West, biological weapons under development on Riems island, and apparent nuclear tests carried out in the vicinity of the Baltic coast, it would make sense for some of the nuclear development programs to be conducted on Bornholm or elsewhere in that general area. Highly secretive and potentially dangerous military research projects seem to have been deliberately clustered in this sparsely populated area around the Baltic coast, far from Allied forces in both directions at the time that work was begun. The following formerly secret Allied intelligence documents confirm that there were indeed nuclear materials and programs on Bornholm.]

C.S.D.I.C. (U.K.) S.R.G.G. 1118. [Recorded conversation of two German prisoners of war held in the United Kingdom. AFHRA A5415 frames 284–285]

M 159—General der Panzertruppen Von THOMA (GOC German AFRIKORPS) Captd MIDDLE EAST 4 Nov 42

CS/981 Generalleutnant KITTEL (Comd. METZ and Comd. 462 Volksgren. Div.) Captd METZ 22 Nov 44

Information received: 10 Jan 1945

TRANSLATION

KITTEL: (Re atom bomb). It's a perfectly horrible thing.

THOMA: A technical man has written about it, saying the problem has been completely solved theoretically, but that the process can't be controlled(?).

KITTEL: That's the question. At the passing-out parade of an officer's course the FÜHRER—I sent for one of the officers personally, for they were the ones who were at METZ—

THOMA: He's lying. There's absolutely no such thing as the atom business.

KITTEL: Unfortunately there is.

THOMA: Then he would have used it long ago.

KITTEL: No; he isn't using it, because the others have promised to retaliate with chemical warfare. [...]

THOMA: But there's no such thing as an atom bomb.

KITTEL: The experiments with it are carried out on BORNHOLM; the island has been evacuated and no-one may enter or leave the place.

THOMA: What do they do there?

KITTEL: They carry out their experiments there. Apparently they've got another trump card up their sleeve.

[Heinrich Kittel was a very high-ranking general in the German army and thus a valuable source of information, including some information on the German nuclear program. He was captured by Allied forces after being wounded at Metz, France, on 22 November 1944, so all of his knowledge about German activities was very up-to-date as of this recorded conversation. In contrast, General Wilhelm von Thoma had been captured in 1942 while fighting in North Africa, so he had no firsthand knowledge of subsequent developments (and was skeptical of secondhand reports).

Kittel's comments suggest that he was aware of one or more successful atomic bomb tests prior to his capture. The atomic bomb seemed to be much more than an abstract concept to him. For example, he said that:

- It was "a perfectly horrible thing."
- It "unfortunately" existed.
- The decision had already been made not to use it (implying it was available to use) due to Allied threats of retaliation by dropping mustard agent on German cities (see Section A.4.2).

If Kittel associated the atomic bomb most closely with Bornholm and seemed to believe that the bomb had been tested, that suggests that the test(s) occurred either on Bornholm or somewhere near Bornholm along the Baltic coast. That would be highly consistent with other information in Sections D.10–D.11.

Germany built a number of high-tech facilities on Bornholm, yet the local Danish resistance (and modern Danish museum curators) never figured out what exactly the Germans were doing. That indicates that German forces kept local Danish residents well away from the facilities, or else they would have seen and reported just what the Germans were doing there. Any high-ranking German military officer or official who visited would tour the German facilities and see little or nothing of the local residents, so as far as they were concerned, Bornholm was "evacuated"—not the whole island, just the relevant parts. Even today, the large majority of the Bornholm population lives in the town of Rønne on the west side of the island, and the rest is very sparsely populated. (Occupying Soviet forces removed all of the German equipment and documentation from Bornholm at the end of the war, perpetuating the mystery.)]

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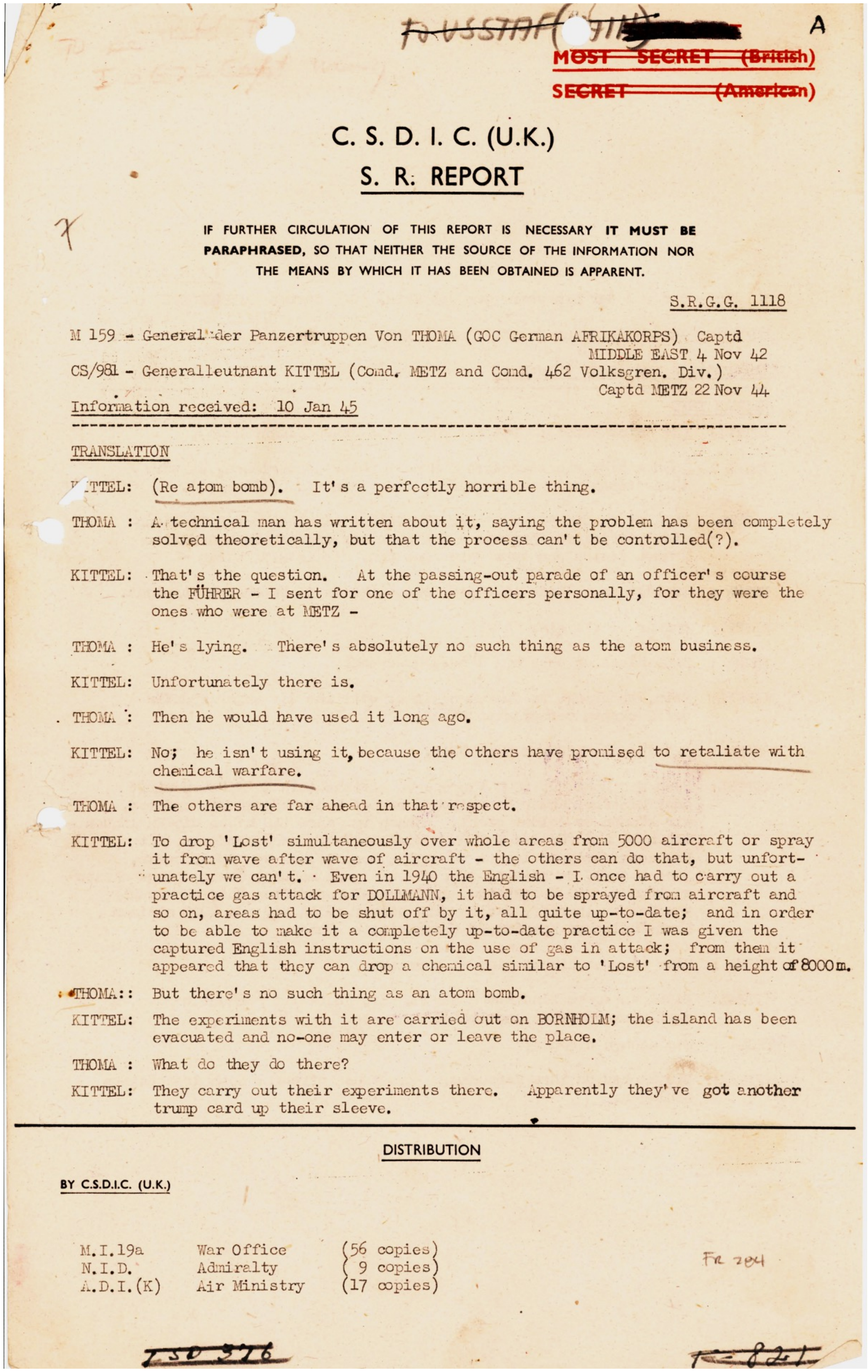
AFHRA folder 512.619C-6C 1944-1945



TO USSTAF [redacted] A

~~MOST SECRET (British)~~

~~SECRET (American)~~

C. S. D. I. C. (U.K.)

S. R. REPORT

IF FURTHER CIRCULATION OF THIS REPORT IS NECESSARY **IT MUST BE PARAPHRASED,** SO THAT NEITHER THE SOURCE OF THE INFORMATION NOR THE MEANS BY WHICH IT HAS BEEN OBTAINED IS APPARENT.

S.R.G.G. 1118

M 159 - General der Panzertruppen Von THOMA (GOC German AFRIKAKORPS) Captd MIDDLE EAST 4 Nov 42

CS/981 - Generalleutnant KITTEL (Comd. METZ and Comd. 462 Volksgren. Div.) Captd METZ 22 Nov 44

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TRANSLATION

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KITTEL: That's the question. At the passing-out parade of an officer's course the FÜHRER - I sent for one of the officers personally, for they were the ones who were at METZ -

THOMA : He's lying. There's absolutely no such thing as the atom business.

KITTEL: Unfortunately there is.

THOMA : Then he would have used it long ago.

KITTEL: No; he isn't using it, because the others have promised to retaliate with chemical warfare.

THOMA : The others are far ahead in that respect.

KITTEL: To drop 'Lost' simultaneously over whole areas from 5000 aircraft or spray it from wave after wave of aircraft - the others can do that, but unfortunately we can't. Even in 1940 the English - I once had to carry out a practice gas attack for DOLLMANN, it had to be sprayed from aircraft and so on, areas had to be shut off by it, all quite up-to-date; and in order to be able to make it a completely up-to-date practice I was given the captured English instructions on the use of gas in attack; from them it appeared that they can drop a chemical similar to 'Lost' from a height of 8000 m.

THOMA : But there's no such thing as an atom bomb.

KITTEL: The experiments with it are carried out on BORNHOLM; the island has been evacuated and no-one may enter or leave the place.

THOMA : What do they do there?

KITTEL: They carry out their experiments there. Apparently they've got another trump card up their sleeve.

DISTRIBUTION

BY C.S.D.I.C. (U.K.)

M.I.19a	War Office	(56 copies)
N.I.D.	Admiralty	(9 copies)
A.D.I.(K)	Air Ministry	(17 copies)

Fr 284

Figure D.329: C.S.D.I.C. (U.K.) S.R.G.G. 1118. [Recorded conversation of two German prisoners of war held in the United Kingdom. AFHRA folder 512.619C-6C 1944–1945; AFHRA A5415 frame 284.]

S.R.G.G.1118

M 159 - General der Panzertruppen Von THOMA (GOC German AFRIKAKORPS) Captd MIDDLE EAST 4 Nov 42

CS/931 - Generalleutnant KITTEL (Comd., METZ and Comd. 462 Volksgren. Div.) Captd METZ 22 Nov 44

Information received: 10 Jan 45

GERMAN TEXT

KITTEL: (Re 'atom bomb'): Das ist eine ganz scheussliche Sache.

THOMA : Da hat hier ein technischer Mann darüber geschrieben, es wäre theoretisch vollkommen gelöst, aber nicht zu bändigen(?).

KITTEL: Das ist ja die Frage. Der FÜHRER hat also bei der Entlassung eines Offiziersjahrgangs - ich habe mir eigens einen Offizier kommen lassen und zwar waren das die, die in METZ waren -

THOMA : Er lügt ja. Eine Atomgeschichte gibt es ja überhaupt garnicht.

KITTEL: Leider gibt's sie.

THOMA : Dann hätte er es schon längst gebraucht.

KITTEL: Nein, er bringt es deswegen nicht, weil ihm die anderen dafür den Gaskrieg versprochen haben.

THOMA : Da sind die anderen weit über.

KITTEL: Wenn man Lost aus 5000 Flugzeugen gleichzeitig in Flächen wirft oder hintereinander in Wellen abregnet - das können die anderen, wir können es leider nicht. Schon im Jahre '40 haben die Engländer - ich habe mal für den DOLLMANN eine Gasübung machen müssen, mit Flugzeug abregnen lassen und so Sachen, Ziehen von Sperriegeln, ganz modern, da kriegte ich, um eine ganz moderne Übungsanlage machen zu können, die erbeuteten englischen Vorschriften über Verwendung von Gas im Angriff, daraus ging hervor, dass sie aus 8000 m einen Lost-ähnlichen Kampfstoff abschmeissen können.

THOMA : Eine Atomgeschichte gibt es garnicht.

KITTEL: Diese Versuche sind auf BORNHOLM, die Insel ist geräumt worden, da darf niemand 'raus und 'rein.

THOMA : Was machen die dort?

KITTEL: Die machen da ihre Versuche. Sie haben offenbar noch irgendeinen Schlager.

FR 285

Figure D.330: C.S.D.I.C. (U.K.) S.R.G.G. 1118. [Recorded conversation of two German prisoners of war held in the United Kingdom. AFHRA folder 512.619C-6C 1944–1945; AFHRA A5415 frame 285.]

Horace K. Calvert to R. V. Jones. 13 March 1945. [NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL]

A report dated 27 February 1945 reflecting a conversation between Generalleutnant Kittel and General Eberbach (both German P.W.'s) has been received. The following dialogue is reported:

> KITTEL: I only wish that the Poles, with whom we shall have to co-operate economically afterwards in any case, will be reasonable, but they won't be reasonable, they don't know how to be. EAST PRUSSIA will become a new ALSACE-LORRAINE. Our children will again meet their death over that stupid question, even though the people are promising now to eradicate all wars. By that time new means will have been found; if aircraft are forbidden they'll discover other things.
>
> EBERBACH: The splitting up of the atom, or something like that.
>
> KITTEL: That already exists; that will come very soon; that will smash everything up.

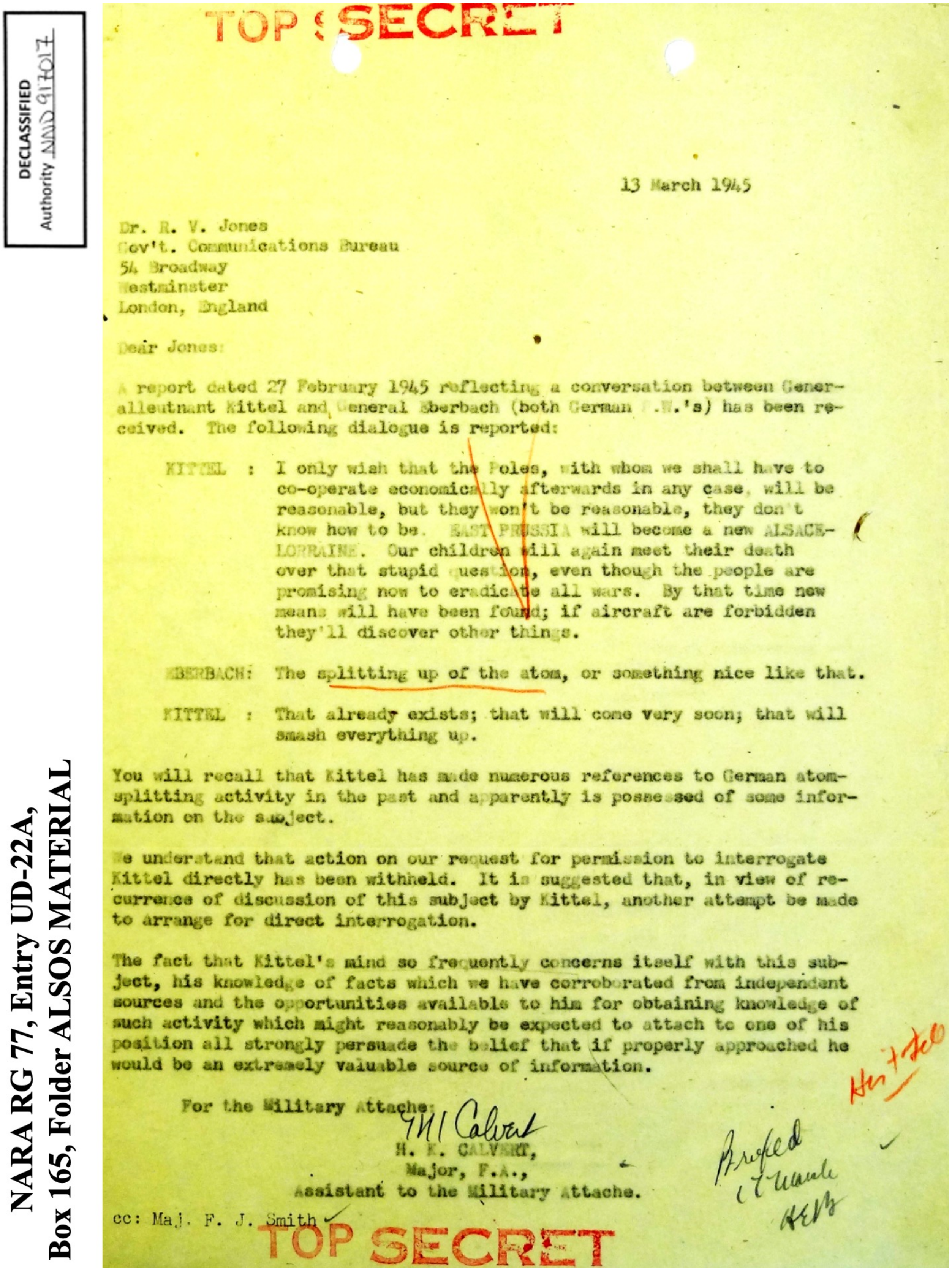
You will recall that Kittel has made numerous references to German atom-splitting activity in the past and apparently is possessed of some information on the subject.

We understand that action on our request for permission to interrogate Kittel directly has been withheld. It is suggested that, in view of recurrence of discussion of this subject by Kittel, another attempt be made to arrange for direct interrogation.

The fact that Kittel's mind so frequently concerns itself with this subject, his knowledge of facts which we have corroborated from independent sources and the opportunities available to him for obtaining knowledge of such activity which might reasonably be expected to attach to one of his position all strongly persuade the belief that if properly approached he would be an extremely valuable source of information.

[Did Heinrich Kittel ever provide details of what he knew about the German nuclear program to Allied interrogators, friends or family in Germany, a diary or memoirs, etc.? Can any relevant records be found?

Note that Horace Calvert emphasized Kittel's "knowledge of facts which we have corroborated from independent sources and the opportunities available to him for obtaining knowledge of such [nuclear] activity." Calvert was a very highly placed Allied official investigating German nuclear work, and as of mid-March 1945, he seemed convinced that there was a serious German nuclear weapons program and that Kittel had accurate information about it.]



DECLASSIFIED
Authority NND 917017

TOP SECRET

13 March 1945

Dr. R. V. Jones
Gov't. Communications Bureau
54 Broadway
Westminster
London, England

Dear Jones:

A report dated 27 February 1945 reflecting a conversation between Generalleutnant Kittel and General Eberbach (both German P.W.'s) has been received. The following dialogue is reported:

KITTEL : I only wish that the Poles, with whom we shall have to co-operate economically afterwards in any case, will be reasonable, but they won't be reasonable, they don't know how to be. EAST PRUSSIA will become a new ALSACE-LORRAINE. Our children will again meet their death over that stupid question, even though the people are promising now to eradicate all wars. By that time new means will have been found; if aircraft are forbidden they'll discover other things.

EBERBACH: The splitting up of the atom, or something nice like that.

KITTEL : That already exists; that will come very soon; that will smash everything up.

You will recall that Kittel has made numerous references to German atom-splitting activity in the past and apparently is possessed of some information on the subject.

We understand that action on our request for permission to interrogate Kittel directly has been withheld. It is suggested that, in view of recurrence of discussion of this subject by Kittel, another attempt be made to arrange for direct interrogation.

The fact that Kittel's mind so frequently concerns itself with this subject, his knowledge of facts which we have corroborated from independent sources and the opportunities available to him for obtaining knowledge of such activity which might reasonably be expected to attach to one of his position all strongly persuade the belief that if properly approached he would be an extremely valuable source of information.

For the Military Attache:

HK Calvert
H. K. CALVERT,
Major, F.A.,
Assistant to the Military Attache.

cc: Maj. F. J. Smith

TOP SECRET

NARA RG 77, Entry UD-22A,
Box 165, Folder ALSOS MATERIAL

Figure D.331: Horace K. Calvert to R. V. Jones. 13 March 1945 [NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL].

S. H. Kirkland, Jr. 31 March 1948. Memorandum for Chief, Air Intelligence Division. Subject: Daily Activity Report. [AFHRA folder 122.25 Jan–May 1948; AFHRA A1036 electronic pp. 2211–2212, frames 2238–2239]

[...]

Confirmation of Possibility of Uranium Deposits on Bornholm Island.

Uranium has been discovered on Danish owned island evacuated by the Russians two years ago. The deposit is said to be huge, with estimates running up to 500,000 tons. A Copenhagen dispatch to Svenska Dagbladet of Stockholm reports that the ore is contained in a granite outcropping running about 60 miles into the earth; the exploitable upper part alone, however, should yield 5,000 tons of uranium.

SOURCE: New York, 13 March 1948, NANA. Evaluation: B-2. CLASSIFICATION: (SECRET)

Strategic Vulnerability Branch Comment: The Strategic Vulnerability Branch has been able to uncover evidence* supporting the existence of radioactivity on the Danish island of Bornholm. The island is completely radioactive. Not only the land mass, but the surrounding sea water, atmosphere and local flora and fauna show radioactivity. The local inhabitants are large in stature, healthy and robust. Their virility extends over a period much longer than normal. There have been many cases of men 80 to 90 years old retaining their vigor.

This extraordinary radioactivity makes it highly probable that uranium exists on the island, possibly in large quantities. It has been reported that the island is rich in radium and thorium. This would indicate that a uranium deposit of 5,000 tons may actually exist on the island. Bornholm was evacuated by the Russians in 1946. It is situated within an area of Soviet pressure.

Reference: Item of Interest of 16 March 1948. *Source: Biology of Radium and Uranium published by Czech Radiological Institute, Prague 1932. (Mr. Rosenzweig, Ext. 71911).

[Just exactly what nuclear work was conducted on Bornholm by the Germans during the war, and what was removed by the Russians after the war?

Although the idea (apparently from the 1932 source) that natural radioactivity can promote health is now laughably outdated, the above document confirms that scientists knew there was significant radioactivity on Bornholm both before and after World War II. If Bornholm's radioactivity was known by scientists in Prague in 1932, that information might be one factor that attracted German interest in the island during the war. If there were uranium or thorium deposits, Germany may have mined them during the war.

If Bornholm was known to have elevated levels of radioactivity after the war, were those due to the mining of natural deposits, wartime work on enriching uranium or breeding plutonium on the island, or wartime tests of nuclear explosives on or near the island?]

SECRET

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON

31 March 1948

MEMORANDUM FOR CHIEF, AIR INTELLIGENCE DIVISION

SUBJECT: Daily Activity Report

1. Major S.S. Whitt briefed Major Paul B. Miller, Air Attache Branch, on information desired from air attaches, as Major Miller is to visit all air attache stations overseas. (Major Whitt, Ext. 71133).

2. Captain E.C. Currey, Jr., conferred with Lt. Col. Houston, Captain Hale, and Captain Coe, CM Branch, regarding special intelligence requirements of the Strategic Vulnerability Branch. (Captain Currey, Ext. 71133).

3. Lt. (j.g.) C.D. Chandler (WAVE) is assisting in Phase I work on Category 67 preparatory to the loan of target jackets in that category for use by Project "Salt Mine" under the direction of the Intelligence Division, General Staff, United States Army. (CONFIDENTIAL) (Lt. Cdr. R.E. Miles, Ext. 2323).

4. Lt. Cdr. R.E. Miles and Dr. J.C. Pettee attended a committee meeting on the CIA-IAC Ad Hoc Committee on the Industrial Card File, at the Central Intelligence Agency. (CONFIDENTIAL) (Lt. Cdr. Miles, Ext. 2323).

5. Lt. Col. Kirkland attended a conference with General Cabell, Colonel Price, Lt. Col. Heston, Air Installations, Colonel Yancey, 311th Reconnaissance Wing, Colonel Newell, Budget and Fiscal, Lt. Col. Cochrane, Aeronautical Chart Service, to discuss effects of proposed move of the Aeronautical Chart Plant in St. Louis. (Lt. Col. Kirkland, Ext. 4510).

6. Item of Interest:

Confirmation of Possibility of Uranium Deposits on Bornholm Island.

Uranium has been discovered on Danish owned island evacuated by the Russians two years ago. The deposit is said to be huge, with estimates running up to 500,000 tons. A Copenhagen dispatch to Svenska Dagbladet of Stockholm reports that the ore is contained in a granite outcropping running about 60 miles into the earth; the exploitable upper part alone, however, should yield 5,000 tons of uranium.

SECRET

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Reference: Item of Interest of 16 March 1948. *Source: Biology of Radium and Uranium published by Czech Radiological Institute, Prague 1932. (Mr. Rosenzweig, Ext. 71911).

I talked this item over with Dr. Possony when DA reported it about 4 weeks ago. Possony didn't think much of it. SSM

W.W. Foster

S.H. KIRKLAND, Jr.
Lt. Colonel, USAF
Acting Chief, Strategic Vulnerability Branch
Air Intelligence Division
(DI/USAF - ONI)

Figure D.332: S. H. Kirkland, Jr. 31 March 1948. Memorandum for Chief, Air Intelligence Division. Subject: Daily Activity Report. [AFHRA folder 122.25 Jan–May 1948; AFHRA A1036 electronic pp. 2211–2212, frames 2238–2239]

D.5 Fission Reactors for Breeding Pu-239 and/or U-233

[Ludwig Bewilogua (German, 1906–1983), Kurt Diebner, Paul Harteck, Otto Haxel (German, 1909–1998), and many others worked in teams trying to develop fission reactors suitable for breeding plutonium-239 from natural uranium-238 or uranium-233 from natural thorium-232. Two reactors were on the brink of criticality by the end of the war, and there is some evidence that other reactors may have actually become operational during the war. This section covers:

D.5.1. Scientific knowledge about breeding Pu-239 and U-233.

D.5.2. Known and suspected fission reactors.

For breeding using particle accelerators (electronuclear breeding), see Section D.6.]

D.5.1 Scientific Knowledge About Breeding Pu-239 and U-233

[The following documents demonstrate the knowledge of scientists in Germany:

- By 1934, scientists knew that element 94, or plutonium-239, could be produced and purified (pp. 3794–3795).
- No later than 1940, scientists understood that plutonium-239 could be used to create a bomb (pp. 3800–3826).
- During the war, scientists also understood that uranium-233 could be produced and used to create a bomb (pp. 3832–3836).]

Ida Tacke Noddack. 1934. Über das Element 93. *Angewandte Chemie.* 47:37:653–655.

Man kann ebensogut annehmen, daß bei dieser neuartigen Kernzertrümmerung durch Neutronen erheblich andere "Kernreaktionen" stattfinden, als man sie bisher bei der Einwirkung von Protonen- und α-Strahlen auf Atomkerne beobachtet hat. Bei den letztgenannten Bestrahlungen findet man nur Kernumwandlungen unter Abgabe von Elektronen, Protonen und Heliumkernen, wodurch sich bei schweren Elementen die Masse der bestrahlten Atomkerne nur wenig ändert, da nahe benachbarte Elemente entstehen. Es wäre denkbar, daß bei der Beschießung schwerer Kerne mit Neutronen diese Kerne in mehrere größere Bruchstücke zerfallen, die zwar Isotope bekannter Elemente, aber nicht Nachbarn der bestrahlten Elemente sind.

One could assume equally well that when neutrons are used to produce nuclear disintegrations, some distinctly new nuclear reactions take place which have not been observed previously with proton or alpha-particle bombardment of atomic nuclei. In the past one has found that transmutations of nuclei only take place with the emission of electrons, protons, or helium nuclei, so that the heavy elements change their mass only a small amount to produce near neighboring elements. When heavy nuclei are bombarded by neutrons, it is conceivable that the nucleus breaks up into several large fragments, which would of course be isotopes of known elements but would not be neighbors of the irradiated element.

[...*A*]us dem β-strahlenden Element 93 das Element 94 entstehen müßte. Dieses Element sollte man verhältnismäßig leicht chemisch von 93 trennen können.

[...B]eta decay of element 93 would produce element 94. It should be relatively easy to separate this chemically from element 93.

***Angewandte Chemie* 47:37:653-655 (1934)**

Über das Element 93.

Von Dr.-Ing. IDA NODDACK, Berlin.

(Eingeg. 10. September 1934.)

Vor etwa vier Monaten wurde in dieser Zeitschrift über die Lücken des Periodischen Systems berichtet[1]). Am Schluß der Arbeit wurde auf die Möglichkeit der Entdeckung von Transuranen (d. h. Elementen, die im System auf das Uran folgen) eingegangen.

Wenige Wochen später erschienen zuerst in der Tagespresse, dann auch in der Fachliteratur Nachrichten, daß es zwei Forschern, Prof. *Fermi* in Rom und Ingenieur *Koblic* in Joachimsthal, unabhängig voneinander gelungen sei, das Element mit der Ordnungszahl 93 zu entdecken.

Wir wollen uns zunächst mit den Angaben von F e r m i[2]) beschäftigen. *Fermi* hat die Frage untersucht, ob man die von *Curie* und *Joliot* entdeckte sogenannte induzierte Radioaktivität, die beim Beschießen von Atomkernen mit α-Strahlen entsteht, auch durch die Einwirkung von Neutronen hervorrufen kann.

Er brachte in ein Glasgefäß Berylliumpulver und Radiumemanation. Die Emanation emittiert α-Strahlen, diese treffen auf die Atomkerne des Berylliums und lösen in ihnen Neutronen aus. Die Neutronen durchdringen die Wände des Glasgefäßes und können auf in der Nähe befindliche Stoffe einwirken. *Fermi* brachte eine Reihe von Elementen in elementarer Form oder als Verbindungen in die Nähe seiner Strahlenquelle, ließ die Neutronen einwirken und setzte dann die bestrahlten Stoffe vor einen Geiger-Zähler. Zahlreiche Elemente sandten nach Bestrahlung mit Neutronen eine Zeitlang β-Strahlen aus, wiesen also in der Tat induzierte Radioaktivität auf[3]). Auf die Hypothesen, die *Fermi* zur Erklärung der zum Teil recht verwickelten Erscheinungen aufstellt[4]), soll hier nicht eingegangen werden, da uns nur ein Fall, die angebliche Entstehung des Elements 93, interessiert. Zum Studium der induzierten Radioaktivität des Urans brachte *Fermi* Uranylnitratlösung, die er von allen radioaktiven Zerfallsprodukten befreit hatte, in die Nähe seiner Neutronenquelle. Mit Hilfe des Geiger-Zählers konnte er zeigen, daß die Lösung durch die Bestrahlung radioaktiv geworden war und β-Strahlen aus-

[1]) *I. Noddack*, diese Ztschr. **47**, 301 [1934].
[2]) *E. Fermi*, Nature **133**, 898 [1934].
[3]) Natürlich wird nicht die Gesamtzahl der Atome des bestrahlten Stoffes radioaktiv, sondern nur eine unwägbare Menge, in diesem Fall einige hundert Atome.
[4]) *E. Fermi*, Nature **133**, 757 [1934].

sandte. Die Auswertung der Abklingungskurve ergab, daß nicht nur ein, sondern mindestens fünf radioaktive Elemente von verschiedenen Halbwertszeiten entstanden waren, wobei es bisher, wie *Fermi* betont, noch unsicher ist, ob diese Elemente nacheinander oder nebeneinander entstehen.

Es gelang nun *Fermi*, eins dieser neu entstandenen R a d i o e l e m e n t e, und zwar eins mit der H a l b w e r t s z e i t 13 m i n, auf chemischem Wege abzutrennen. Er verfuhr dabei so, daß er die bestrahlte stark salpetersaure Uranylnitratlösung mit etwas Manganosalz versetzte, zum Kochen erhitzte, und dann Natriumchlorat zugab. In dem ausgeschiedenen Mangandioxyd war der größte Teil der β-Aktivität mit der Halbwertszeit von 13 min enthalten. *Fermi* versucht nun zu beweisen, daß das Radioelement, dem diese β-Aktivität zukommt, mit keinem bekannten Element in der Nähe des Urans isotop ist. Er setzt zu diesem Zweck zu der salpetersauren Lösung von bestrahltem Uranylnitrat nacheinander β-strahlende Isotope folgender Elemente: Protactinium (91), Thor (90), Actinium (89), Radium (88), Wismut (83) und Blei (82) und fällt dann Mangandioxyd mit Natriumchlorat. Alle die genannten β-strahlenden Elemente gehen nach *Fermi* nicht in den Niederschlag. Da das unbekannte Radioelement aber in die Manganfällung geht, und da es seinem Verhalten nach auch nicht mit Radon (86) und Ekacäsium (87) isotop sein kann, zieht *Fermi* den Schluß, daß es das unbekannte Element 93 (vielleicht auch 94 oder 95) sein könnte.

Diese Beweisführung ist nicht stichhaltig. Die Tatsache, daß *Fermi* nicht nur den bekannten unmittelbaren Nachbarn des Urans, das Protactinium, mit seinem neu entstandenen β-Strahler vergleicht, sondern mehrere Elemente bis herab zum Blei, beweist, daß er eine Reihe aufeinander folgender Abbauprozesse (unter Abgabe von Elektronen, Protonen und Heliumkernen) für möglich hält, die schließlich zur Bildung des Radioelements mit der Halbwertszeit 13 min führen. — Wenn er aber das tut, ist nicht einzusehen, warum er zwischen Uran (92) und Blei (82) das Element Polonium (84) nicht berücksichtigt, und warum er gerade beim Blei Halt macht; denn die alte Anschauung, daß die ununterbrochene Reihe radioaktiver Elemente beim Blei oder vielmehr beim Thallium (81) aufhört, ist ja gerade durch die anfangs erwähnten Versuche von *Curie* und *Joliot* aufgehoben. *Fermi* hätte also sein neues Radioelement mit a l l e n bekannten Elementen vergleichen müssen.

Wie man aus der analytischen Chemie weiß, gehen zahlreiche Elemente, wenn sie in salpetersaurer Lösung als Verbindungen, atomar oder kolloidal, vorliegen, beim Fällen eines Mangandioxydniederschlages aus der Lösung in diesen hinein.

Um das Verhalten der Elemente bei der von *Fermi* verwandten F ä l l u n g s m e t h o d e zu prüfen, haben wir 100 cm^3 einer 55%ig salpetersauren Lösung hergestellt, die fast sämtliche stabilen Elemente in Mengen von je einigen Milligramm in gelöster oder kolloider Form enthielt. Diese Lösung wurde mit 200 mg Manganonitrat versetzt und zum Kochen erhitzt, dann wurden 2 g Kaliumchlorat (trocken) langsam zugegeben. Der dabei ausgefallene Mangandioxydniederschlag wurde chemisch und spektroskopisch auf die mit dem Mangan ausgefallenen Elemente geprüft. Er enthielt folgende Elemente: Ti, Nb, Ta, W, Ir, Pt, Au und Si nahezu quantitativ, Sb, Pb, Bi, Ni und Co teilweise.

Fermi hat — wie schon erwähnt — auch nicht geprüft, ob Polonium (84) in die Manganfällung geht. Ein mit Polonium ausgeführter Versuch zeigte, daß dieses Element nahezu quantitativ in den MnO_2-Niederschlag eingeht[5]). Der Beweis, daß das neue Radioelement die Ordnungszahl 93 hat, ist also noch keineswegs geglückt, da *Fermi* ihn nur durch ein unvollkommen durchgeführtes Ausschlußverfahren versucht hat.

Man kann ebensogut annehmen, daß bei dieser neuartigen Kernzertrümmerung durch Neutronen erheblich andere „Kernreaktionen" stattfinden, als man sie bisher bei der Einwirkung von Protonen- und α-Strahlen auf Atomkerne beobachtet hat. Bei den letztgenannten Bestrahlungen findet man nur Kernumwandlungen unter Abgabe von Elektronen, Protonen und Heliumkernen, wodurch sich bei schweren Elementen die Masse der bestrahlten Atomkerne nur wenig ändert, da nahe benachbarte Elemente entstehen. Es wäre denkbar, daß bei der Beschießung schwerer Kerne mit Neutronen diese Kerne in mehrere g r ö ß e r e Bruchstücke zerfallen, die zwar Isotope bekannter Elemente, aber nicht Nachbarn der bestrahlten Elemente sind.

Auch der Befund, daß das neue Radioelement in saurer Lösung bei Fällung von Rheniumsulfid in diesen Niederschlag geht, spricht nicht für 93; denn erstens absorbiert das Rheniumsulfid gern andere Stoffe, und zweitens läßt die Voraussage der vermutlichen Eigenschaften von 93 es noch keineswegs sicher erscheinen, daß dieses Element ein säurebeständiges Sulfid bilden würde.

Weiterhin würde sich aus den Versuchen von *Fermi*, wenn seine Deutung richtig wäre, die von ihm nicht erwähnte Folgerung ergeben, daß aus dem β-strahlenden Element 93 das Element 94 entstehen müßte. Dieses Element sollte man verhältnismäßig leicht chemisch von 93 trennen können.

Man muß noch weitere Untersuchungen abwarten, ehe man behaupten darf, daß hier das Element 93 wirklich gefunden ist. *Fermi* selbst ist in dieser Hinsicht, wie bereits erwähnt wurde, vorsichtig, nur in einem Referat[6]) über seine Versuche und in den Berichten der Tagespresse glaubt man schon des Resultates sicher zu sein.

Die **zweite Angabe** über die Auffindung des Elements 93 stammt von Odolen K o b l i c[7]). Er teilte mit, daß er aus dem Waschwasser der gerösteten Pechblende von Joachimsthal reine Salze des Elements 93 in erheblicher Menge (die Pechblende sollte etwa 1% dieses Elements enthalten) gewonnen hätte. Er beschrieb Eigenschaften des Elements und seiner Verbindungen, bestimmte sein Atomgewicht und nahm an, daß es die Muttersubstanz des Protactiniums sei, er gab ihm nach seinem Vaterlande den Namen „Bohemium". Auch diese Nachricht fand eine außerordentlich große und kritiklose Verbreitung in den Tageszeitungen der ganzen Welt.

Durch Vermittlung von Herrn Dr. *M. Speter* übersandte mir Herr *Koblic* zwei Proben seines Präparates mit dem Wunsche, diese auf die Gegenwart des Elements 93 zu untersuchen.

Die chemische und die röntgenspektroskopische Untersuchung zeigten, daß die Präparate kein 93 enthielten, sondern M i s c h s a l z e v o n S i l b e r - u n d T h a l l i u m v a n a d a t u n d - w o l f r a m a t mit überschüssiger Wolframsäure waren. *Koblic* hat sich nach Mitteilung dieses Befundes von der Gegenwart des Wolframs überzeugt und seine Behauptung von der Auffindung des Elements 93 zurückgenommen[8]).

[5]) Für die Überlassung des Poloniumpräparates und für die Aktivitätsmessungen bei diesem Versuch bin ich Herrn Dr. *J. Fränz* zu Dank verpflichtet. [6]) Nature **133**, 863 [1934].
[7]) *O. Koblic*, Chemiker-Ztg. **58**, 581 [1934].
[8]) *O. Koblic*, ebenda **58**, 683 [1934]. Österr. Chemiker-Ztg. **37**, 140 [1934].

Es erübrigt sich daher, hier die Reaktionen zu erläutern, die *Koblic* dem vermeintlichen neuen Element zugeschrieben hatte und die sich alle als Reaktionen eines Gemisches von Vanadin und Wolfram erklären lassen[9]).

Vor kurzem (11. August) kam aus Amerika die Nachricht, daß es *Smith* und *Steinbach* in New Jersey gelungen sei, ein Element von höherem Atomgewicht als Uran aufzufinden. Da über diesen Befund bisher nur unklare Zeitungsmeldungen vorliegen, kann man noch nicht sagen, um was es sich handelt. [A. 107.]

[9]) Herr *Koblic* hat in seinem Widerruf nur das Wolfram, nicht auch das Vanadin erwähnt, obschon ihm brieflich der ungefähre Gehalt seiner Präparate an diesen beiden Elementen mitgeteilt und die vermeintlichen Bohemium-Reaktionen durch ein Gemisch von Vanadin und Wolfram erklärt worden waren.

Figure D.333: Ida Tacke Noddack. 1934. Über das Element 93. *Angewandte Chemie.* 47:37:653–655.

RK. 4239 / 27 MAI 1935

Physikalisches Institut für radioaktive Substanzen

Bad Godesberg, den 20. Mai 1935.
Auguste Viktoriastraße 7.

An den Führer und Reichskanzler Herrn Adolf Hitler

Berlin. 169

Betrifft: Transuran Radium A bis C.

Mein Chemiker A.Blau in Bad Godesberg hatte während seinem Studium auf der Technichen Hochschule in Hannover im Jahre 1903 an den Versuchen mit Radium teilgenommen, welches das Ehepaar Curie in Frankreich im Jahre 1898 durch Zufall entdeckt hatte. Der hohe Wert von Radium für die Jndustrie und bei der Krebsbehandlung usw. ist schon lange von prominenten Vertretern der Wissenschaft aller Länder anerkannt. Leider gibt es von diesem kostbaren Element auf der ganzen Welt nur etwa 500 Gramm, und 1 Gramm kostet heute noch 240 000 Mark. Da die ganze Welt Radium braucht, sind eifrige Forscher der ganzen Welt bemüht, dem Mangel an Radium durch die Erfindung von Künstlichem Radium zu begegnen, was bis zur Stunde noch keinem gelungen ist.

Unter den Männern, die sich um die Herstellung von künstlichem Radium bemühten, befand sich auch der oben erwähnte Chemiker A.Blau. Nach zehnjährigen und überaus schwierigen Versuchen gelang es ihm als einzigster Forscher künstliches Radium in jeder gewünschten Menge und Stärke herzustellen. Seine Erfindung erläuterte Blau in einem Schreiben an den ehemaligen deutschen Kronprinzen Wilhelm, der ihn mit einem Empfehlungsschreiben an Herrn Adolf Hitler verwies.

Am 7.12.31. ging ein entsprechendes Schreiben an Herrn Adolf Hitler, Braunes Haus in München, welches die Nr. B.J.1/203 a trug, dem eine Beschreibung der Erfindung beigegeben war. Da keine Antwort erfolgte, benutzte der Chemiker A.Blau den Besuch des Herrn Adolf Hitler am 27.1.32. im Hotel Dreesen zu Bad Godesberg zu einer Unterredung, die ihm auch gewährt wurde. Bei der Aussprache, an der sich auch Herr Oberleutnant Brückner beteiligte, überreichte Blau das kronprinzliche Empfehlungsschreiben, und Herr Adolf Hitler und Herr Oberleutnant Brückner versprachen dem Erfinder auf die Sache zurückzukommen. Bei einer Flasche Rheinwein machte der Erfinder eingehende Ausführungen über sein künstliches Radium, und Herr Oberleutnant Brückner nahm das kronprinzliche Empfehlungsschreiben sowie die schriftliche Begründung der Erfindung an sich. Der Erfinder schrieb am 4.2.32. unter Nr. B.J.1/203 a nachstehenden Brief:

An den Völkischen Beobachter
z.H. des Herrn Adolf Hitler
München.

Sehr geehrter Herr Hitler!

Jch nehme nochmals Bezug auf mein Angebot vom 7.12.31. und meiner persönlichen Rücksprache mit Jhnen und Herrn Oberleutnant Brückner im Hotel Dreesen hier über mein obiges Angebot laut Prospekt und frage höflichst an, wann ich zur Vorführung resp. praktischen Ausführung meiner Erfindung über radioaktive Elektrolyse pp. nach dort kommen soll, und bitte mir umgehend Nachricht zukommen zu lassen.

Jch bemerke noch kurz, daß ich Jhnen den absoluten Beweis für meine Erfindung bei der Vorführung erbringe, was für Sie und Jhrer parteipolitischen Richtung von weittragender Bedeutung ist.

1. Anlage!

Hochachtungsvoll ergebenst!
gez. A.Blau.

Leider ist auf das alles bis zur Stunde noch nichts geschehen.

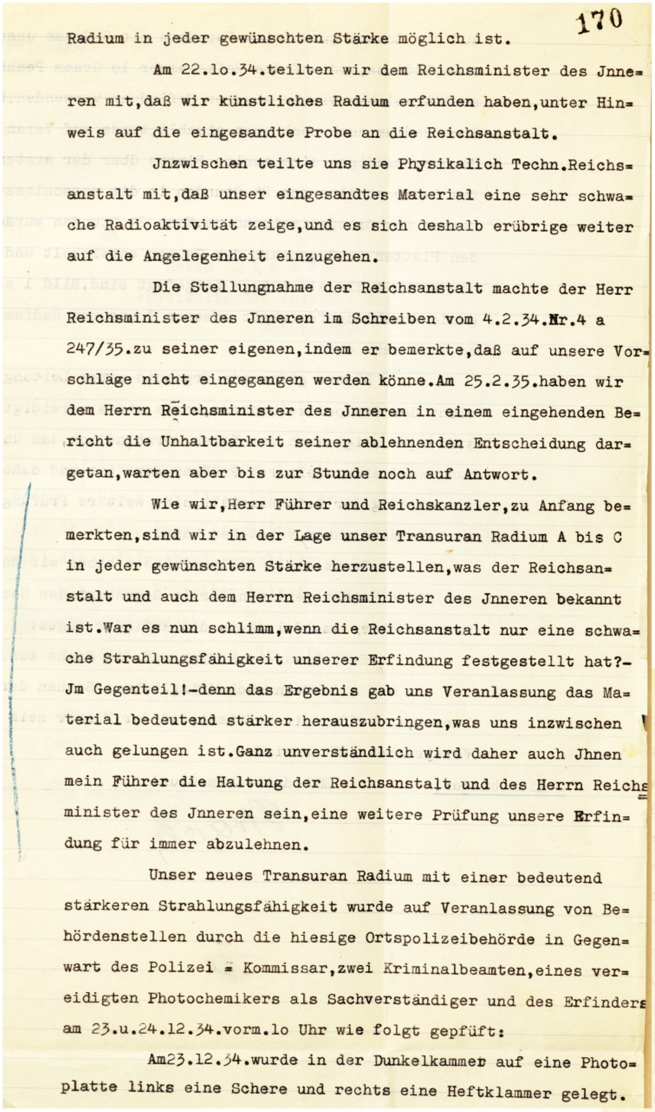
Jnzwischen hat der Chemiker A.Blau trotz dieser Enttäuschung an seiner Erfindung weiter gearbeitet, und mit dem Unterzeichneten ein Physikalisches Jnstitut für radioaktive Substanzen in Bad Godesberg gegründet. die Strahlungsfähigkeit unseres Transuran Radiums haben wir mehrmals durch Lichtbilder bewiesen, und somit den Beweis für unsere Behauptungen erbracht.

Umden Radiumgehalt unseres Transuran Radiums genau festzustellen, sind sehr teuere Apparate erforderlich, zu deren Anschaffung uns die Mittel fehlen. UM nun für weitere Arbeiten eine Grundlage zu haben, oder besser gesagt, um Klarheit darüber zu bekommen, wie stark der Radiumgehalt unseres Transuran Radiums ist, schickten wir am 6.10.34. ein Gramm von unserer Erfindung an die Physikalich Technische Reichsanstalt Berlin - Charlottenburg und baten um Prüfung nach seinem Radiumgehalt, wobei wir bemerkten, das uns die Herstellung von künstlichem

Bundesarchiv Berlin-Lichterfelde R 43-II/342

https://invenio.bundesarchiv.de/invenio/direktlink/9bd5f753-48a5-439d-aef7-6341624b1221/

Figure D.334: 20 May 1935 proposal to Adolf Hitler to artificially create radioactive elements beyond uranium for applications of national importance [Bundesarchive Berlin-Lichterfelde R 43-II/342 https://invenio.bundesarchiv.de/invenio/direktlink/9bd5f753-48a5-439d-aef7-6341624b1221/]. Although the scientific details and merits of this particular proposal are unclear, at the very least it demonstrates very early German interest in creating and harnessing transuranic elements.



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Radium in jeder gewünschten Stärke möglich ist.

Am 22.1o.34.teilten wir dem Reichsminister des Jnneren mit,daß wir künstliches Radium erfunden haben,unter Hinweis auf die eingesandte Probe an die Reichsanstalt.

Jnzwischen teilte uns sie Physikalich Techn.Reichsanstalt mit,daß unser eingesandtes Material eine sehr schwache Radioaktivität zeige,und es sich deshalb erübrige weiter auf die Angelegenheit einzugehen.

Die Stellungnahme der Reichsanstalt machte der Herr Reichsminister des Jnneren im Schreiben vom 4.2.34.Nr.4 a 247/35.zu seiner eigenen,indem er bemerkte,daß auf unsere Vorschläge nicht eingegangen werden könne.Am 25.2.35.haben wir dem Herrn Reichsminister des Jnneren in einem eingehenden Bericht die Unhaltbarkeit seiner ablehnenden Entscheidung dargetan,warten aber bis zur Stunde noch auf Antwort.

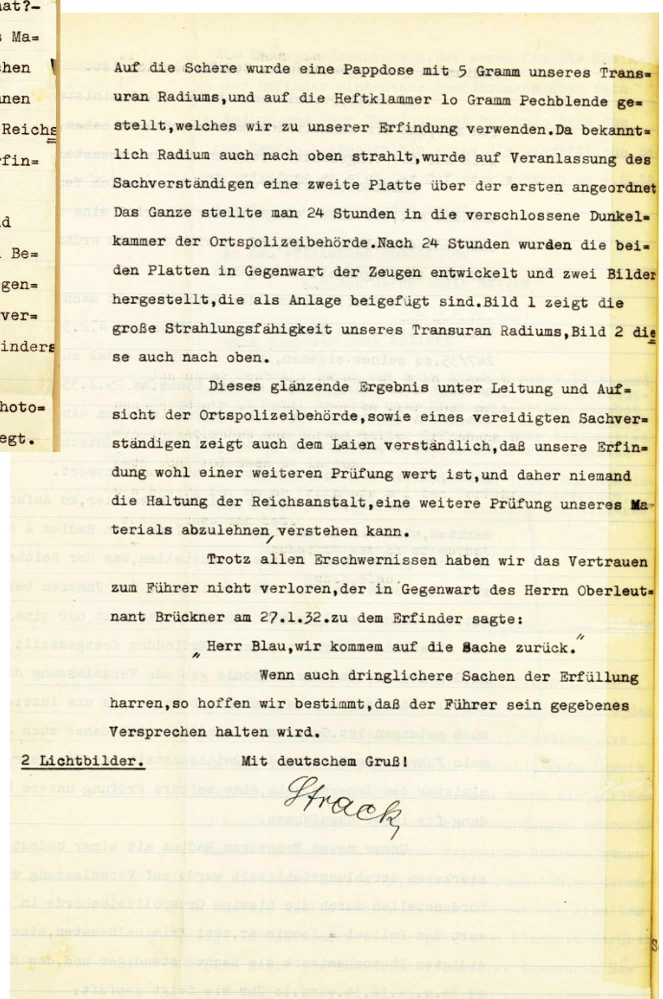
Wie wir,Herr Führer und Reichskanzler,zu Anfang bemerkten,sind wir in der Lage unser Transuran Radium A bis C in jeder gewünschten Stärke herzustellen,was der Reichsanstalt und auch dem Herrn Reichsminister des Jnneren bekannt ist.War es nun schlimm,wenn die Reichsanstalt nur eine schwache Strahlungsfähigkeit unserer Erfindung festgestellt hat?- Jm Gegenteil!-denn das Ergebnis gab uns Veranlassung das Material bedeutend stärker herauszubringen,was uns inzwischen auch gelungen ist.Ganz unverständlich wird daher auch Jhnen mein Führer die Haltung der Reichsanstalt und des Herrn Reichsminister des Jnneren sein,eine weitere Prüfung unsere Erfindung für immer abzulehnen.

Unser neues Transuran Radium mit einer bedeutend stärkeren Strahlungsfähigkeit wurde auf Veranlassung von Behördenstellen durch die hiesige Ortspolizeibehörde in Gegenwart des Polizei - Kommissar,zwei Kriminalbeamten,eines vereidigten Photochemikers als Sachverständiger und des Erfinders am 23.u.24.12.34.vorm.1o Uhr wie folgt gepfüft:

Am23.12.34.wurde in der Dunkelkammer auf eine Photoplatte links eine Schere und rechts eine Heftklammer gelegt.

Bundesarchiv Berlin-Lichterfelde R 43-II/342

https://invenio.bundesarchiv.de/invenio/direktlink/9bd5f753-48a5-439d-aef7-6341624b1221/



Auf die Schere wurde eine Pappdose mit 5 Gramm unseres Transuran Radiums,und auf die Heftklammer 1o Gramm Pechblende gestellt,welches wir zu unserer Erfindung verwenden.Da bekanntlich Radium auch nach oben strahlt,wurde auf Veranlassung des Sachverständigen eine zweite Platte über der ersten angeordnet Das Ganze stellte man 24 Stunden in die verschlossene Dunkelkammer der Ortspolizeibehörde.Nach 24 Stunden wurden die beiden Platten in Gegenwart der Zeugen entwickelt und zwei Bilder hergestellt,die als Anlage beigefügt sind.Bild 1 zeigt die große Strahlungsfähigkeit unseres Transuran Radiums,Bild 2 diese auch nach oben.

Dieses glänzende Ergebnis unter Leitung und Aufsicht der Ortspolizeibehörde,sowie eines vereidigten Sachverständigen zeigt auch dem Laien verständlich,daß unsere Erfindung wohl einer weiteren Prüfung wert ist,und daher niemand die Haltung der Reichsanstalt,eine weitere Prüfung unseres Materials abzulehnen,verstehen kann.

Trotz allen Erschwernissen haben wir das Vertrauen zum Führer nicht verloren,der in Gegenwart des Herrn Oberleutnant Brückner am 27.1.32.zu dem Erfinder sagte:

„Herr Blau,wir kommem auf die Sache zurück."

Wenn auch dringlichere Sachen der Erfüllung harren,so hoffen wir bestimmt,daß der Führer sein gegebenes Versprechen halten wird.

2 Lichtbilder. Mit deutschem Gruß!

Strack

Figure D.335: 20 May 1935 proposal to Adolf Hitler to artificially create radioactive elements beyond uranium for applications of national importance [Bundesarchive Berlin-Lichterfelde R 43-II/342 https://invenio.bundesarchiv.de/invenio/direktlink/9bd5f753-48a5-439d-aef7-6341624b1221/]. Although the scientific details and merits of this particular proposal are unclear, at the very least it demonstrates very early German interest in creating and harnessing transuranic elements.

G-55. Josef Schintlmeister and Friedrich Hernegger. Über ein bisher unbekanntes alphastrahlendes chemisches Element. June 1940.

Mit diesen Konzentraten wird gegenwärtig das chemische Verhalten des neuen Elementes weiter erforscht. Seine bisher festgestellten chemischen Eigenschaften ermöglichen übrigens bereits eine weitgehende Anreicherung, prinzipiell sogar schon die Reindarstellung. Sie können unserer Auffassung nach nur so gedeutet werden, dass ein Eka-Osmium (Ordnungszahl 94) oder allenfalls ein Eka-Rhenium (Ordnungszahl 93) vorliegt.

With these concentrates, the chemical behavior of the new element is currently being researched further. Incidentally, its chemical properties that have hitherto been determined already make it possible to enrich it extensively, and in principle, even to purify it. In our opinion, they can only be interpreted as having an eka-osmium (element 94) or at least an eka-rhenium (element 93) present.

G-55. Josef Schintlmeister and Friedrich Hernegger. June 1940.
Über ein bisher unbekanntes alphastrahlendes chemisches Element.

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Anlage zu Bb. Nr. 2518/41 WaF

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Über ein bisher unbekanntes,alphastrahlendes chemisches Element

G-55 (Ref. No. 141)

(Bericht über den Stand der Arbeiten im Juni 1940)

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Einleitung

Enthält ein Mineral winzige Einschlüsse radioaktiver Substanzen,so wird es durch die α-Strahlen verfärbt.Um die Einschlüsse bilden sich also Verfärbungshöfe aus.J.Joly fand nun im Jahre 1922 in Glimmer manchmal Höfe,deren Halbmesser auf eine Reichweite der erzeugenden α-Strahlen in Luft von etwa 1 cm und 2 cm schliessen lassen.α-Strahlen solcher Reichweite waren jedoch nicht bekannt.Die Strahlen dieser Reichweiten wurden späterhin von verschiedensten Forschern beobachtet.[1] Dabei wurden nicht blos aus Verfärbungshöfen in Glimmern,sondern zuerst von H. Ziegert 1928 auch durch Messung der von den einzelnen Strahlen erzeugten Ionisation die Reichweite bestimmt. Da diese verschiedenen Methoden dieselben Reichweiten ergaben,war damit zugleich bewiesen,dass α-Strahlen und nicht irgendwelche andere Strahlen vorliegen.Ziegert fand diese Strahlen in Zink wieder,konnte jedoch den Träger dieser Strahlung durch chemische Operationen von Zink abtrennen.Er schreibt am Schlusse

- 11 -

mit der Muttersubstanz RaD des Poloniums,dieses wird somit in bleihaltigen [redacted] Präparaten ständig nacherzeugt,ist sehr schwer zu entfernen und störte die bisherigen Messungen. Mit diesen Konzentraten wird gegenwärtig das chemische Verhalten des neuen Elementes weiter erforscht.Seine bisher festgestellten chemischen Eigenschaften ermöglichen übrigens bereits eine weitgehende Anreicherung,prinzipiell sogar schon die Reindarstellung.Sie können unserer Auffassung nach nur so gedeutet werden,dass ein Eka-Osmium (Ordnungszahl 94) oder allenfalls ein Eka-Rhenium (Ordnungszahl 93) vorliegt.

Wien im Juni 1940

Josef Schintlmeister
Friedrich Hernegger

II.Physikalisches Institut der Universität Wien,
Institut für Radiumforschung der Akademie der Wissenschaften in Wien.

Figure D.336: G-55. Josef Schintlmeister and Friedrich Hernegger. June 1940. Über ein bisher unbekanntes alphastrahlendes chemisches Element.

G-59. Carl Friedrich von Weizsäcker. The Possibility of Obtaining Energy from U^{238}. 17 July 1940.

[See document photos on pp. 3802–3807.]

[...] ^{238}U durch thermische Neutronen [...] Das erste Neutron erzeugt das Isotop ^{239}U, das nach Hahn in 23 Minuten zerfällt. Dabei muss ^{239}Eka-Re entstehen. Im folgenden wird die Wahrscheinlichkeit der Entstehung und der Spaltbarkeit dieses Kerne geprüft. [...]

Dieses Eka-Re kann dann in dreifacher Weise verwendet werden:

1. zum Bau sehr kleiner Maschinen

2. als Sprengstoff

3. durch Beimischung zur Umwandlung anderer Elemente in grossen Mengen.

[...] ^{238}U by thermal neutrons [...] The first neutron produces the isotope ^{239}U, which according to Hahn decays in 23 minutes. That must produce ^{239}Eka-Re [a new element]. In the following, the probability of the creation and the fissionability of these nuclei is examined. [...]

This Eka-Re can then be used in three ways:

1. to build very small reactors

2. as an explosive

3. by mixture for the conversion of other elements in large quantities.

Carl Friedrich von Weizsäcker. 11 June 1941. Energieerzeugung aus dem Uranisotop der Masse 238 und anderen schweren Elementen (Herstellung und Verwendung des Elements 94). [AMPG 7314, KWIP 7, Folder 4 Pu; see also Karlsch 2005, pp. 320–324]

[See document photos on pp. 3808–3813.]

Patentansprüche.

1. Verfahren zur Energieerzeugung aus ^{238}U, dadurch gekennzeichnet, daß ^{238}U mit zwei thermischen Neutronen beschossen wird, wodurch zunächst über β-Zerfälle ein Element 94 der Masse 239 entsteht, das durch das zweite Neutron eine Kernspaltung erfährt, bei der sowohl eine ungeheure Energie abgegeben wird, als auch neue Neutronen und Kerne entstehen.

2. Verfahren zur Energiegewinnung aus ^{238}U nach Anspruch 1, dadurch gekennzeichnet, daß die zur Umwandlung größerer Mengen des ^{238}U in Element 94 notwendigen Neutronen in einer "Uranmaschine" erzeugt werden.

Patent claims.

1. Method for the production of energy from ^{238}U, characterized in that ^{238}U is bombarded with two thermal neutrons, whereby after beta decays forms an element 94 with mass 239, which by the second neutron experiences a nuclear fission, in which both a tremendous energy is released, as well as new neutrons and nuclei arise.

2. The method for generating energy from ^{238}U according to claim 1, characterized in that the neutrons necessary to convert large quantities of the ^{238}U into element 94 are generated in a "uranium machine."

3. Verfahren zur Energieerzeugung aus ^{238}U bzw. Element 94 nach Anspruch 1, dadurch gekennzeichnet, daß das durch Neutronenanlagerung erzeugte Element 94 durch bekannte chemische Verfahren von dem verbleibenden Uran abgetrennt wird und dann in reiner bzw. geeignet wählbarer Konzentration verwendbar vorliegt.

3. The method for generating energy from the element U or element 94 according to claim 1, characterized in that the neutron-produced element 94 is separated from the remaining uranium by known chemical methods, and then is available in pure or suitably selected concentration.

4. Verfahren zur Energieerzeugung und Neutronenproduktion aus schwer spaltbaren schweren Kernen (z.B. ^{238}U, Thorium, Blei, Bismut etc.), dadurch gekennzeichnet, daß das nach Anspruch 3 erhaltene Element 94 diesen Elementen in geeigneter Menge zugesetzt wird, so daß sie einen autokatalytischen Spaltprozess durch Neutronen durchmachen können, bei dem Energie erzeugt wird und neue Atomkerne entstehen.

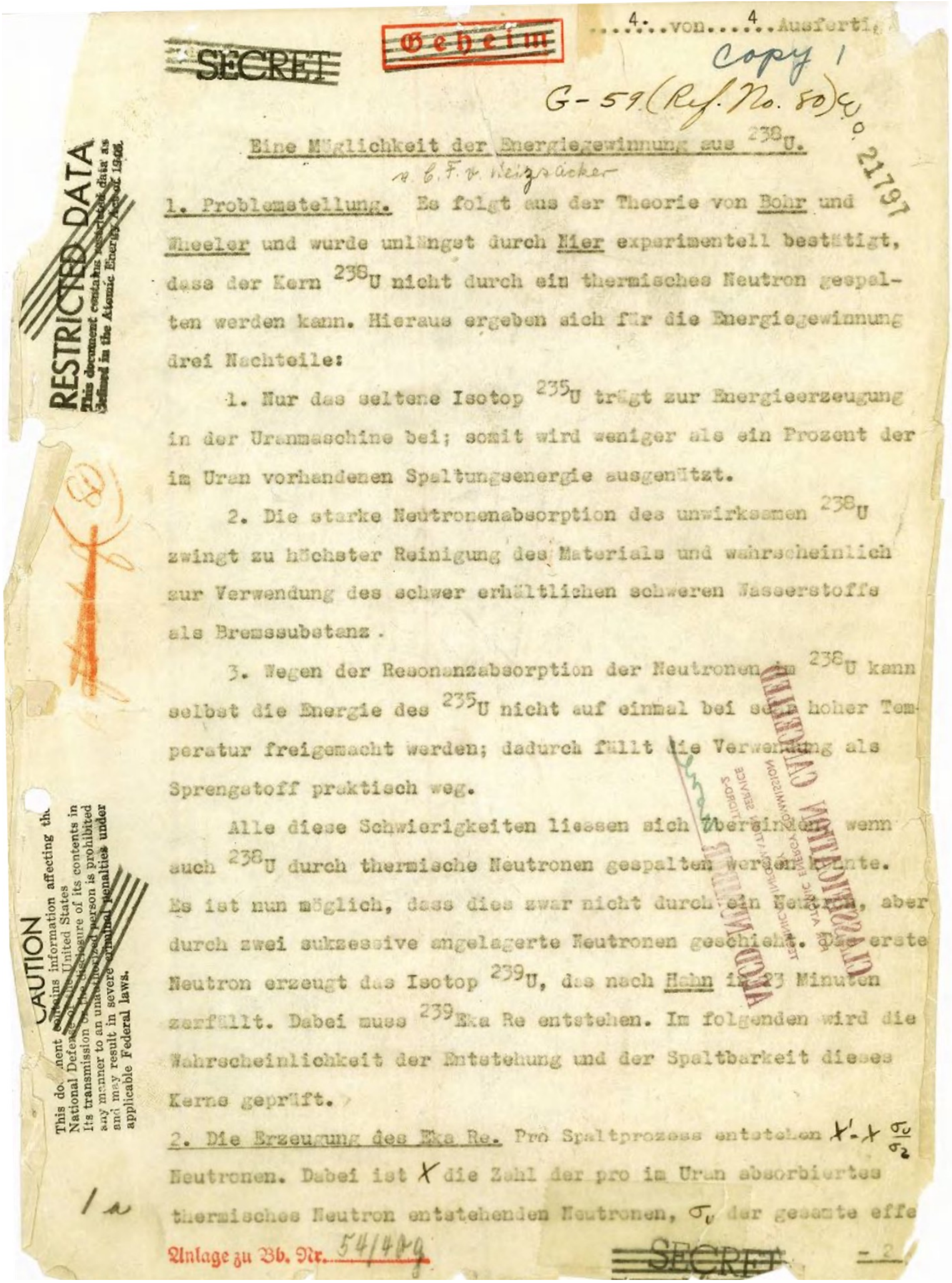
4. Method for the production of energy and neutron production from heavy fissionable nuclei (for example, ^{238}U, thorium, lead, bismuth, etc.), characterized in that the element 94 obtained according to claim 3 is added to these elements in a suitable amount, so that they can undergo an autocatalytic fission process by neutrons, in which energy is generated and new atomic nuclei are formed.

5. Verfahren zur explosiven Erzeugung von Energie und Neutronen aus der Spaltung des Elements 94, dadurch gekennzeichnet, daß das nach Anspruch 3 hergestellte Element 94 in solcher Menge an einen Ort gebracht wird, z.B. in eine Bombe, daß die bei einer Spaltung entstehenden Neutronen in der überwiegenden Mehrzahl zur Anregung neuer Spaltungen verbraucht werden und nicht die Substanz verlassen.

5. Method for the explosive generation of energy and neutrons from the fission of the element 94, characterized in that the element 94 produced according to claim 3 is brought to a location in such an amount, e.g. in a bomb, that the vast majority of the neutrons produced during each fission event are used to produce new fission events and do not leave the substance.

6. Verfahren zur Erzeugung sehr kleiner handlicher Maschinen zur Gewinnung von Kernenergie und von Neutronen, z.T. nach Anspruch 3 and 4 und unter Zugrundelegung der Kenntnisse über eine “Uranmaschine”, dadurch gekennzeichnet, daß man nur so viel Element 94 an einem Ort vereinigt, (u.U. nach Beimischung geeigneter, neutronenbremsender und/oder absorbierender Zusatzelemente) daß Explosionen vermieden werden, und die Energieabgabe kontinuierlich erfolgt.

6. Process for the production of very small, handy machines for obtaining nuclear energy and neutrons, in part according to claims 3 and 4, and on the basis of the knowledge of a “uranium machine,” characterized in that one brings together only so much element 94 in one place (depending on the admixture of suitable, neutron-slowing and/or absorbing additional elements) that explosions are avoided and the energy is discharged continuously.



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G-59 (Ref. No. 80)

Eine Möglichkeit der Energiegewinnung aus ^{238}U.

v. C. F. v. Weizsäcker

1. Problemstellung. Es folgt aus der Theorie von Bohr und Wheeler und wurde unlängst durch Nier experimentell bestätigt, dass der Kern ^{238}U nicht durch ein thermisches Neutron gespalten werden kann. Hieraus ergeben sich für die Energiegewinnung drei Nachteile:

1. Nur das seltene Isotop ^{235}U trägt zur Energieerzeugung in der Uranmaschine bei; somit wird weniger als ein Prozent der im Uran vorhandenen Spaltungsenergie ausgenützt.

2. Die starke Neutronenabsorption des unwirksamen ^{238}U zwingt zu höchster Reinigung des Materials und wahrscheinlich zur Verwendung des schwer erhältlichen schweren Wasserstoffs als Bremssubstanz.

3. Wegen der Resonanzabsorption der Neutronen im ^{238}U kann selbst die Energie des ^{235}U nicht auf einmal bei sehr hoher Temperatur freigemacht werden; dadurch fällt die Verwendung als Sprengstoff praktisch weg.

Alle diese Schwierigkeiten liessen sich überwinden, wenn auch ^{238}U durch thermische Neutronen gespalten werden könnte. Es ist nun möglich, dass dies zwar nicht durch ein Neutron, aber durch zwei sukzessive angelagerte Neutronen geschieht. Das erste Neutron erzeugt das Isotop ^{239}U, das nach Hahn in 23 Minuten zerfällt. Dabei muss ^{239}Eka Re entstehen. Im folgenden wird die Wahrscheinlichkeit der Entstehung und der Spaltbarkeit dieses Kerns geprüft.

2. Die Erzeugung des Eka Re. Pro Spaltprozess entstehen $\nu' - \nu \frac{\sigma_v}{\sigma_2}$ Neutronen. Dabei ist ν die Zahl der pro im Uran absorbiertes thermisches Neutron entstehenden Neutronen, σ_v der gesamte effe

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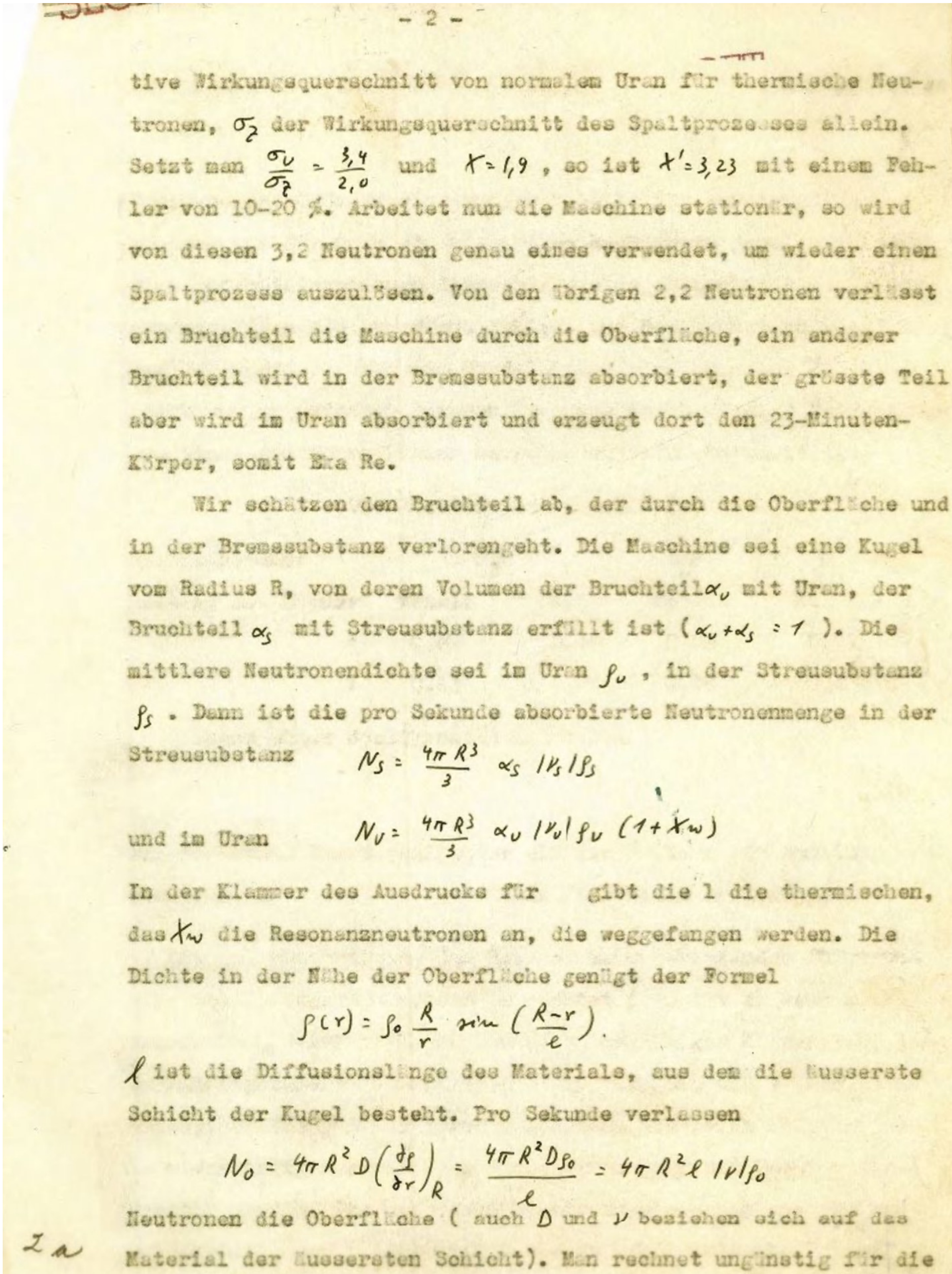
Figure D.337: Carl Friedrich von Weizsäcker's July 1940 report explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-59].



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tive Wirkungsquerschnitt von normalem Uran für thermische Neutronen, σ_z der Wirkungsquerschnitt des Spaltprozesses allein. Setzt man $\frac{\sigma_U}{\sigma_z} = \frac{3{,}4}{2{,}0}$ und $\chi = 1{,}9$, so ist $\chi' = 3{,}23$ mit einem Fehler von 10–20 %. Arbeitet nun die Maschine stationär, so wird von diesen 3,2 Neutronen genau eines verwendet, um wieder einen Spaltprozess auszulösen. Von den übrigen 2,2 Neutronen verlässt ein Bruchteil die Maschine durch die Oberfläche, ein anderer Bruchteil wird in der Bremssubstanz absorbiert, der grösste Teil aber wird im Uran absorbiert und erzeugt dort den 23-Minuten-Körper, somit Eka Re.

Wir schätzen den Bruchteil ab, der durch die Oberfläche und in der Bremssubstanz verlorengeht. Die Maschine sei eine Kugel vom Radius R, von deren Volumen der Bruchteil α_U mit Uran, der Bruchteil α_S mit Streusubstanz erfüllt ist ($\alpha_U + \alpha_S = 1$). Die mittlere Neutronendichte sei im Uran ρ_U, in der Streusubstanz ρ_S. Dann ist die pro Sekunde absorbierte Neutronenmenge in der Streusubstanz

$$N_S = \frac{4\pi R^3}{3} \alpha_S |\nu_S| \rho_S$$

und im Uran

$$N_U = \frac{4\pi R^3}{3} \alpha_U |\nu_U| \rho_U (1 + \chi_w)$$

In der Klammer des Ausdrucks für gibt die 1 die thermischen, das χ_w die Resonanzneutronen an, die weggefangen werden. Die Dichte in der Nähe der Oberfläche genügt der Formel

$$\rho(r) = \rho_0 \frac{R}{r} \sin\left(\frac{R-r}{\ell}\right).$$

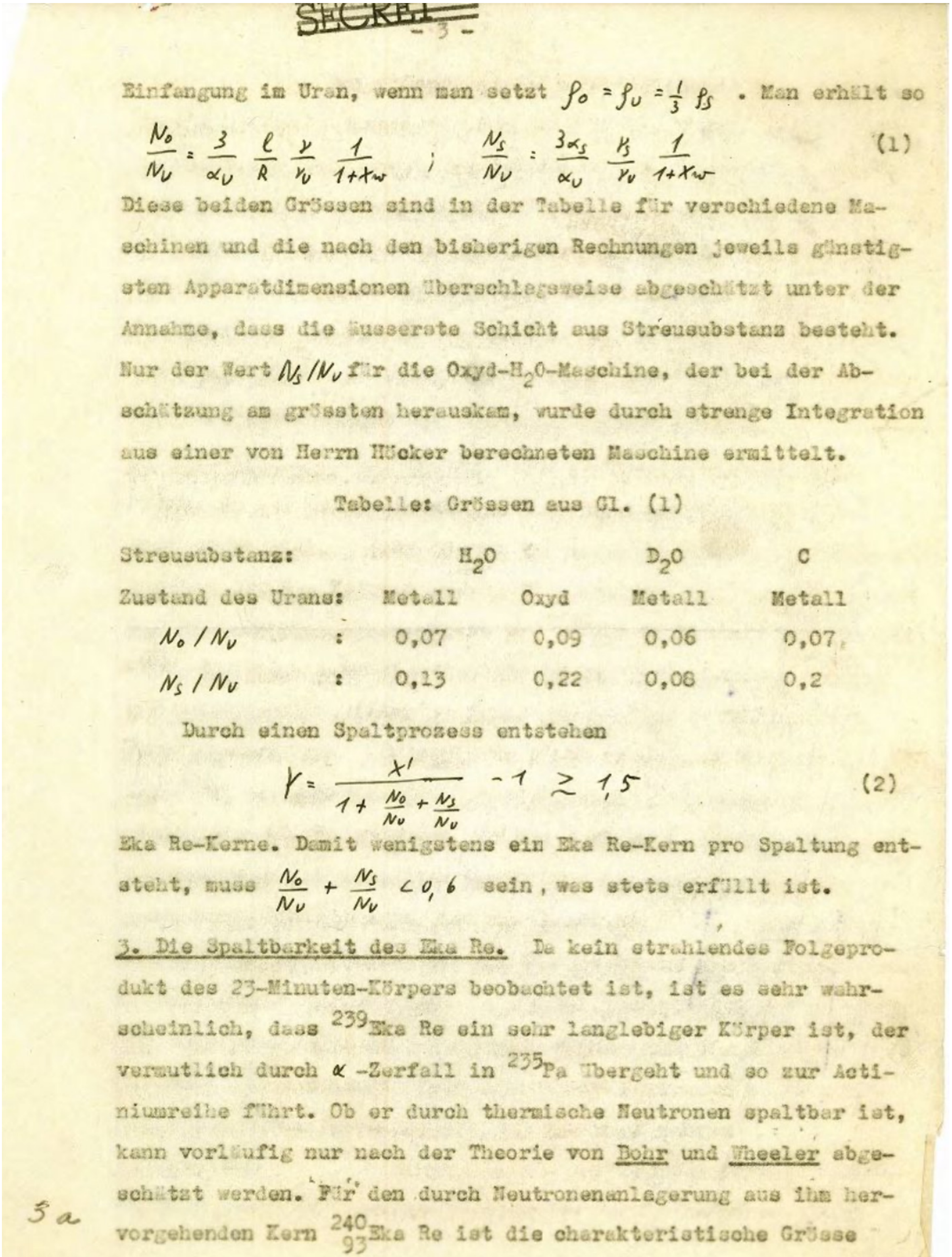
ℓ ist die Diffusionslänge des Materials, aus dem die äusserste Schicht der Kugel besteht. Pro Sekunde verlassen

$$N_0 = 4\pi R^2 D \left(\frac{\partial \rho}{\partial r}\right)_R = \frac{4\pi R^2 D \rho_0}{\ell} = 4\pi R^2 \ell |\nu| \rho_0$$

Neutronen die Oberfläche (auch D und ν beziehen sich auf das Material der äussersten Schicht). Man rechnet ungünstig für die

2a

Figure D.338: Carl Friedrich von Weizsäcker's July 1940 report explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-59].



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- 3 -

Einfangung im Uran, wenn man setzt $\rho_o = \rho_U = \frac{1}{3}\rho_s$. Man erhält so

$$\frac{N_o}{N_U} = \frac{3}{\alpha_U}\,\frac{\ell}{R}\,\frac{\nu}{\nu_U}\,\frac{1}{1+xw}\;;\qquad \frac{N_s}{N_U} = \frac{3\alpha_s}{\alpha_U}\,\frac{\nu_s}{\nu_U}\,\frac{1}{1+xw} \tag{1}$$

Diese beiden Grössen sind in der Tabelle für verschiedene Maschinen und die nach den bisherigen Rechnungen jeweils günstigsten Apparatdimensionen überschlagsweise abgeschätzt unter der Annahme, dass die äusserste Schicht aus Streusubstanz besteht. Nur der Wert N_s/N_U für die Oxyd-H_2O-Maschine, der bei der Abschätzung am grössten herauskam, wurde durch strenge Integration aus einer von Herrn Höcker berechneten Maschine ermittelt.

Tabelle: Grössen aus Gl. (1)

Streusubstanz:		H_2O		D_2O	C
Zustand des Urans:		Metall	Oxyd	Metall	Metall
N_o/N_U	:	0,07	0,09	0,06	0,07
N_s/N_U	:	0,13	0,22	0,08	0,2

Durch einen Spaltprozess entstehen

$$\gamma = \frac{x'}{1+\frac{N_o}{N_U}+\frac{N_s}{N_U}} - 1 \gtrsim 1{,}5 \tag{2}$$

Eka Re-Kerne. Damit wenigstens ein Eka Re-Kern pro Spaltung entsteht, muss $\frac{N_o}{N_U}+\frac{N_s}{N_U} < 0{,}6$ sein, was stets erfüllt ist.

3. Die Spaltbarkeit des Eka Re. Da kein strahlendes Folgeprodukt des 23-Minuten-Körpers beobachtet ist, ist es sehr wahrscheinlich, dass ^{239}Eka Re ein sehr langlebiger Körper ist, der vermutlich durch α-Zerfall in ^{235}Pa übergeht und so zur Actiniumreihe führt. Ob er durch thermische Neutronen spaltbar ist, kann vorläufig nur nach der Theorie von Bohr und Wheeler abgeschätzt werden. Für den durch Neutronenanlagerung aus ihm hervorgehenden Kern $^{240}_{93}$Eka Re ist die charakteristische Grösse

3 a

Figure D.339: Carl Friedrich von Weizsäcker's July 1940 report explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-59].

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$x = \frac{Z^2/A}{(Z^2/A)_{lim}} = 0{,}754$. Dem entspricht nach der Zeichnung l.c. S.433 eine Spaltungs-Schwellenenergie von etwa E_S = 4,8 MeV. Andererseits kann für die Anlagerung des Neutrons an den Kern von ursprünglich gerader Neutronenzahl eine Energieausbeute von E_B = 5,2 MeV geschätzt werden. Der Überschuss von E_B über E_S ist kleiner als für ^{235}U, doch macht die bisherige Bewährung der Theorie die Spaltbarkeit jedenfalls wahrscheinlich. Die empirische Prüfung der Frage wird wohl erst möglich sein, wenn durch die Maschine selbst wägbare Mengen der Substanz erzeugt werden.

4. Die Verwendung des Eka Re. Setzen wir nun voraus, das ^{239}Eka Re sei durch thermische Neutronen spaltbar, so ist es doch nicht sicher, dass die in der Maschine gebildeten Kerne ausreichen, um den Betrieb aufrechtzuerhalten; denn vermutlich ist der Spalt-Wirkungsquerschnitt des ^{239}Eka Re kleiner als der des ^{235}U. Man kann dann aber das Eka Re vom Uran chemisch trennen und nachträglich wieder in jedem gewünschten Verhältnis mit Uran mischen. Ist x' für Eka Re nicht wesentlich kleiner als für ^{235}U, so wird die mit dieser Mischung betriebene Maschine stets mehr Eka Re erzeugen als sie verbrennt. Die Eka Re-Menge, die nach der vollständigen Umwandlung des ursprünglich vorhandenen Urans übrigbleibt, ist der Bruchteil $\gamma/(1+\gamma)$ der anfänglichen Uranmenge. Wählt man den Eka Re-Gehalt des Gemisches hoch, so kann man N_S klein gegen N_U machen, unter Umständen sogar ganz auf eine Streusubstanz verzichten. Umgibt man die Maschine noch mit Uran, so werden die herauslaufenden Neutronen mit zur Erzeugung von Eka Re verwendet, und man darf nahezu $\gamma = x'_{Eka\,Re} - 1$ setzen. Wenn $x'_{Eka\,Re}$ ebenfalls von der Grössenordnung 3 ist, so wäre gegen 2/3 unserer Uranvorräte in Eka Re umwandelbar.

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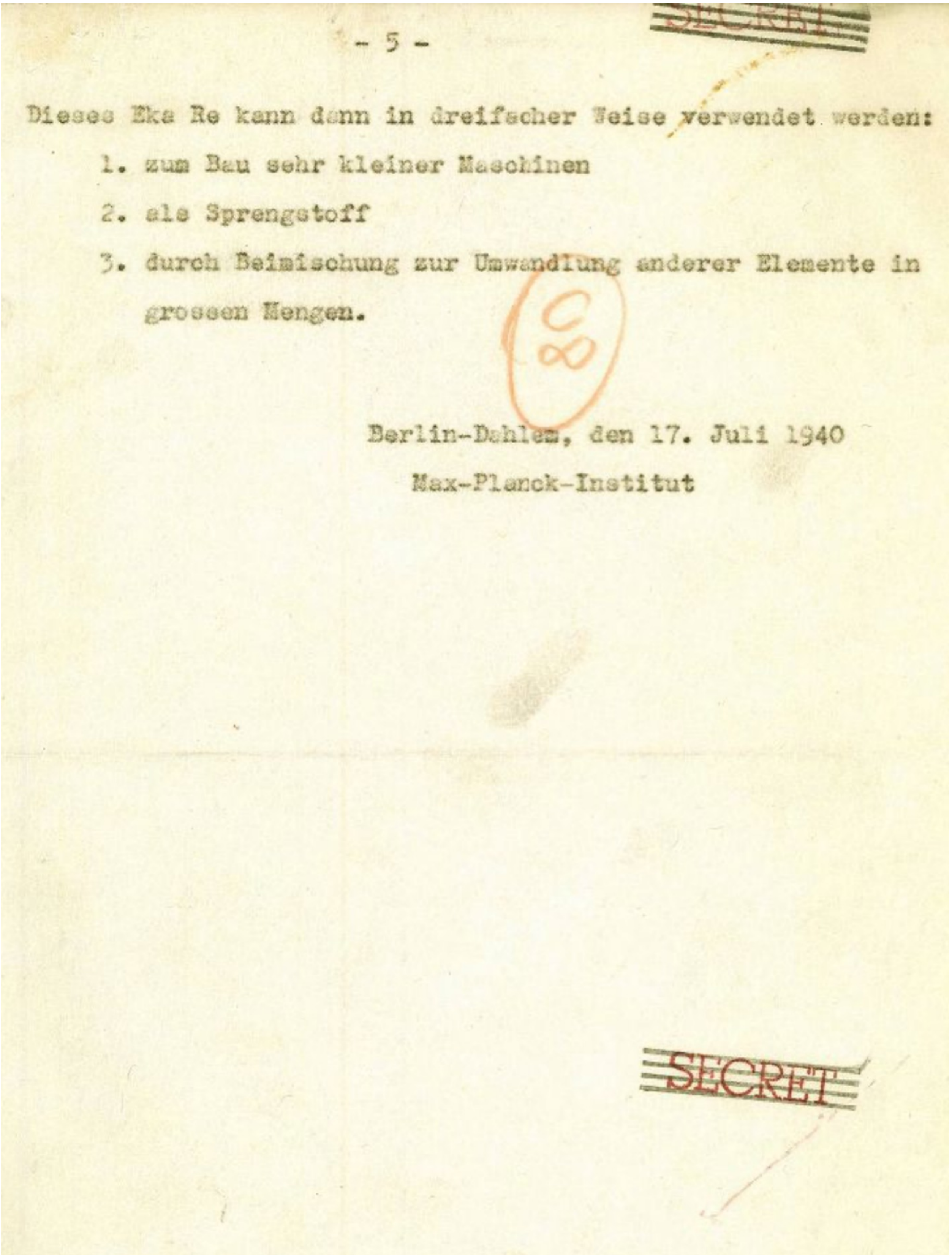
Figure D.340: Carl Friedrich von Weizsäcker's July 1940 report explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-59].



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Dieses Eka Re kann dann in dreifacher Weise verwendet werden:

1. zum Bau sehr kleiner Maschinen
2. als Sprengstoff
3. durch Beimischung zur Umwandlung anderer Elemente in grossen Mengen.

Berlin-Dahlem, den 17. Juli 1940

Max-Planck-Institut

SECRET

Figure D.341: Carl Friedrich von Weizsäcker's July 1940 report explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-59].

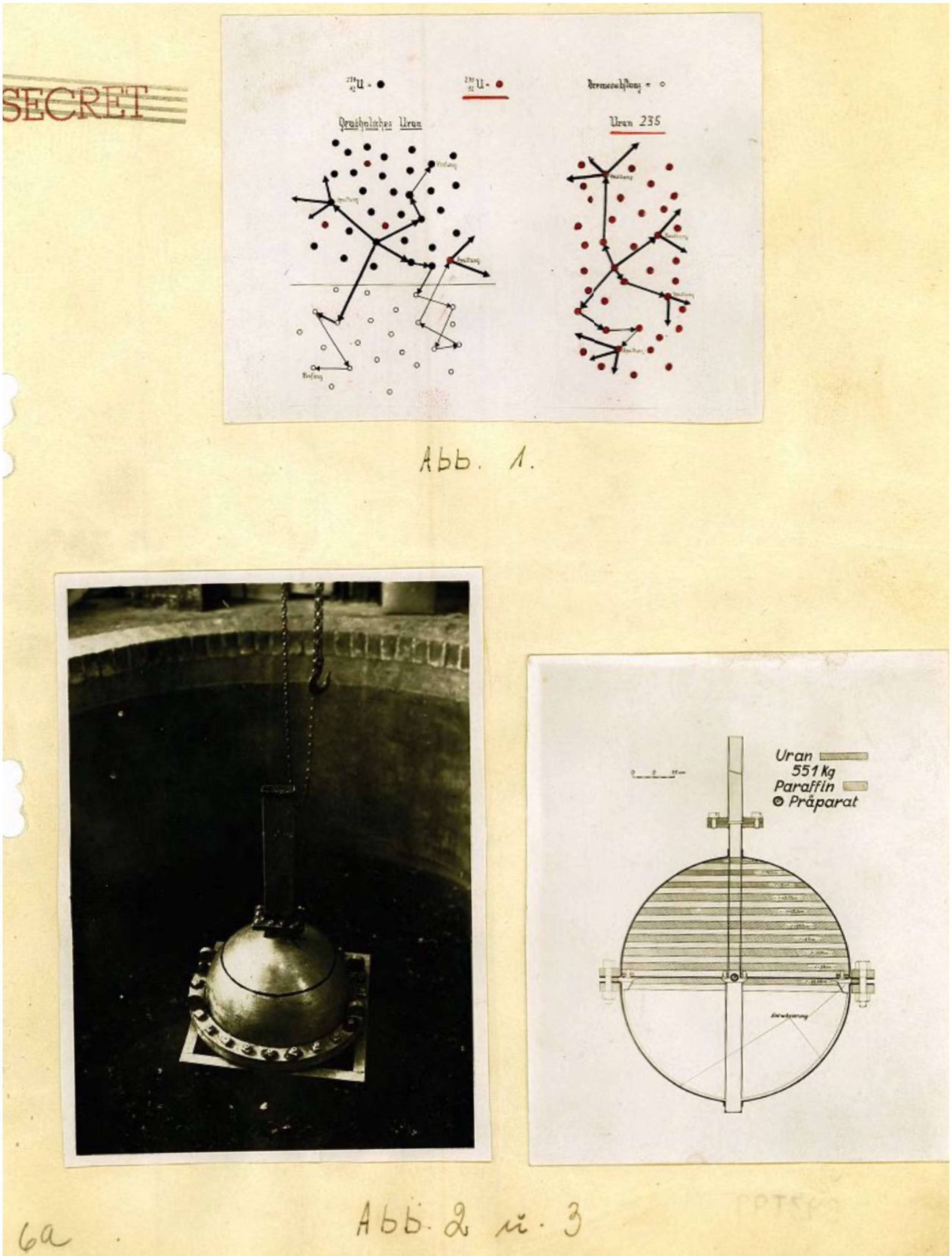
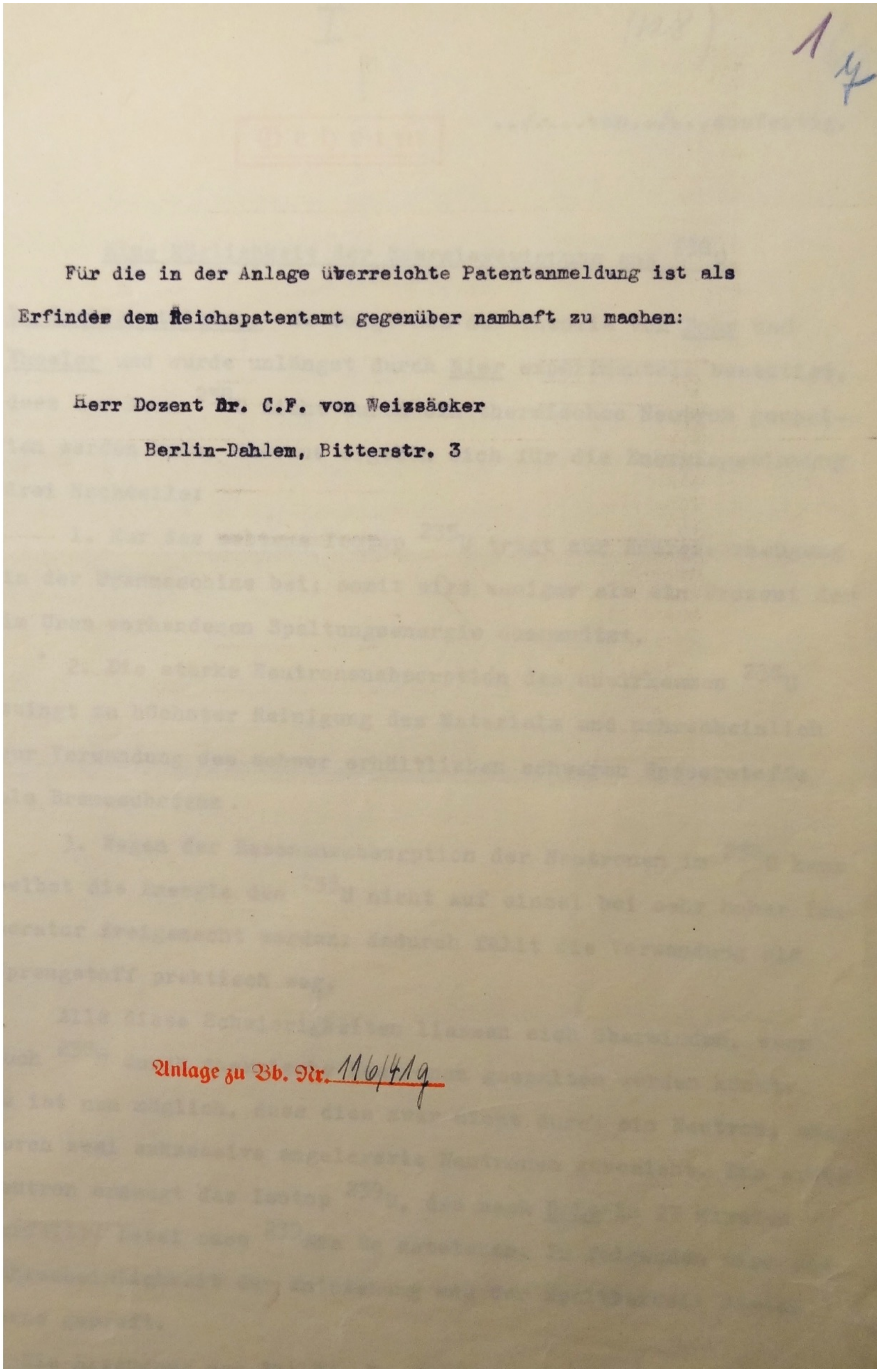


Figure D.342: Carl Friedrich von Weizsäcker's July 1940 report explaining the feasibility of breeding plutonium-239 and using it to make fission bombs or fission reactors. [G-59].

AMPG 7314, KWIP 7, Folder 4 Pu


Für die in der Anlage überreichte Patentanmeldung ist als Erfinder dem Reichspatentamt gegenüber namhaft zu machen:

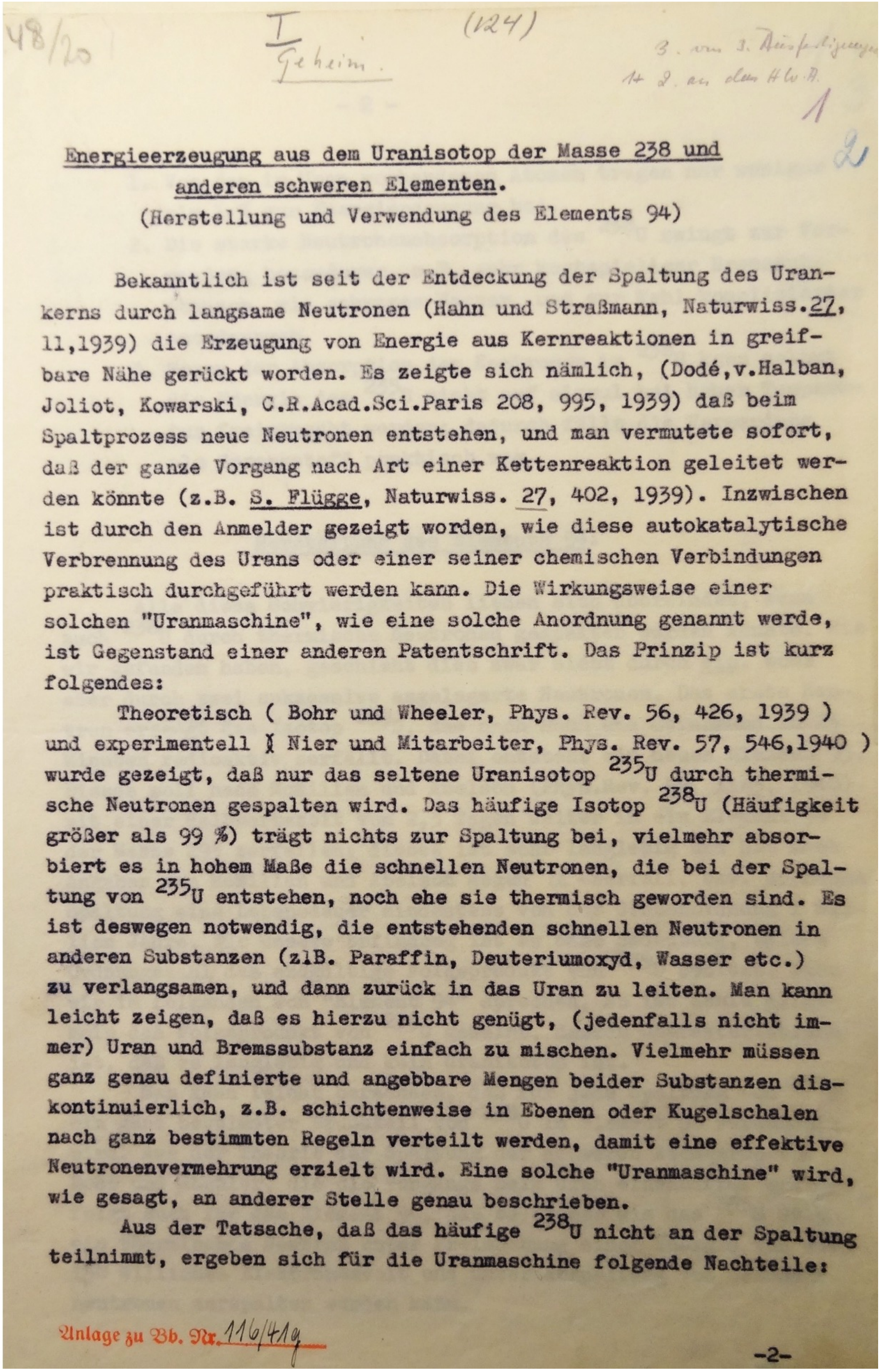
Herr Dozent Dr. C.F. von Weizsäcker

Berlin-Dahlem, Bitterstr. 3

Anlage zu Bb. Nr. 116/41g

Figure D.343: Carl Friedrich von Weizsäcker's 11 June 1941 patent application on breeding plutonium-239 and using it to make fission bombs or fission reactors [AMPG 7314, KWIP 7, Folder 4 Pu].

AMPG 7314, KWIP 7, Folder 4 Pu



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Geheim

(124)

3. von 3. Ausfertigungen
1+2. an dem HWA.

Energieerzeugung aus dem Uranisotop der Masse 238 und anderen schweren Elementen.

(Herstellung und Verwendung des Elements 94)

Bekanntlich ist seit der Entdeckung der Spaltung des Urankerns durch langsame Neutronen (Hahn und Straßmann, Naturwiss.27, 11,1939) die Erzeugung von Energie aus Kernreaktionen in greifbare Nähe gerückt worden. Es zeigte sich nämlich, (Dodé,v.Halban, Joliot, Kowarski, C.R.Acad.Sci.Paris 208, 995, 1939) daß beim Spaltprozess neue Neutronen entstehen, und man vermutete sofort, daß der ganze Vorgang nach Art einer Kettenreaktion geleitet werden könnte (z.B. S. Flügge, Naturwiss. 27, 402, 1939). Inzwischen ist durch den Anmelder gezeigt worden, wie diese autokatalytische Verbrennung des Urans oder einer seiner chemischen Verbindungen praktisch durchgeführt werden kann. Die Wirkungsweise einer solchen "Uranmaschine", wie eine solche Anordnung genannt werde, ist Gegenstand einer anderen Patentschrift. Das Prinzip ist kurz folgendes:

Theoretisch (Bohr und Wheeler, Phys. Rev. 56, 426, 1939) und experimentell (Nier und Mitarbeiter, Phys. Rev. 57, 546,1940) wurde gezeigt, daß nur das seltene Uranisotop ^{235}U durch thermische Neutronen gespalten wird. Das häufige Isotop ^{238}U (Häufigkeit größer als 99 %) trägt nichts zur Spaltung bei, vielmehr absorbiert es in hohem Maße die schnellen Neutronen, die bei der Spaltung von ^{235}U entstehen, noch ehe sie thermisch geworden sind. Es ist deswegen notwendig, die entstehenden schnellen Neutronen in anderen Substanzen (z.B. Paraffin, Deuteriumoxyd, Wasser etc.) zu verlangsamen, und dann zurück in das Uran zu leiten. Man kann leicht zeigen, daß es hierzu nicht genügt, (jedenfalls nicht immer) Uran und Bremssubstanz einfach zu mischen. Vielmehr müssen ganz genau definierte und angebbare Mengen beider Substanzen diskontinuierlich, z.B. schichtenweise in Ebenen oder Kugelschalen nach ganz bestimmten Regeln verteilt werden, damit eine effektive Neutronenvermehrung erzielt wird. Eine solche "Uranmaschine" wird, wie gesagt, an anderer Stelle genau beschrieben.

Aus der Tatsache, daß das häufige ^{238}U nicht an der Spaltung teilnimmt, ergeben sich für die Uranmaschine folgende Nachteile:

Anlage zu Bb. Nr. 116/41g

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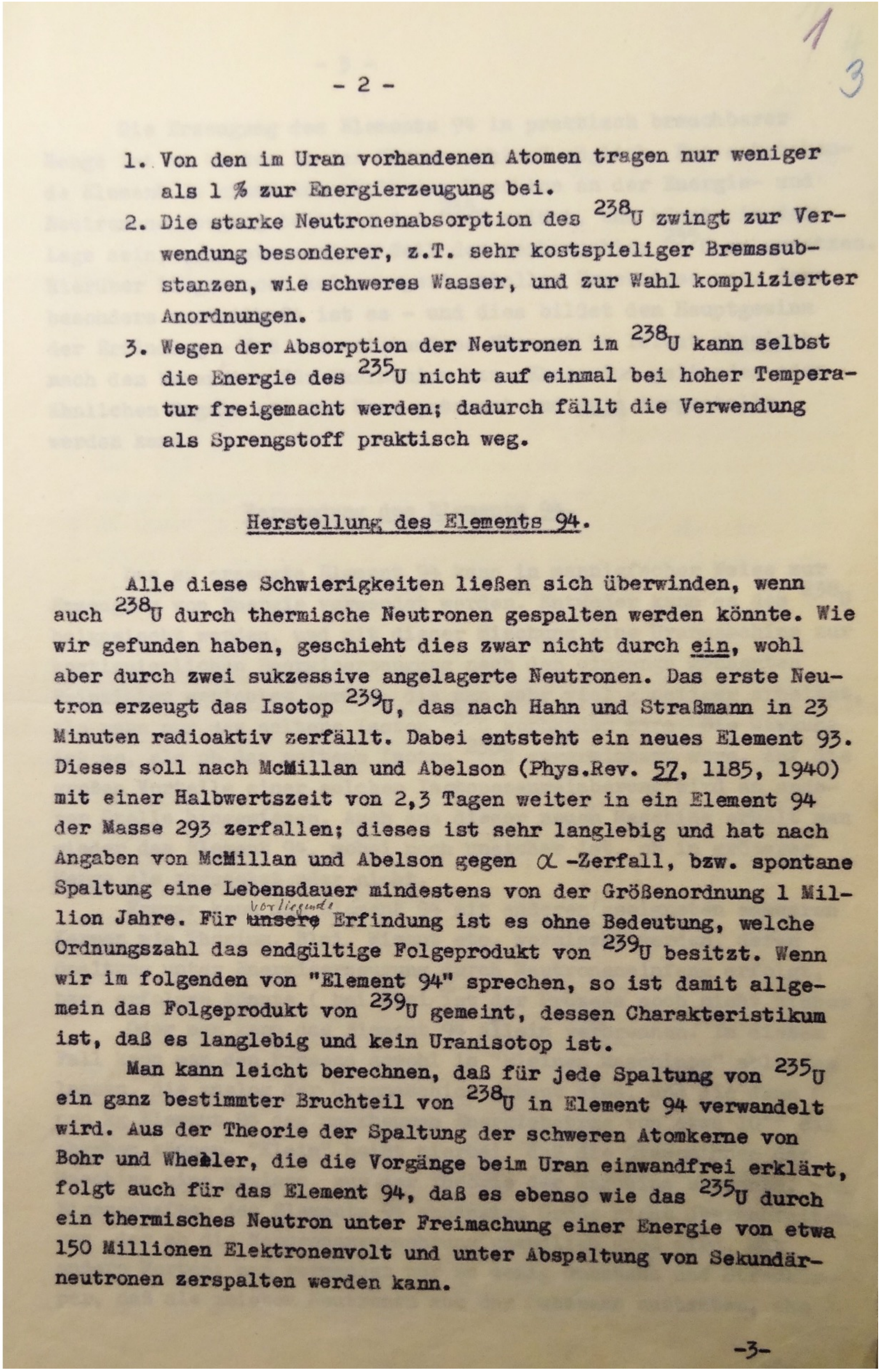
Figure D.344: Carl Friedrich von Weizsäcker's 11 June 1941 patent application on breeding plutonium-239 and using it to make fission bombs or fission reactors [AMPG 7314, KWIP 7, Folder 4 Pu].

AMPG 7314, KWIP 7, Folder 4 Pu



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1. Von den im Uran vorhandenen Atomen tragen nur weniger als 1 % zur Energierzeugung bei.
2. Die starke Neutronenabsorption des ^{238}U zwingt zur Verwendung besonderer, z.T. sehr kostspieliger Bremssubstanzen, wie schweres Wasser, und zur Wahl komplizierter Anordnungen.
3. Wegen der Absorption der Neutronen im ^{238}U kann selbst die Energie des ^{235}U nicht auf einmal bei hoher Temperatur freigemacht werden; dadurch fällt die Verwendung als Sprengstoff praktisch weg.

Herstellung des Elements 94.

Alle diese Schwierigkeiten ließen sich überwinden, wenn auch ^{238}U durch thermische Neutronen gespalten werden könnte. Wie wir gefunden haben, geschieht dies zwar nicht durch ein, wohl aber durch zwei sukzessive angelagerte Neutronen. Das erste Neutron erzeugt das Isotop ^{239}U, das nach Hahn und Straßmann in 23 Minuten radioaktiv zerfällt. Dabei entsteht ein neues Element 93. Dieses soll nach McMillan und Abelson (Phys.Rev. 57, 1185, 1940) mit einer Halbwertszeit von 2,3 Tagen weiter in ein Element 94 der Masse 293 zerfallen; dieses ist sehr langlebig und hat nach Angaben von McMillan und Abelson gegen α-Zerfall, bzw. spontane Spaltung eine Lebensdauer mindestens von der Größenordnung 1 Million Jahre. Für ~~unsere~~ vorliegende Erfindung ist es ohne Bedeutung, welche Ordnungszahl das endgültige Folgeprodukt von ^{239}U besitzt. Wenn wir im folgenden von "Element 94" sprechen, so ist damit allgemein das Folgeprodukt von ^{239}U gemeint, dessen Charakteristikum ist, daß es langlebig und kein Uranisotop ist.

Man kann leicht berechnen, daß für jede Spaltung von ^{235}U ein ganz bestimmter Bruchteil von ^{238}U in Element 94 verwandelt wird. Aus der Theorie der Spaltung der schweren Atomkerne von Bohr und Wheeler, die die Vorgänge beim Uran einwandfrei erklärt, folgt auch für das Element 94, daß es ebenso wie das ^{235}U durch ein thermisches Neutron unter Freimachung einer Energie von etwa 150 Millionen Elektronenvolt und unter Abspaltung von Sekundärneutronen zerspalten werden kann.

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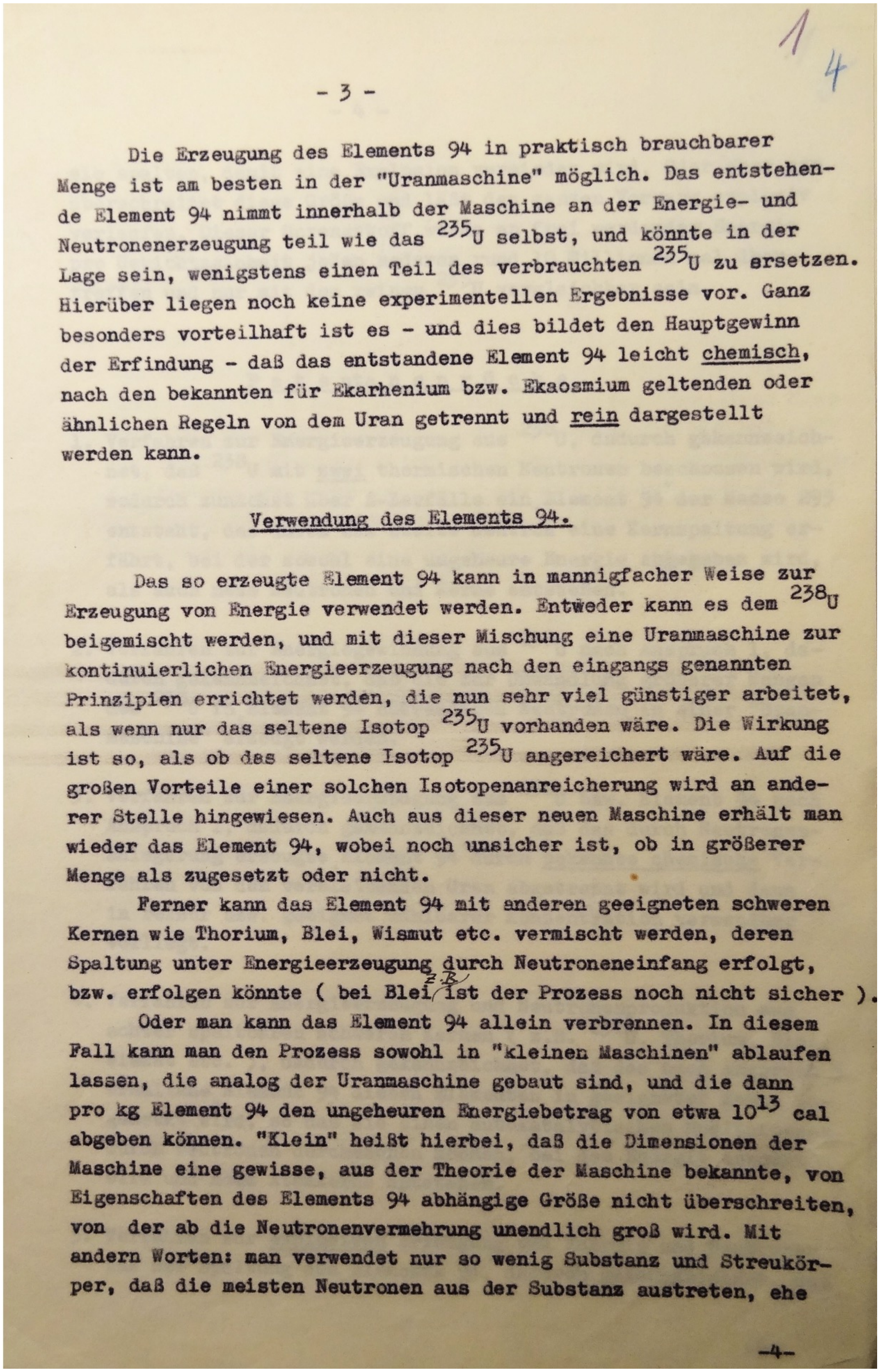
Figure D.345: Carl Friedrich von Weizsäcker's 11 June 1941 patent application on breeding plutonium-239 and using it to make fission bombs or fission reactors [AMPG 7314, KWIP 7, Folder 4 Pu].

AMPG 7314, KWIP 7, Folder 4 Pu



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Die Erzeugung des Elements 94 in praktisch brauchbarer Menge ist am besten in der "Uranmaschine" möglich. Das entstehende Element 94 nimmt innerhalb der Maschine an der Energie- und Neutronenerzeugung teil wie das ^{235}U selbst, und könnte in der Lage sein, wenigstens einen Teil des verbrauchten ^{235}U zu ersetzen. Hierüber liegen noch keine experimentellen Ergebnisse vor. Ganz besonders vorteilhaft ist es - und dies bildet den Hauptgewinn der Erfindung - daß das entstandene Element 94 leicht chemisch, nach den bekannten für Ekarhenium bzw. Ekaosmium geltenden oder ähnlichen Regeln von dem Uran getrennt und rein dargestellt werden kann.

Verwendung des Elements 94.

Das so erzeugte Element 94 kann in mannigfacher Weise zur Erzeugung von Energie verwendet werden. Entweder kann es dem ^{238}U beigemischt werden, und mit dieser Mischung eine Uranmaschine zur kontinuierlichen Energieerzeugung nach den eingangs genannten Prinzipien errichtet werden, die nun sehr viel günstiger arbeitet, als wenn nur das seltene Isotop ^{235}U vorhanden wäre. Die Wirkung ist so, als ob das seltene Isotop ^{235}U angereichert wäre. Auf die großen Vorteile einer solchen Isotopenanreicherung wird an anderer Stelle hingewiesen. Auch aus dieser neuen Maschine erhält man wieder das Element 94, wobei noch unsicher ist, ob in größerer Menge als zugesetzt oder nicht.

Ferner kann das Element 94 mit anderen geeigneten schweren Kernen wie Thorium, Blei, Wismut etc. vermischt werden, deren Spaltung unter Energieerzeugung durch Neutroneneinfang erfolgt, bzw. erfolgen könnte (bei Blei z.B. ist der Prozess noch nicht sicher).

Oder man kann das Element 94 allein verbrennen. In diesem Fall kann man den Prozess sowohl in "kleinen Maschinen" ablaufen lassen, die analog der Uranmaschine gebaut sind, und die dann pro kg Element 94 den ungeheuren Energiebetrag von etwa 10^{13} cal abgeben können. "Klein" heißt hierbei, daß die Dimensionen der Maschine eine gewisse, aus der Theorie der Maschine bekannte, von Eigenschaften des Elements 94 abhängige Größe nicht überschreiten, von der ab die Neutronenvermehrung unendlich groß wird. Mit andern Worten: man verwendet nur so wenig Substanz und Streukörper, daß die meisten Neutronen aus der Substanz austreten, ehe

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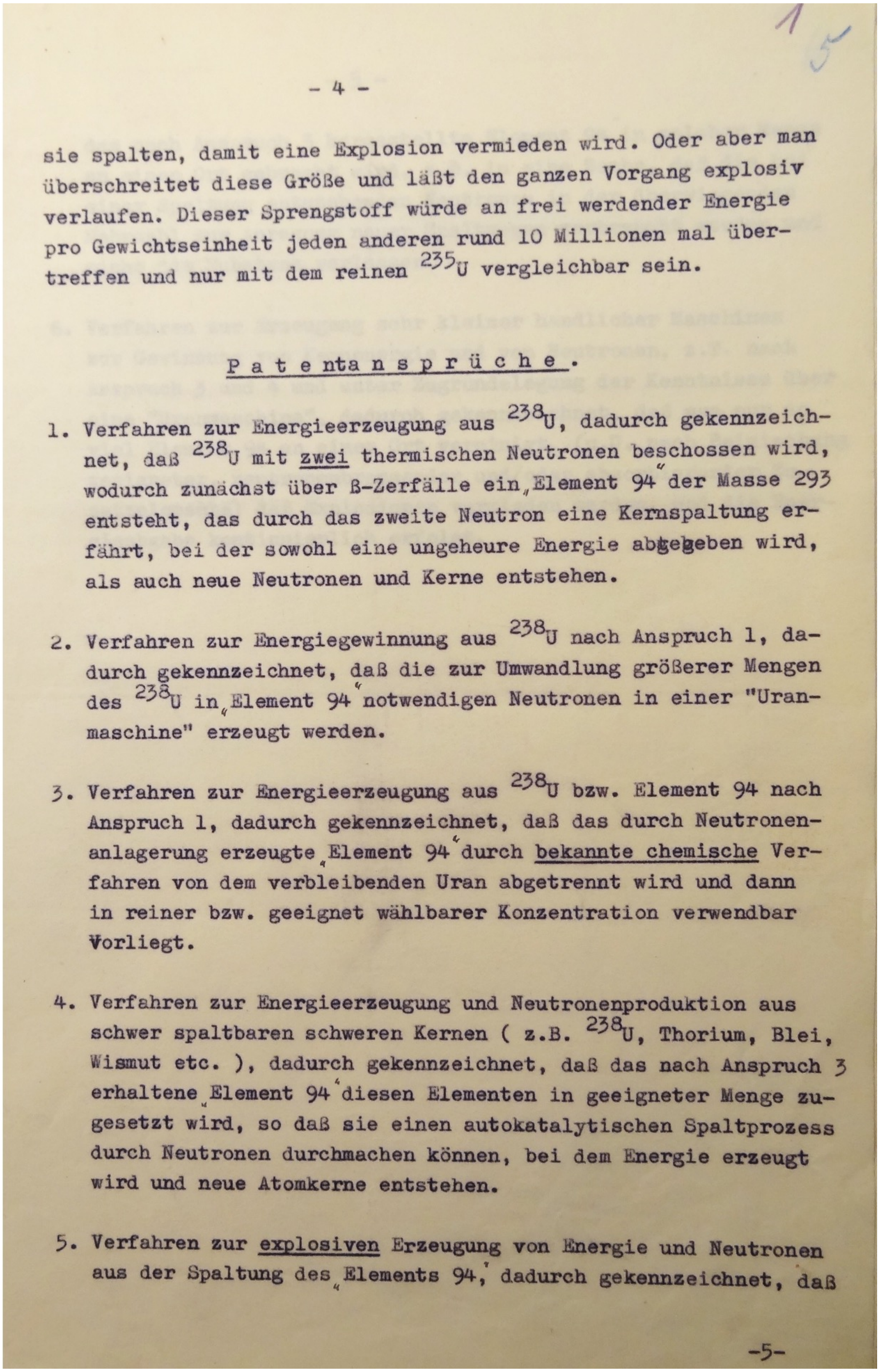
Figure D.346: Carl Friedrich von Weizsäcker's 11 June 1941 patent application on breeding plutonium-239 and using it to make fission bombs or fission reactors [AMPG 7314, KWIP 7, Folder 4 Pu].

AMPG 7314, KWIP 7, Folder 4 Pu



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sie spalten, damit eine Explosion vermieden wird. Oder aber man überschreitet diese Größe und läßt den ganzen Vorgang explosiv verlaufen. Dieser Sprengstoff würde an frei werdender Energie pro Gewichtseinheit jeden anderen rund 10 Millionen mal übertreffen und nur mit dem reinen ^{235}U vergleichbar sein.

P a t e n t a n s p r ü c h e .

1. Verfahren zur Energieerzeugung aus ^{238}U, dadurch gekennzeichnet, daß ^{238}U mit zwei thermischen Neutronen beschossen wird, wodurch zunächst über ß-Zerfälle ein „Element 94“ der Masse 293 entsteht, das durch das zweite Neutron eine Kernspaltung erfährt, bei der sowohl eine ungeheure Energie abgegeben wird, als auch neue Neutronen und Kerne entstehen.

2. Verfahren zur Energiegewinnung aus ^{238}U nach Anspruch 1, dadurch gekennzeichnet, daß die zur Umwandlung größerer Mengen des ^{238}U in „Element 94“ notwendigen Neutronen in einer "Uranmaschine" erzeugt werden.

3. Verfahren zur Energieerzeugung aus ^{238}U bzw. Element 94 nach Anspruch 1, dadurch gekennzeichnet, daß das durch Neutronenanlagerung erzeugte „Element 94“ durch bekannte chemische Verfahren von dem verbleibenden Uran abgetrennt wird und dann in reiner bzw. geeignet wählbarer Konzentration verwendbar vorliegt.

4. Verfahren zur Energieerzeugung und Neutronenproduktion aus schwer spaltbaren schweren Kernen (z.B. ^{238}U, Thorium, Blei, Wismut etc.), dadurch gekennzeichnet, daß das nach Anspruch 3 erhaltene „Element 94“ diesen Elementen in geeigneter Menge zugesetzt wird, so daß sie einen autokatalytischen Spaltprozess durch Neutronen durchmachen können, bei dem Energie erzeugt wird und neue Atomkerne entstehen.

5. Verfahren zur explosiven Erzeugung von Energie und Neutronen aus der Spaltung des „Elements 94“, dadurch gekennzeichnet, daß

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Figure D.347: Carl Friedrich von Weizsäcker's 11 June 1941 patent application on breeding plutonium-239 and using it to make fission bombs or fission reactors [AMPG 7314, KWIP 7, Folder 4 Pu].

AMPG 7314, KWIP 7, Folder 4 Pu

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das nach Anspruch 3 hergestellte Element 94 in solcher Menge an einen Ort gebracht wird, z.B. in eine Bombe, daß die bei einer Spaltung entstehenden Neutronen in der überwiegenden Mehrzahl zur Anregung neuer Spaltungen verbraucht werden und nicht die Substanz verlassen.

6. Verfahren zur Erzeugung sehr kleiner handlicher Maschinen zur Gewinnung von Kernenergie und von Neutronen, z.T. nach Anspruch 3 und 4 und unter Zugrundelegung der Kenntnisse über eine "Uranmaschine", dadurch gekennzeichnet, daß man nur so viel Element 94 an einem Ort vereinigt, (u.U. nach Beimischung geeigneter, neutronenbremsender und/oder absorbierender Zusatzelemente) daß Explosionen vermieden werden, und die Energieabgabe kontinuierlich erfolgt.

ARCHIV DER MAX-PLANCK-GESELLSCHAFT

Mappe 4
Pu

Abteilung: I

Laufzeit: 1940 - 1941 Repositur: 34

Blattzahl: 11 Bestell-Nr.: 7314

Figure D.348: Carl Friedrich von Weizsäcker's 11 June 1941 patent application on breeding plutonium-239 and using it to make fission bombs or fission reactors [AMPG 7314, KWIP 7, Folder 4 Pu].

G-94. Fritz Houtermans. Zur Frage der Auslösung von Kern-Kettenreaktionen. August 1941. Same as report G-267.

[See document photos on pp. 3816–3823.]

[U.S.-created English abstract:] Brief summary covering the following aspects: Analysis of the factors which prevent nuclear fission. Possibility of fission with fast neutrons. Fission with thermal neutrons. Need for enrichment of U^{235}. Difficulty and expense of isotope separation. Moderators: D_2O, beryllium or beryllium oxide, carbon. Effect of temperature on absorption of thermal neutrons. Possibility of chain reaction with natural isotope mixtures of U at low temperatures. Calculations for critical mass. Although difficulty of getting economical power from lower temperature pile, there are other gains possible, e.g., radioisotopes; formation of 239 isotope, which is also subject to fission by thermal neutrons.

[Excerpts:]

[I.] Kernspaltung wurde bisher bekanntlich an den Atomkernen U^{238}, U^{235}, Th^{232}, Pa^{231} und Jo^{230} beobachtet. Kernspaltung kann durch geladene Teilchen (Protonen oder Deuteronen) einer Energie von etwa 5–6 MeV, γ-Quanten einer Energie der gleichen Größenordnung und durch Neutronen ausgelöst werden. [...]

[VII.] Vergleichen wir etwa die Neutronenergiebigkeit einer solchen Apparatur mit der besten bisherigen Neutronenquelle, einem Zyklotron, so zeigt sich leicht, daß eine solche Anlage mit einer Menge natürlichen Urangemischs von ca. 1 t der Leistung von etwa 10^4 bis 10^5 Zyklotrons entspricht. [...]

Denn bei allen denkbaren Apparaturen, die eine Kettenreaktion an isoliertem U^{235} gestatten, würde ja nur 1/139 der gesamten zur Verfügung stehenden Uranmenge als "Brennstoff" oder "Explosivesstoff" benutzt werden, während bei der Isotopentrennung auch für die unverwertbaren Mengen von U^{238} Energie aufgewandt werden muß.

[I.] Nuclear fission has been observed to date for the atomic nuclei U^{238}, U^{235}, Th^{232}, Pa^{231}, and Jo^{230}. Nuclear fission can be triggered by charged particles (protons or deuterons) with an energy of approximately 5–6 MeV, γ photons with an energy of the same magnitude, and by neutrons. [...]

[VII.] If, for example, we compare the neutron yield of such a reactor with the best previous neutron source, a cyclotron, it is easy to see that such a reactor, with a quantity of natural uranium mixture of about 1 ton, has a power of about 10^4 to 10^5 cyclotrons. [...]

For all conceivable devices that permit a chain reaction with purified U^{235}, only 1/139 of the total available uranium would be used as "fuel" or "explosive", while during isotope separation, impractical amounts of energy must also be expended on U^{238}.

Um diesen Punkt näher zu verstehen, müssen wir uns die Frage stellen, was aus denjenigen Neutronen wird, die bei der hier behandelten Kettenreaktion (U–schwere Bremssubstanz bei tiefer Temperatur) entstehen und nicht nach außen entweichen. Wir sehen oben, daß durch Ausschaltung der Neutronen-einfangung durch den Wasserstoff der einzig noch vorhandene Konkurrenzprozess, der in der Tat einen großen Teil der Neutronen schluckt, die Resonanzeinfangung des U^{238} ist. Bei dieser Resonanzeinfangung entsteht bekanntlich zunächst der 23 min-Körper, ein U^{239}_{92}, aus dem durch β-Zerfall zunächst Ek-Re^{239}_{93} entsteht, das wahrscheinlich selbst wieder β-aktiv ist und einem weiteren Körper der (4n+3)-Reihe liefert. [...] Im letzteren Falle aber muß das entstehende langlebige Isotop des Atomgewichts 239 selbst wieder Thermospaltung zeigen. [...] Jedes Neutron, das anstatt an U^{235} Spaltung zu bewirken von U^{238} eingefangen wird, schafft also einen neuen, durch thermische Neutronen spaltbaren Kern. Wir können daher eine Apparatur, die es ge-stattet, mit einem Energieumsatz an wägbaren Mengen U^{235} die Kettenreaktion ablaufen lassen, gleichzeitig als eine Isotopenumwandlungsapparatur ansehen. Der Vorteil gegenüber einer Isotopentrennungsapparatur ist aber der, daß das neugeschaffene Produkt, das ja eine Kernladung von 93 oder mehr hat, chemisch nicht mehr mit dem Uran identisch und daher mit gewöhnlichen chemischen Methoden abzutrennen ist. Da nun viel größere Mengen, nämlich das 139fache an U^{238} zur Verfügung stehen, so ist die Verwertbarmachung desselben als "Brennstoff" für eine Kettenreaktion ein für unsere Themenstellung viel wichtigerer Vorgang, als die Isotopentrennung, die bloß das U^{235} zu verwerten gestattet.

Für die Anregung zu dieser Arbeit und deren Ermöglichung danke ich Baron Manfred von Ardenne.

To understand this point in more detail, we have to ask ourselves what will become of the neutrons that are formed during the chain reaction (U-moderator at low temperature) and do not escape to the outside. We see above that by eliminating neutron capture by hydrogen, the only competitive process that actually absorbs a large portion of the neutrons is the resonance capture by U^{238}. This resonance capture is known to produce the 23-minute nucleus, U^{239}_{92}, for which β decay results in Ek-Re^{239}_{93}, which is likely to be β-active again and produces another (4n+3)-type body. [...] In the latter case, however, the resulting long-lived isotope of atomic weight 239 must again be fissionable by thermal neutrons. [...] Every neutron which, instead of fissioning U^{235}, is captured by U^{238} creates in this way a new nucleus, fissionable by thermal neutrons. We can therefore regard an apparatus that allows the chain reaction to proceed with an energy conversion of measurable amounts of U^{235} as an isotope conversion apparatus. The advantage over an isotope separation apparatus, however, is that the newly created product, which indeed has a nuclear charge of 93 or more, is no longer chemically identical to uranium and therefore can be purified by ordinary chemical methods. Since much larger quantities are available, namely 139 times more U^{238}, the utilization of it as "fuel" for a chain reaction is a much more important process for our topic than isotope separation, which only allows U^{235} to be used.

For suggesting this work and making it possible, I thank Baron Manfred von Ardenne.

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UNCLASSIFIED

G 94 (Ref 14)

Zur Frage der Auslösung von Kern-Kettenreaktionen

von Fritz G. Houtermans

Mitteilung aus dem Laboratorium Manfred von Ardenne

Berlin-Lichterfelde-Ost

Inhalt:

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Zur Frage der Auslösung von Kern-Kettenreaktionen.

von Fritz G. Houtermans

Mitteilung aus dem Laboratorium Manfred von Ardenne

Berlin-Lichterfelde-Ost

I. Einleitung. Allgemeine Gesichtspunkte.

Die Möglichkeit einer Energiegewinnung aus Reaktionen des Atomkernes ist, ähnlich wie bei der Ausnutzung chemischer Energie weitgehend abhängig von der Möglichkeit von Kettenreaktionen, d.h. davon, daß die zur Auslösung einer exothermen Reaktion nötige Aktivierungs-Energie durch die Reaktion selbst geliefert wird. Obwohl eine große Anzahl von exothermen Reaktionen der Atomkerne seit langem bekannt sind, mußte die Frage nach einer Möglichkeit von Kern-Kettenreaktionen bis vor einigen Jahren negativ beantwortet werden. Der Grund hierfür liegt darin, daß die "Aktivierungswärme", also die zur Auslösung einer Kettenreaktion nötige Energie nach dem damaligen Stand unserer Kenntnisse nur durch ein geladenes Teilchen oder ein γ-Quant auf den Kern übertragen werden.konnte. Da nun der Wirkungsquerschnitt des Kernes für die Auslösung von Kettenreaktionen nur etwa 10^{-8} des Wirkungsquerschnittes der Elektronenhülle des Atoms beträgt, ist die Wahrscheinlichkeit für die Auslösung einer Kettenreaktion durch ein geladenes Teilchen oder ein γ -Quant sehr klein. Sie beträgt selbst in den günstigsten bekannten Fällen von Kernresonanzen höchstens etwa 10^{-3} bis 10^{-} Die Ursache hierfür ist prinzipieller Natur. Sie liegt darin, daß ein geladenes Teilchen infolge der Coulomb-Kräfte in sehr erheblichem Maße Energie an die Hüllenelektronen des Atoms ab-

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gibt, und daher seine Energie im allgemeinen durch Ionisation der Atome viel eher verliert, als es einen zur Auslösung einer Kernreaktion führenden Kerntreffer macht. Das Gleiche gilt für γ-Quanten. Hier ist es die Energieabgabe durch den Compton-Effekt an die Hüllenelektronen, der die Wahrscheinlichkeit für eine Energiedissipation an der Atomhülle viel größer macht, als die Wahrscheinlichkeit für das Quant, vom Kern absorbiert zu werden und eine Kernreaktion auszulösen.

Erst durch die Entdeckung des Neutrons als eines Teilchens, das keine elektromagnetische Wechselwirkung mit den Elektronen der Atomhülle hat, war daher prinzipiell die Möglichkeit einer Kern-Kettenreaktion gegeben, denn ein Neutron kann im wesentlichen seine Energie nur durch Kerntreffer verlieren. Der Verfasser hat schon im Jahre 1932 in seiner Antrittsvorlesung an der Technischen Hochschule Berlin auf diese prinzipielle Möglichkeit hingewiesen und die Bedingung für die Bildung einer Kern-Kettenreaktion angegeben. Diese besteht darin, daß eine Kern-Kettenreaktion eintreten muß, sobald eine Reaktion bekannt ist, bei der mit der Wahrscheinlichkeit 1 an einem Kern durch ein Neutron ein weiteres Neutron ausgelöst wird, dessen Energie seinerseits imstande ist, an einem anderen Kern wieder ein Neutron auszulösen. Durch die Entdeckung der Spaltung schwerer Elemente durch Neutronen (Hahn und Strassmann 1938) ist nun bekanntlich inzwischen ein solcher Reaktionsmechanismus tatsächlich gefunden worden. Wesentlich ist hierbei nicht die Tatsache der sehr hohen freiwerdenden Reaktionsenergie in Höhe von etwa 180 MeV, sondern daß bei diesem Prozess neben den beiden großen Kerntrümmern, in die das schwere Atom aufspaltet, noch einige freie Neutronen entstehen, die ihrerseits wieder eine Kernspaltung hervorrufen können. Die Frage der Ausnutzung eines solchen Prozesses zur Auslösung von Kern-Kettenreaktionen ist also lediglich eine Frage möglichst maximaler Ausnutzung der entstehenden Neutronen. Der Verfasser hat im Zusammenhang mit anderen Problemstellungen, noch bevor die Kernspaltung bekannt war, eine Anzahl Überlegungen und Experimente angestellt, die als Ziel eine möglichst vollständige Ausnutzung entstehender Neu-

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tronen zugunsten einer bestimmten Kernreaktion gehabt haben. In vorliegender Mitteilung sollen diese Überlegungen speziell auf die Kernspaltung angewendet und verschiedene aus ihnen folgenden Möglichkeiten diskutiert werden.

Kernspaltung wurde bisher bekanntlich an den Atomkernen U^{238}, U^{235}, Th^{232}, Pa^{231} und Jo^{230} beobachtet. Kernspaltung kann durch geladene Teilchen (Protonen oder Deuteronen) einer Energie von etwa 5–6 MeV, γ-Quanten einer Energie der gleichen Größenordnung und durch Neutronen ausgelöst werden. Nach dem oben Gesagten kommt für die Auslösung einer Kettenreaktion nur der letztgenannte Mechanismus, die Kernspaltung durch Neutronen in Frage. Die Zahl ν der bei jeder Kernspaltung frei werdenden Neutronen beträgt etwa 2 – 4. Die Auslösung einer Kettenreaktion hat jedoch zur Voraussetzung, daß alle Konkurrenzprozesse, durch die ein einmal entstandenes Neutron verloren gehen kann, ohne seinerseits eine Kernspaltung hervorzurufen, in hinreichendem Maße ausgeschaltet werden können.

II. Die Konkurrenzprozesse.

Es ist daher nötig, alle diese Konkurrenzprozesse und ihre Wahrscheinlichkeiten im einzelnen zu diskutieren. Die Konkurrenzprozesse, die zum Verlust eines Neutrons führen, ohne eine Kernspaltung zu bewirken, sind:

1. Das Herauslaufen eines Neutrons aus dem Versuchsvolumen, in dem die Kernspaltung hervorgerufen werden kann. Die Wahrscheinlichkeit hierfür soll mit w_1 bezeichnet werden.
2. Die Abbremsung eines Neutrons durch elastische Stöße, die zu einem solchen Energieverlust führt, daß die Energie nicht mehr ausreicht, um eine Kernspaltung zu bewirken; Wahrscheinlichkeit w_2.
3. Die Wahrscheinlichkeit eines solchen Energieverlustes eines Neutrons durch unelastische Stöße, w_3

Figure D.349: The August 1941 report by Fritz Houtermans (working in collaboration with Manfred von Ardenne) explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-94].

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4. Die Wahrscheinlichkeit der Einfangung eines Neutrons durch einen Atomkern des Reaktionselementes selbst, die aber nicht zu einer Kernspaltung, sondern zur Bildung eines neuen, radioaktiven Isotops führt, w_4.

5. Die Einfangung durch Kerne eines neben der Reaktionssubstanz im Versuchsvolumen enthaltenen Elements, mit der Wahrscheinlichkeit w_5.

Wir wollen zunächst die Möglichkeit einer Kettenreaktion in einem unendlich großen Versuchsvolumen prüfen, wobei also die Wahrscheinlichkeit für den ersten Konkurrenzprozess, das Herauslaufen, w_1 verschwindet, da es natürlich eine notwendige, wenn auch nicht hinreichende Bedingung für die Möglichkeit einer Kettenreaktion in einem <u>endlichen</u> Volumen ist, daß diese bei unendlichem Volumen möglich ist. Wir werden sehen, daß die Größe des kritischen Volumens, bei dem die Kettenreaktion gerade noch möglich wird, in ganz bestimmter Weise von einer bestimmten für die Kettenreaktion bei unendlichem Volumen charakteristischen Größe in einfacher Weise abhängt.

III. Kettenreaktionen durch Kernspaltung mit schnellen Neutronen.

Kernspaltung durch schnelle Neutronen ist an den Elementen U, Th, Pa bekannt. Von diesen kommt für eine etwaige technische Ausnutzung nur Uran und allenfalls Thorium praktisch in Frage. Wir wollen hier zunächst untersuchen, ob prinzipiell diese Spaltung mit schnellen Neutronen zu einer Kettenreaktion führen kann. Als Konkurrenzprozess kommen hier bei unendlichem Volumen nur der unter 2., 3., 4. und 5. genannte vor allem die Abbremsung unter die Schwellenenergie der Kernspaltung durch elastische Kernstreuung oder unelastische Kernstreuung (Kernanregung), sowie die unter 4. und 5. genannten Prozesse (Einfangung) in Frage. Doch dürfen wir auch w_4 als

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sehr klein annehmen. Für U^{238} ist bei hohen Energien die Wahrscheinlichkeit einer Einfangung unter nachfolgender Ausstrahlung sicher als klein gegen die mit Spaltung oder Entweichen des Neutrons verbundene anzusehen, also w_4 zu vernachlässigen. Allgemein setzen wir für die Wahrscheinlichkeit w_j eines Elementarprozesses mit einem Neutron

$$w_j = v \cdot c_i \cdot \sigma_{j,i} \qquad (1)$$

wo der Index j auf einen bestimmten Elementarprozess (z.B. Streuung, Absorption, Spaltung) hinweist, c_i die Anzahl der Kerne pro cm^3 bedeutet, an der dieser Elementarprozess stattfindet und $\sigma_{j.i}$ den Wirkungsquerschnitt dieses Kerns für den entsprechenden Elementarprozess bedeutet. v ist die Neutronengeschwindigkeit. Setzen wir ferner für die mittlere Zahl der pro Spaltprozess durch schnelle Neutronen neu entstehenden Neutronen ν und sei η die Wahrscheinlichkeit dafür, daß das Neutron entweder, ohne eine Spaltung zu bewirken bis unter die Schwellenenergie abgebremst wird oder dabei absorbiert wird, ohne eine Spaltung zu bewirken, so erhalten wir als kritische Bedingung, daß die Reaktionskette nicht abreißt die daß die Zahl χ der Spaltprozesse pro Neutron $\gtrapprox$ 1 wird, also

$$\chi = \nu\,(1-\eta) \geqq 1 \qquad (2)$$

ist. Versuchen wir nun η zu berechnen, Wir wollen zunächst, um gleich die günstigsten Bedingungen anzunehmen, voraussetzen, daß wir es mit reinem metallischen Uran zu tun haben, also alle Streu- und Absorptionsprozesse durch Fremdatome wegfallen. Ferner wollen wir zunächst die Streuung als rein elastisch betrachten. Über die Richtungsverteilung dürfen wir Isotropie im Schwerpunktsystem annehmen, was der Tatsache entspricht, daß der kugelsymmetrische Anteil der Wellenfunktion des Kerns einen wesentlichen Beitrag zur Streuung liefert. Für hohe Energien ($\lambda \ll R$), wo R den Kernradius und λ die de Broglie-Wellenlänge des Neutrons bedeutet, ist diese Annahme durchaus gerechtfertigt. Der Energieverlust Δ E pro

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Stoß bei einer Energie E des stoßenden Neutrons beträgt dann bei einem Ablenkungswinkel Θ im Schwerpunktsystem:

$$\Delta E = E\,(1 - \cos\Theta)\;\frac{2M}{(M+1)^2} \qquad (3)$$

wo M die Masse des gestoßenen Kerns in Einheiten der Neutronenmasse bedeutet. Der mittlere Energieverlust ist

$$\overline{\Delta E} = E \cdot \frac{2M}{(M+1)^2} \qquad (4)$$

Betrachten wir nun eine Anzahl n_o Neutronen einer primären Energie E_o, so werden diese durch Bremsung Energie und durch Absorption und Spaltung an Zahl verlieren. Die zeitliche Energieverminderung ergibt sich in reinem Uran zu

$$\frac{dE}{dt} = - E \cdot v \cdot \sigma_d \cdot c_u \cdot \frac{2M}{(M+\ )^2} \qquad (5)$$

wo σ_d den Streuquerschnitt des Urankerns bedeutet. Die Verminderung der Zahl n erfolgt nach der Gleichung

$$\frac{dn}{dt} = - n \cdot v \cdot \sigma_s \cdot c_u \qquad (6)$$

wo σ_s der Wirkungsquerschnitt für die Kernspaltung des Urankerns ist. Dann wird

$$\frac{dn}{dE} = \frac{n}{E} \cdot \frac{\sigma_s}{\sigma_d} \cdot \frac{(M+1)^2}{2M} = \frac{n}{E} \cdot \gamma \qquad (7)$$

und die Wahrscheinlichkeit einer Unterschreitung der Schwellenenergie η

$$\eta = e^{-\int_{E_s}^{E_o} \gamma(E)\, d(\ln E)} \qquad (8)$$

Wenn wir die Ausbeutefunktion der Kernspaltung also σ_s in erster Näherung unterhalb E_s Null und oberhalb E_s als konstant und ferner, was sicher ungefähr berechtigt ist, σ_d im fraglichen Intervall ebenfalls konstant setzen, wird

$$\eta = \left(\frac{E_s}{E_o}\right)^{\gamma} \qquad (9)$$

wo

$$\gamma = \frac{\sigma_s}{\sigma_d} \cdot \frac{(M+1)^2}{2M} \qquad (10)$$

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Nach Bohr und Wheeler (2) erfolgt zweifellos der Anstieg der Ausbeutefunktion für die Spaltung ziemlich steil und erreicht sehr bald einen Sättigungswert. Dies bestimmt auch mit dem experimentellen Befund von Ladenburg und Mitarbeitern (3) überein, daß die Ausbeute zwischen 2 und 4 MeV sich nicht merklich ändert. Unsere Annahme σ_s = const für E ist also sicher berechtigt. Die Grenzen für die experimentellen Daten sind:

$$2{,}2 < E_o < 3{,}5 \text{ MeV}$$
$$1{,}0 < E_s < 2{,}0$$
$$0{,}28 < E_s/E_o < 0{,}91$$
$$0{,}15 < \sigma_s < 0{,}5 \cdot 10^{-24} \text{ cm}^2$$
$$\sigma_d \sim 6 \cdot 10^{-24} \text{ cm}^2$$
$$1{,}5 < \gamma < 10$$

Fig. 1. gibt eine Übersicht über den resultierenden Wert von η. Die genannten Konstanten sind nur sehr ungenau bekannt bzw. nicht publiziert. In Fig. 1 bedeutet das schraffierte Gebiet die in Abhängigkeit von E_s/E_o möglichen Lagen von η, wobei die einzelnen schrägen Geraden den verschiedenen Werten von σ_s/σ_d entsprechen. In Fig. 1. geben die horizontalen Geraden die Werte unter denen η liegen muß, wenn für ν ein bestimmter, an der betreffenden Geraden angegebener Wert angenommen wird. Nach den Angaben von Joliot und Savitch, Szilard und Zinn u.a. (4,5 und 6,7) ist 1.5 < ν < 3,5. Allerdings beziehen sich diese Angaben für ν auf die Spaltung durch thermische Neutronen am U^{235}. Da auch die Wahrscheinlichkeitsverhältnisse bezüglich der Spaltungsprodukte bei der Spaltung durch schnelle Neutronen etwas anders liegen als bei der Spaltung des U^{235}, ist es nicht möglich, den Wert für ν, der für diese Reaktion gefunden wurde, für die an U^{238} ohne weiteres zu übernehmen. Doch kann man erwarten, daß sich die beiden Werte von ν nicht sehr unterscheiden. Unter diesen Voraussetzungen zeigt Fig.1., daß die Auslösung einer Kettenreaktion an reinem metallischen Uran durchaus <u>möglich</u> erscheint, wenn die Wahrscheinlichkeit unelastischer Streuung w vernachlässigt werden kann!

Ganz anders liegen die Verhältnisse, wenn man dem Uran leichte Atome beimischt; in diesem Fall haben wir für γ zu

Figure D.350: The August 1941 report by Fritz Houtermans (working in collaboration with Manfred von Ardenne) explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-94].

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setzen

$$\gamma = \frac{\sum_i (\sigma_{e,i}\, c_i) + \sigma_s \cdot c_u}{\sum_i (\sigma_{d,i}\, c_i\, \mu_i) + \sigma_u c_u\, \mu_u} \qquad (11)$$

wo die Summen über sämtliche im Reaktionsvolumen vorhandenen Kernsorten zu erstrecken sind und

$$\mu_i = \frac{2\, M_i}{(M_i + 1)^2} \quad ; \quad \mu_u = \frac{2\, M_u}{(M_u + 1)^2} = 0.834 \cdot 10^{-2} \qquad (12)$$

bedeuten. Die außerordentliche starke Abhängigkeit der Energieabnahme mit der Veringerung der Masse der Zusatzatome bewirkt, daß schon für U_3O_8 im allgemeinen eine Kettenreaktion sogar unter den hier zugrunde liegenden Voraussetzungen nicht möglich erscheint. Nur für $E_o \geqq$ 2,8 MeV, und $\nu \sim 3$ würde die Kette nicht abreißen. Die Möglichkeit, daß wirklich eine Kettenreaktion zustande kommt, hängt also wesentlich an der Verwendung reinen Urans, sowie an der hier gemachten Voraussetzung, daß der Streuquerschnitt der unelastischen Streuung (Konkurrenzprozess 3) klein gegen den der elastischen Streuung ist. Untersuchungen hierüber sind an schweren Elementen noch wenig durchgeführt worden. Da die fraglichen Energien weit unter der Bindungsenergie des Neutrons liegen, kommen (n,2n)-Reaktionen nicht in Frage, doch ist es wahrscheinlich, daß Kernzustände, eventuell auch metastabiler Art wie bei In und Pb angeregt werden können. Zusammenfassend läßt sich feststellen:

Eine Kettenreaktion durch Kernspaltung mit schnellen Neutronen ist prinzipiell an reinem Uran (ohne Isotopentrennung) möglich, wenn der Querschnitt für unelastische Kernstreuung neben dem elastischen Streuquerschnitt als klein angesehen werden kann und ν für diesen Prozess als $> \sim 1{,}5$ ist.

Zur Prüfung der in diesem Abschnitt behandelten Möglichkeiten sind experimentelle Untersuchungen erforderlich mit dem Ziel einer genauen Messung von ν für U^{238} und schnelle Neutronen, von E_o, E_s und σ_s in Abhängigkeit von der

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Energie (Ausbeutefunktion) und vor allem des Wirkungsquerschnittes für unelastische Kernstreuung.

IV. Kernspaltung durch thermische Neutronen.

Kernspaltung durch thermische Neutronen ist von allen in der Natur vorkommenden Isotopen bisher nur am U^{235} beobachtet, das im natürlichen Uran im Verhältnis 1:139 enthalten ist. Während hier der Konkurrenzprozess 2 ganz wegfällt, da eine untere Grenze, der zur Spaltung nötigen Neutronenenergie nicht existiert, spielt hier der Konkurrenzprozess 5 die entscheidende Rolle, denn das U^{238} ist hier als Verunreinigung anzusehen, und der Einfangvorgang durch U^{238} mit folgender Ausstrahlung und Bildung des 23 min-Körpers bildet hier den wesentlichen Konkurrenzprozess.

Die Einfangung hat bekanntlich bei ca. 5 eV eine scharfe Resonanz. Oberhalb und unterhalb dieser Resonanzenergie ist der Einfangquerschnitt des U^{238} sehr klein und würde selbst bei der Konzentration von 138/139 kaum schaden. Dabei ist es auch möglich, daß die Resonanz nicht aus einem, sondern aus mehreren Bändern besteht. Es kommt also möglichst darauf an, daß die Neutronen bei ihrer Abbremsung zu thermischen Energien das Resonanzband möglichst schnell durchlaufen, also pro Stoß möglichst viel Energie verlieren. Da, wie theoretisch zu erwarten ist, und experimentell bestätigt scheint, die Thermospaltung des U^{235} dem 1/v -Gesetz folgt, ist es nötig, die Neutronen bis auf thermische Energien abzubremsen. Um ein möglichst schnelles Passieren der Gefahrenzone des Resonanzbandes zu bewirken, muß man die Masse der Bremssubstanz möglichst klein wählen, also eine wasserstoffhaltige Substanz zusetzen. Nun hat aber Wasserstoff auch einen Einfangquerschnitt für Einfangung von thermischen Neutronen, der der Reaktion $H^1, (n, \gamma) D^2$, entspricht. Man kann also von vornherein ohne jede Rechnung sagen, daß eine Kette nicht möglich ist, - selbst wenn das Resonanzgebiet passiert ist - wenn für thermische Neutronen

$$(\nu_{th} - 1)\, \sigma_{s,th}\, c_{235} < \sigma_{e,238}\, c_{238} + \sigma_{e,b}\, c_b \qquad (13)$$

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ist, wo ν_{th} wieder Zahl der beim Spaltprozess entstehenden Neutronen, $\sigma_{s,th}$ der Wirkungsquerschnitt des U^{235} für Spaltung $\sigma_{e,238}$ und $\sigma_{e,b}$ die Einfangquerschnitte für thermische Neutronen durch U^{238} bzw. die Bremssubstanz und die c, die entsprechenden Atomkonzentrationen bedeuten.

Zur genaueren Berechnung ist es erforderlich, die Wahrscheinlichkeit des Hauptprozesses, der Resonanzeinfangung zu berechnen. Bezeichnen wir mit w_r die Wahrscheinlichkeit eines Neutrons der Energie E, von U238 im Laufe seiner Abbremsung nicht resonanz-verschluckt zu werden, so gestaltet sich die Rechnung, die wir hier zunächst nur für leichten Wasserstoff als Bremssubstanz durchführen wollen sehr einfach. Für jeden einzelnen Stoß ist die Wahrscheinlichkeit einer Resonanzeinfangung u(E) gegeben durch

$$u(E) = \frac{\sigma_{c,238} \cdot c_{238}}{\sigma_{e,238} \cdot c_{238} + \sigma_{d,H} \cdot c_H} \qquad (14)$$

Die Gesamtwahrscheinlichkeit w_r ergibt sich aus der Wahrscheinlichkeit u unter Berücksichtigung der Geschwindigkeitsverteilung, die aus (2) für isotrope Richtungsverteilung folgt. Für w_r gilt dann

$$E\, w_r(E) = \left[1 - u(E)\right] \int_0^E w_r(x)\, dx \qquad (15)$$

und durch Differentiation die homogene Differentialgleichung

$$\frac{dw_r}{dE} - \left[\frac{u(E)}{E} + \frac{du}{dE} \cdot \frac{1}{1 - u(E)}\right] w_r = 0 \qquad (16)$$

die durch den Ansatz

$$w_r = (1 - u) \cdot e^{-\int_0^E u(E) \cdot E^{-1} dE} \qquad (17)$$

gelöst wird. Da wir E so groß wählen können, daß für E selbst $\sigma_{e,238}$ noch sehr klein ist, d.h. hinreichend hoch über der Resonanz, wird einfach

$$\ln w_r = - \int_0^\infty u\, d \ln E \qquad (18)$$

Setzt man für den Verlauf von $\sigma_{e,238}$ die Breit-Wigner-Formel ein, so ist es günstig zunächst von dieser einen zu 1/v proportionalen Anteil des Wirkungsquerschnittes für

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Energien, die hinreichend weit unter der Resonanzenergie liegen, abzuspalten. Die Ein-Niveauformel von Breit-Wigner für eine Resonanzeinfangung gibt:

$$\sigma_e = \sigma_o \cdot (E_\lambda / E)^{1/2} \cdot (\Gamma/2)^2 \left[(E - E_r)^2 + (\Gamma/2)^2 \right]^{-1} \qquad (19)$$

und dieses zerlegen wir in einen Anteil

$$\sigma' = \sigma_o \cdot (E_\lambda / E)^{1/2} \cdot (\Gamma/2)^2 \left[E_r^2 + (\Gamma/2)^2 \right]^{-1} \qquad (20)$$

der erst bei thermischen Energien einen merklichen Beitrag zur Einfangung zeigt und den gleichen Gang mit 1/v aufweist, wie der Spaltungsquerschnitt, und einen eigentlichen Resonanzanteil

$$\sigma_{e,} = \sigma_o \cdot (E_\lambda / E)^{1/2} (\Gamma/2)^2 \left\{ \left[(E - E_\lambda)^2 + (\Gamma/2)^2 \right]^{-1} - \left[E^2 - (\Gamma/2)^2 \right]^{-1} \right\} \qquad (21)$$

Dieser letzte Anteil läßt sich mit hinreichend guter Näherung für unsere Zwecke im Resonanzgebiet selbst, wo $u(E) \lessapprox 1$ ist durch einen Ansatz der Form

$$\sigma_{e,r} \sim (E - E_r)^{-2} \qquad (22)$$

darstellen und erhalten

$$\int_0^\infty u\, d(\ln E) = \beta \cdot \left(\frac{c_{238}}{c_H} \right)^{1/2} \qquad (23)$$

wo β eine von der Linienbreite Γ abhängige Konstante ist. Somit wird, wenn wir

$$\frac{c_H}{c_{238}} = k \qquad (24)$$

schreiben,

$$\ln w_r = - \beta\, k^{-1/2} \qquad (25)$$

Wir können jetzt die Bedingung dafür, daß die Kettenreaktion nicht abreißt, formulieren: Die Zahl der Neutronen χ die durch ein Neutron erzeugt wird, muß größer als 1 sein,

Figure D.351: The August 1941 report by Fritz Houtermans (working in collaboration with Manfred von Ardenne) explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-94].

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also:

$$K = \frac{n'}{n_o} = w_r \cdot \nu_{th} \cdot \frac{c_{235} \; \sigma_s}{c_{235}\,\sigma_s + c_{238} \cdot \sigma'_e + c_H \sigma_H} \geqq 1 \qquad (26)$$

Hierin zeigen sämtliche vorkommenden Wirkungsquerschnitte die gleiche Abhängigkeit von der Energie, nämlich Proportionalität mit $\frac{1}{v}$, sodaß der Bruch unabhängig von der Energie wird. Bezeichnen wir mit

$$\frac{\sigma'_e}{\sigma_s} = \alpha \quad ; \quad \frac{\sigma_H}{\sigma_s} = \gamma \qquad (27)$$

sowie das Isotopenverhältnis von U^{238} zu U^{235}

$$\frac{c_{238}}{c_{235}} = a \qquad (28)$$

so wird die kritische Bedingung zu

$$\nu_{th} \cdot w_r \cdot \frac{1}{1 + a\alpha + \gamma\, k/a} \geqq 1 \qquad (29)$$

oder ausgeschrieben

$$K = \nu_{th} \frac{e^{-\beta k^{-1/2}}}{1 + \alpha a + \gamma\, k/a} \geqq 1 \qquad (30)$$

Hierin ist ohne Isotopentrennung nur das Beimengungsverhältnis des Wasserstoffs k willkürlich veränderlich, und man sieht, daß es für gegebene Werte der anderen Konstanten einen optimalen Wert von k gibt, der K zu einem Maximum macht. Der physikalische Grund hierfür liegt natürlich darin, daß eine Erhöhung der Wasserstoffkonzentration einerseits ein schnelleres Durchlaufen des Resonanzbandes bewirkt, andererseits aber die Wahrscheinlichkeit vergrößert, daß ein Neutron nach Durchlaufen des Resonanzbandes nicht von U^{235} sondern von einem H-Kern absorbiert wird. Setzt man auf Grund der Versuche von Halban, Savitch und Kowarsky (4, 5) Zahlenwerte ein, so findet sich für k = 62 ein Wert von $w_r = 0{,}84$ und die Konstante β wird $\beta \sim 1{,}4$. Auf Grund dieser Daten ergibt sich auf Grund der von Joliot (4,5) gefundenen Zahl $\nu_{th} \sim 3{,}5$ und mit den Werten $\sigma_{e,r} = 3000 \cdot 10^{-24}\,cm^2$, $\sigma_{d,H} = 20 \cdot 10^{-24}\,cm^2$, $\sigma_{e,H} = 0{,}27 \cdot 10^{-}\,cm^2$,

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$\sigma_s = 2 \cdot 10^{-24}\,cm^2$ und $\sigma'_e = 1{,}2 \cdot 10^{-24}\,cm^2$ und $\Gamma \sim 0{,}2$ der optimale Wert von k zu k = 4 und $K \sim 0{,}75$.

Man sieht also, daß selbst unter diesen günstigen Bedingungen, bei Annahme des größten gemessenen Wertes für $\nu_{th} \sim 3{,}5$ eine <u>Reaktionskette ohne Isotopentrennung auch bei unendlichem Volumen nicht möglich ist.</u>

V. Möglichkeiten zur Auslösung einer Kettenreaktion mit thermischen Neutronen.

1. Isotopentrennung.

Die auf der Hand liegende Möglichkeit, eine Kettenreaktion mit thermischen Neutronen auszulösen, besteht natürlich darin, das Isotop U^{235} anzureichern. Aus Formel (30) folgt, daß unter Benutzung der freilich recht unsicheren oben angeführten Daten eine Anreicherung auf das etwa 2-3fache, d.h. auf eine Konzentration des U^{235} von 1,5 bis 2 % genügen würde, um mit k = 10 - 15 den kritischen Wert für K gerade zu erreichen. Doch bietet die Isotopentrennung wägbarer Mengen schwerer Elemente heute noch so erhebliche Schwierigkeiten und erfordert, wie der Verfasser an anderer Stelle (8) gezeigt hat, so erhebliche Energien, daß es durchaus zweifelhaft erscheint, ob unter diesen Umständen die zur Isotopentrennung oder Anreicherung erforderliche Energie nicht sogar die beim Spaltprozess zu gewinnende Energie übersteigt. Es ist daher wichtig, sich nach anderen Methoden umzusehen, um die erwähnten Konkurrenzprozesse auszuschalten, bzw. die Wahrscheinlichkeit für die Kernspaltung an U^{235} gegenüber diesen zu erhöhen.

Im folgenden sollen, ohne die Formel hierfür im einzelnen abzuleiten, qualitativ zwei Wege diskutiert werden, die es erlauben, das bezeichnete Ziel auch ohne Isotopentrennung zu erreichen.

2. Wahl einer schwereren Bremssubstanz als Wasserstoff, insbesondere schweren Wassers.

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Der Konkurrenzprozess 6, die Einfangung eines Neutrons durch die dem Uran zugemischte Bremssubstanz, läßt sich weitgehend dadurch eliminieren, daß die Bremssubstanz so gewählt wird, daß diese keinen oder nur einen sehr kleinen Einfangquerschnitt für Neutronen besitzt. Es ist auf Grund von Formel (30) klar, daß sich dann, (wenn wir unter k jetzt analog zu früher das Verhältnis c_b/c_{238} verstehen), da jetzt der letzte Term im Nenner von (30) wegfällt, k so groß wählen läßt, daß eine hinreichende Bremsung gegeben ist, ohne daß damit die Gefahr der Neutronen vergrößert wird, statt eine Spaltung zu bewirken, eine nutzlose Einfangung an einem Kern der Bremssubstanz zu erleiden. In Tabelle 1 ist der mittlere, relative Energieverlust für einige leichte Elemente, die als Bremssubstanz in Frage kommen gegeben. Hieraus ist ersichtlich, daß der mittlere Energieverlust ΔE mit steigender Masse sehr rasch abnimmt.

Tabelle 1.

Hierdurch ist aber andererseits wieder der Wahl der Bremssubstanz eine Grenze gesetzt, denn <u>je kleiner der Energieverlust ist, desto länger verweilt das Neutron im Energiebereich des Resonanzbandes</u>, und desto mehr Stöße sind zum Passieren desselben erforderlich. Damit erhöht sich aber in erheblichem Umfange die Gefahr einer Resonanzverschluckung durch U^{238}. Dies ist auch der Grund, weshalb man nicht einfach die Bremssubstanz weglassen kann, auch wenn man die erhebliche Vergrößerung des Reaktionsvolumens, die durch die langsamere Abbremsung bewirkt würde, in Kauf nehmen wollte. Eine Überschlagsrechnung zeigt, daß im reinen Uran, abgesehen von der Absohnitt III diskutierten Möglichkeit einer Kettenreaktion mit schnellen Neutronen, die Resonanzeinfangung an U^{238} alle Neutronen praktisch wegfängt, bevor diese das thermische Gebiet erreichen. Dies bewirkt, daß der in Abschnitt III diskutierte Elementarprozess und die Thermospaltung sich - wenigstens bei dem natürlichen Isotopengemisch - <u>niemals gegenseitig unterstützen</u> können, da die Bedingungen, die den einen ermöglichen, den anderen ausschließen.

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Praktisch erscheint als Bremssubstanz wohl schwerer Wasserstoff und zwar in der Form schweren Wassers geeignet. Die Anwesenheit von Sauerstoff stört hier keineswegs, ja wirkt sogar fördernd, da die Wasserstoffdichte im Wasser größer ist als selbst in festem Wasserstoff, und Sauerstoff sich infolge seines sehr kleinen Streuquerschnittes und des völligen Fehlens einer Absorption für thermische Neutronen sich nicht weiter störend bemerkbar macht. Man könnte aus diesem Grunde auch an flüssigen Ammoniak ND_3 denken, wenn der bisher nicht gut bekannte Einfangquerschnitt des Stickstoffs nicht zu groß ist, oder besser noch an flüssiges Methan, das von allen bekannten Stoffen die höchste Wasserstoffdichte hat. Gegen die Anwendung von Deuterium spricht nur der hohe Preis und die Schwierigkeit der Herstellung in größeren Mengen, die aber im technischen Großbetrieb durchaus möglich ist, zumal das schwere Wasser auch beim Eintreten der Kettenreaktion nicht verbraucht wird, also prinzipiell den Charakter einer einmaligen Anschaffung hat. Als nächst beste Substanz käme wohl Berylliumoxyd oder reines Beryllium in Frage, wobei vielleicht sogar ein kleiner, wenn auch wohl kaum ins Gewicht fallender Gewinn an Neutronen aus dem (n,2n)-Prozess zu erwarten ist, da dieser am Beryllium nur 1,6 MeV erfordert. Schließlich erscheint unter Umständen auch noch Kohlenstoff als Bremssubstanz geeignet, da dieser keinerlei Absorption für thermische Neutronen zeigt. Doch erscheint es fraglich, ob seine immerhin schon ziemlich hohe Masse nicht das Passieren des Resonanzbandes so weit verzögert, daß der Gewinn durch den Wegfall der Absorption bei kleinen Energien wieder wett gemacht wird.

Abschließend zu diesem Abschnitt ist zu sagen; erforderlich sind genaue Messungen der folgenden Größen: Resonanzquerschnitt σ_r von U^{238} für Einfangung, effektive Breite des Resonanzbandes Γ, Untersuchungen über den Charakter der Breite (Doppler- oder Strahlungsbreite) Spaltungsquerschnitt von U^{235} σ_s und σ'_e, Zahl der Neutronen pro Spaltungsprozess ν_{th}, Streu- und Absorptionsquerschnitte $\sigma_{d,b}$ und $\sigma_{e,b}$, der als Bremssubstanz genannten Elemente.

Figure D.352: The August 1941 report by Fritz Houtermans (working in collaboration with Manfred von Ardenne) explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-94].

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3. Relative Erhöhung der Wahrscheinlichkeit für 1/v-Prozesse durch Anwendung tiefer Temperaturen.

Bekanntlich werden Neutronen durch ein bremsendes Medium bis zu einer Energie abgebremst, die der thermischen Energie des bremsenden Mediums entspricht. Es wurde festgestellt, teils durch direkte Messungen mit Neutronenspektrographen nach dem Fizeau-Prinzip, teils durch Absorptionsmessungen an Bor, Lithium und anderen Absorbern, daß eine Erhöhung der Temperatur über die Zimmertemperatur eine Verringerung, eine Erniedrigung der Temperatur eine Erhöhung der Absorption bedingt und, wenigstens bis zu einer Temperatur von etwa 120°K, sich annähernd mit $T^{-1/2}$ ändert. Da nun die Thermospaltung am U^{235} wegen der sehr kurzen Lebensdauer des Compound-Kernes, wie auch experimentell bestätigt wird, ebenfalls dem 1/v-Gesetz folgt, gelten die Ergebnisse über die Temperaturabhängigkeit der Absorption von 1/v-Absorbern ohne weiteres auch für den Spaltungsquerschnitt des U^{235}.

Der Verfasser hat mit einer Anzahl von Mitarbeitern (9) sehr ausführliche und präzise, zum Teil noch unpublizierte Versuche über die Absorption von thermischen Neutronen (der sogenannten C-Gruppe) an Bor, Silber, Cadmium mit Silber und einer Borkammer als Detektor im Temperaturgebiet von 463° K bis zur Temperatur von 20,4° K (flüssiger Wasserstoff) unternommen, deren Ergebnisse in Fig.2. sowie in Tabelle 3 wiedergegeben sind. In Tabelle 2 ist direkt das Verhältnis des Einfangquerschnittes für Neutronen ϑ bei Abbremsung durch ein bestimmtes Medium der betreffenden Temperatur zu dem Querschnitt für thermische Neutronen aus Paraffin bei 300° K angegeben. Hieraus ist ersichtlich, daß bei Abkühlung unter die Temperatur von flüssiger Luft keine Steigerung von ϑ mehr stattfindet, und daß sich insgesamt eine Erhöhung eines 1/v-Querschnittes auf etwa das Doppelte erzielen läßt. Dieses bedeutet aber eine relative Hebung der Wahrscheinlichkeit einer Spaltung des U^{235} auf mindestens das Doppelte gegenüber der

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Resonanzeinfangung durch U^{238}, also dasselbe wie eine mit nur sehr großen Schwierigkeiten durchführbare Anreicherung des seltenen Uran-Isotops auf die doppelte Konzentration. Hierdurch erscheint es durchaus denkbar, daß selbst bei Anwendung von leichtem Wasserstoff als Bremssubstanz <u>bei tiefen Temperaturen eine Kettenreaktion mit dem natürlichen Isotopengemisch von Uran gerade noch möglich</u> wird.

Es ist notwendig, darauf hinzuweisen, daß die hier gegebenen Vorstellungen, ebenso wie unsere gesamte Vorstellung vom Einfangmechanismus thermischer Neutronen überhaupt mit der Gültigkeit des 1/v-Gesetzes für die Absorption von Bor und Lithium stehen und fallen. Die gegen die Gültigkeit dieses Gesetzes sprechenden Versuche von Chadwick und Mitarbeitern (10) scheinen zwar durch neuere amerikanische Arbeiten mit dem Neutronenspektrographen teilweise widerlegt, doch ist die Nachprüfung des 1/v-Gesetzes für Absorber, deren Compound-Kern eine extrem kurze Lebensdauer hat, insbesondere für die Uranspaltnng selbst, aber auch für Bor und Lithium vom Standpunkt der praktischen Ausnutzung der Uranspaltung unbedingt erforderlich.

Theoretisch wäre ja bei strenger Gültigkeit des 1/v-Gesetzes unter der Voraussetzung, daß die thermischen Neutronen wirklich sich im thermischen Gleichgewicht mit dem bremsenden Medium befinden, ein Ansteigen der Absorption von 1/v-Absorbern, darunter auch des U^{235} mit $T^{-1/2}$ bis hinunter zu den tiefsten Temperaturen zu erwarten. In diesem Fall müßte es, da bei der natürlichen Isotopenzusammensetzung des Urans der gesamte Wirkungsquerschnitt des 1/v-Schwanzes der U^{238} - Resonanz wesentlich kleiner ist als der Gesamtquerschnitt $\sigma_{235} \cdot \sigma_s$ des U^{235} mit Sicherheit eine, wenn auch vielleicht sehr niedrige Temperatur geben, bei der die Urankettenreaktion auch mit natürlichem Uran möglich wäre. Es ist aber notwendig, kurz auf die Ursachen dafür einzugehen, daß bei Temperaturen unter etwa 120° K die Neutronen, wie aus Tabelle 2 folgt, nicht mehr thermisches Gleicngewicht erreichen. Nach Fermi, Wick, Pomerentchuk (11, 12) u.a. liegt diese Tatsache daran, daß infolge der chemischen Bindung des Wasserstoffs das Proton beim Zusammenstoß mit dem Neutron nicht mehr als frei angesehen werden darf. Bei Temperaturen, die wesentlich unter der Debye-Temperatur des bremsenden Mediums liegen, wird der

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Energieaustausch des Neutrons mit dem Gitter außerordentlich erschwert. Eine Energieabgabe des Neutrons ist unter diesen Bedingungen nur mehr durch Anregung von 2 oder mehr Phononen möglich. Da aber die Lebensdauer des Neutrons, nachdem es thermische Energie von etwa Zimmertemperatur erreicht hat, so gering ist, daß es nur etwa 140 -200 Stöße in einem wasserstoffhaltigen Medium wie Paraffin oder Wasser machen kann, bis es durch Einfangung durch ein Proton absorbiert wird, reicht diese Lebensdauer nicht aus, um bei tiefen Temperaturen das thermische Gleichgewicht zu erreichen. Bisher unveröffentlichte Experimente vom Verfasser und seinen Mitarbeitern haben gezeigt, daß in Borlösungen, in denen die Lebensdauer des Neutrons auf etwa 60 Stöße verkürzt war, auch das thermische Gleichgewicht der Zimmertemperatur nicht erreicht wird. Die "minimale Abkühlungstemperatur" der Neutronen liegt in diesem Falle bei etwa 700 bis 800° K, auch wenn das Medium sich auf Zimmertemperatur oder der Temperatur der flüssigen Luft befindet.

Umgekehrt wird man daher erwarten müssen, daß wenn die Lebensdauer des Neutrons im bremsenden Medium heraufgesetzt wird, auch wesentlich tiefere Temperaturgleichgewichte als in wasserstoffhaltigen Bremsmedien erzielt werden können. Dies bedeutet, daß die in Absatz 2 dieses Abschnittes besprochenen Maßnahmen (Ersetzung des Wasserstoffes im Bremsmedium durch Deuterium oder ein anderes schwereres Element)geeignet sind,die Lebensdauer des thermischen Neutrons im Bremsmedium um mindestens das Zehnfache zu verlängern. Damit wird aber auch die erreichbare thermische Gleichgewichtsenergie der Neutronen wesentlich heruntergesetzt, und die Uranspaltung an U^{235} sehr viel wahrscheinlicher gemacht. Die Anwendung eines der in Absatz 2 genannten Elemente als Bremsmedium bei tiefer Temperatur, z.B. der des flüssigen Wasserstoffs (20,4°K) oder noch tieferer Temperaturen kommt daher in seiner Wirkung einer Anreicherung des seltenen Uran-Isotops auf das Vielfache gleich.

Die wichtigste Wirkung der Anwendung tiefer Temperaturen und gleichzeitig eines schweren Bremsmediums besteht unter Umständen in einer Wirkung auf die Doppler-Breite der Resonanz des U^{238}. Diese Wirkung soll hier nur erwähnt und im folgenden

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Absatz näher diskutiert werden.

Wir haben also gesehen, daß die Wirkung der gemeinsamen Anwendung schwerer Bremsmedien und tiefer Temperaturen dreifacher Art ist und sich gegenseitig unterstützt in der Richtung, die Auslösung einer Kettenreaktion zu begünstigen, und zwar durch:

1. Ausschaltung der Wasserstoffabsorption für thermische Neutronen als Konkurrenzprozess.
2. Vergrößerung des Spaltquerschnittes des U^{235} durch Gültigkeit des $T^{-1/2}$-Gesetzes prinzipiell bis zu beliebig niedrigen Energien.
3. Möglicherweise Vergrößerung der Wahrscheinlichkeit der Neutronen, das Resonanzband des U^{238} zu passieren durch Verschmälerung desselben infolge des Doppler-Effektes.

4. Selbstregulierende Wirkung und Bedeutung des Doppler-Effektes bei tiefer Temperatur.

Wir haben im vorstehenden Absatz gesehen, daß es zweifellos auch ohne Anwendung einer Isotopentrennung bei hinreichend tiefer Temperatur möglich ist, durch Thermospaltung an U^{235} eine Kettenreaktion in Gang zu bringen. Bevor auf die praktische Bedeutung dieser Tatsache näher eingegangen werden kann, müssen zunächst die als Wirkung einer solchen Kettenreaktion auftretenden Veränderungen im Versuchsvolumen und ihre selbstregulierende Rückwirkung auf die Kettenreaktion behandelt werden.

Von Halban (13) und Flügge (14) haben bei der Diskussion der Uran-Kettenreaktion auf folgenden Gedankengang hingewiesen: Das Eintreten der Kettenreaktion bewirkt durch die frei werdende ungeheure Reaktionswärme von 180 MeV oder $4,14 \cdot 10^{9}$ Kal/Mol momentan eine wesentliche Temperaturerhöhung im Versuchsvolumen, die, wenn hierdurch die Kette nicht rechtzeitig zum Abreißen gebracht wird, zu einer Zerstörung der Apparatur und zur Verdampfung der Versuchssubstanz führen würde. Die genannten Autoren schlagen daher vor, dem Versuchsvolumen Cadmium in sehr geringer Konzentration beizumischen, sodaß die fast temperaturunabhängige Cadmiumabsorption, die energetisch etwas oberhalb der thermischen Energien der Zimmertemperatur beginnt, die Kette rechtzeitig zum Abreißen bringt und damit die Ket-

Figure D.353: The August 1941 report by Fritz Houtermans (working in collaboration with Manfred von Ardenne) explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-94].

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tenreaktion selbstregulierend steuert. Aus den oben angeführten Tatsachen geht jedoch hervor, daß die Anwendung von zusätzlichem Cadmium als Selbstregulativ überflüssig ist. Denn auch in angereichertem Cemisch ist die Resonanzabsorption des U^{238} noch einer der wichtigsten Konkurrenzprozesse. Diese ist aber abgesehen vom Doppler-Effekt, der in gleicher Richtung wirkt, temperaturunabhängig, während die Absorption in U^{235} mit steigender Temperatur oberhalb der Zimmertemperatur mit $T^{-1/2}$ abnimmt. Dies allein schon würde ein Abreißen der Kette bei steigender Temperatur bewirken. Das U^{238} wirkt also genau wie das Cadmium, dessen Absorption ja auch eine Resonanzabsorption ist. Hierzu kommt aber noch selbst bei reinem U^{235}, daß die bisher gar nicht behandelte Wahrscheinlichkeit der Neutronen (w_1 des Abschnitts II), aus dem endlichen Versuchsvolumen herauslaufen, ohne ein Neutron aufzulösen, mit v, also mit $T^{1/2}$ steigen muß, und daher ebenfalls selbstregulierend wirkt.

Schließlich ist noch eine dritte selbstregulierende Wirkung, die mit dem Doppler-Effekt der U^{238}-Resonanz zusammenhängt, zu nennen, über die aber noch zu wenig bekannt ist, um quantitative Schlüsse zu ziehen. Zur Erläuterung der für die ganze Urankette sehr wichtigen Wirkung des Doppler-Effektes muß kurz auf die Natur der Resonanzabsorption des U^{238} eingegangen werden.

Bekanntlich setzt sich die Breite Γ einer Neutronenresonanz für Einfangung zusammen aus einer Doppler-Breite Γ_D, die durch die Temperaturbewegung des einfangenden Kerns bedingt ist, und einer Strahlungsbreite Γ_c, die bedingt ist durch die Ausstrahlungswahrscheinlichkeit des Compound-Kerns. Ist die effektive Breite des Resonanzbandes Γ im wesentlichen durch Ausstrahlung bedingt, so ist die Resonanzabsorption praktisch völlig temperaturunabhängig. In diesem Falle fällt sowohl die im vrigen Absatz unter 3 genannte Wirkung einer Temperaturerniedrigung als auch die im vorigen Absatz erwähnte Selbstregulierung durch den Doppler-Effekt bei Temperaturerhöhung fort. Ist aber $\Gamma_c \ll \Gamma_D$ oder von gleicher Größenordnung, so ist die Resonanzabsorption temperaturabhängig. Die Richtung der Temperaturabhängigkeit ist dabei durch die Schichtdicke bestimmt. Hierauf beruht eine vom

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Verfasser ausgearbeitete Methode, die Doppler-Breite und damit in gewissen Grenzen die natürliche Linienbreite von Neutronenresonanzen zu bestimmen, die inzwischen von Timoshchuk (15) auf das Silber angewandt wurde, wobei er festgestellt hat, daß beim Silber der zweite hier erwähnte Fall ($\Gamma_c \ll \Gamma_d$). vorliegt. Es wäre von sehr großer Bedeutung, für das Problem der Urankettenreaktion, die gleichen Messungen für die Resonanzabsorption von U^{238} durchzuführen. Denn obwohl die gesamte Absorptionswahrscheinlichkeit eines Resonanzbandes durch den Doppler-Effekt ungeändert bleibt, wirkt sich ein Schmäler- und Höherwerden der Linie bei Temperaturerniedrigung bzw. eine Verflachung und Verbreiterung bei Temperaturerhöhung außerordentlich stark auf die Wahrscheinlichkeit w_r eines Neutrons, das Resonanzband bei gegebenem mittleren Energieverlust ΔE zu passieren, aus. Die Wirkung besteht naturgemäß darin, daß ein schmales und hohes Band viel leichter zu passieren ist, als ein breites und niedriges Band. Hierauf beruht die im vorigen Abschnitt erwähnte Wirkung einer Temperaturerniedrigung bei Anwendung eines schweren Bremsmediums. Diese Wirkung ist, wenn die Uran-Resonanzbreite doppler-bedingt ist, zweifellos im Stande bei tiefer Tempe atur die Verkleinerung von w_r gegen Wasserstoff infolge der Vergrößerung von ΔE ganz oder teilweise zu kompensieren oder sogar überzukompensieren.

VI. Kettenreaktionen bei endlichem Versuchsvolumen.

Alle bisherigen Betrachtungen beziehen sich auf ein unendlich großes Versuchsvolumen, sodaß die in Abschnitt II genannte Wahrscheinlichkeit w_1, daß ein Neutron nach außen entweicht, nicht berücksichtigt ist. Die Rechnung für endliches Versuchsvolumen wurde von F. Perrin (16), Flügge u.a.(14,15) durchgeführt. Bezeichnen wir mit n die Neutronendichte, mit κ die in Abschnitt III. und IV. definierte kritische Größe der Kettenreaktion, also für schnelle Neutronen:

$$\kappa = \nu (1 - \eta) \qquad (31)$$

für langsame Neutronen

$$\kappa = \nu_{th} \cdot e^{-\beta k^{-\frac{1}{2}}} \quad \frac{}{1 + \alpha a + \gamma\, k/a} \qquad (32)$$

Ferner

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Ferner D den Diffusionskoeffizienten und t die Zeit, so wird

$$D = \frac{1}{3} \Lambda v = \frac{v}{3 \sum c_i \sigma_{d,i}} \qquad (33)$$

wo Λ die mittlere freie Weglänge der Neutronen in der Versuchssubstanz, v ihre Geschwindigkeit und die $\sigma_{d,i}$ zeitlich über den Verlauf der Abbremsung gemittelte Streuquerschnitte bedeuten. Die Summe im Nenner von (33) ist dabei über alle im Versuchsvolumen vorhandenen Elemente einschließlich des Urans zu erstrecken. Für die Neutronendichte n gilt dann eine Diffusionsgleichung der Form

$$\frac{\partial n}{\partial t} = (K - 1)\, n + D \cdot \Delta n \qquad (34)$$

deren Lösung sich als Eigenwertproblem mit der kritischen Randbedingung darstellt, daß die Neutronendichte an der Oberfläche des Versuchsvolumens verschwindet. Für kugelförmiges Volumen wird dann der kritische Radius R_{kr} in Übereinstimmung mit Perrin

$$R_{kr} = \pi \cdot \left(\frac{D}{K-1} \right)^{1/2} \qquad (35)$$

Bei homogener Verteilung des Urans im Versuchsvolumen wird, wenn $\bar{c}$ eine in bestimmter Weise (mit den Streuquerschnitten als Gewicht) gemittelte Dichte bedeutet, so wird $R_{kr} \sim (\bar{c})^{-1}$ und die kritische Masse M_{kr} $R^3 \bar{c} \sim \bar{c}^{-2}$. Perrin hat ferner auch die Wirkung einer Schutzhülle aus stark neutronenstreuendem Material berechnet, die nach außen entweichende Neutronen ins Inntere reflektiert. Doch wirkt eine solche Schutzhülle in jedem Falle weniger stark als eine zusätzlich angebrachte äußere Uranschicht da der Streuquerschnitt von Uran sowohl für schnelle wie auch für langsame Neutronen größer als der jeder anderen nicht absorbierenden Streusubstanz ist.

Wir sehen also, daß der kritische Radius mit $(K-1)^{-1/2}$ die kritische Masse mit $(K-1)^{-3/2}$ proportional ist.
Die kritische Bedingung zur Auslösung einer Kettenreaktion bei gegebenem Radius des Versuchsvolumens R wird daher:

$$K \geqq 1 + \frac{\text{const}}{R^2} \qquad (36)$$

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VII. Die Bedeutung einer Kettenreaktion bei tiefen Temperaturen als Neutronenquelle und Apparatur zur Isotopenumwandlung.

Wir sahen im letzten Unterabschnitt des Kapitel IV., daß in einer endlichen Menge Uran des natürlichen Isotopengemisch mit einem leichten Element (nicht Wasserstoff) als Bremssubstanz bei irgendeiner, wenn auch im allgemeinen sehr tiefen Temperatur, die Auslösung möglich wird. Es muß nun die Frage behandelt werden, ob eine solche Anordnung irgendwelche praktische Bedeutung für die Lösung des Uran-Problems hat, denn eine Wärmekraftmaschine, die nur bei sehr tiefen Temperaturen arbeitet, hat natürlich kaum praktische Bedeutung.

Aber selbst dann, wenn mit Hilfe einer von außen zu betreibenden Kälteanlage die gesamte durch die Uran-Kettenreaktion frei werdende Wärmetönung unter Energieverbrauch weggekühlt werden muß, stellt eine solche Anlage eine Apparatur dar, die es erlaubt, mit sehr guter Ausbeute und einem, pro Neutron durchaus mäßigen Energieaufwand, Neutronen in so großer Menge zu liefern, wie keine andere atomphysikalische Apparatur es gestattet. Denn bei einer Kettenreaktion werden ja wägbare Mengen des Uranisotops U^{235} umgesetzt, und daher, wenn man die Apparatur etwa so bemißt, daß ein gewisser Bruchteil z.B. 10 bis 20 % der entstehenden Neutronen nach außen entweichen kann, ohne daß die Kette abreißt, auch wägbare Mengen Neutronen frei. Vergleichen wir etwa die Neutronenergiebigkeit einer solchen Apparatur mit der besten bisherigen Neutronenquelle, einem Zyklotron, so zeigt sich leicht, daß eine solche Anlage mit einer Menge natürlichen Urangemischs von ca. 1 t der Leistung von etwa 10^4 bis 10^5 Zyklotrons entspricht. Das Tempo der Abgabe ließe sich dabei durch das Temperaturregime der Apparatur wegen der oben erwähnten selbstregulierenden Wirkung der Kettenreaktion willkürlich regeln. Als Nebenprodukt entstehen bei einer solchen Apparatur durchaus wägbare Mengen derjenigen radioaktiven Substanzen, die nach Hahn und Straßmann als Spaltprodukte der Thermospaltung des Urans entstehen. Es ist durchaus möglich, auch dann, wenn

Figure D.354: The August 1941 report by Fritz Houtermans (working in collaboration with Manfred von Ardenne) explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-94].

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auf den Energiegewinn der Kettenreaktion vollkommen verzichtet wird, diese radioaktiven Substanzen, soweit sie langlebig genug sind, oder auch andere langlebige radioaktive Substanzen, die mit Hilfe der nach außen entweichenden Neutronen erzeugt worden, zur Energiespeicherung etwa für Luminophore zu benutzen. Außerdem w re eine solche Apparatur als makroskopische Neutronenquelle für alle jene Zwecke von großer technischer Bedeutung, die sich aus der Verwendung von Neutronen und künstlich radioaktiven Stoffen für die angewandte Physik, Chemie, Biologie und vor allem für die Physiologie ergeben.

Schließlich aber hätte eine Apparatur, die bei tiefer Temperatur eine Kettenreaktion an U^{235} gestattet, auch insofern große praktische Bedeutung, als sie, wenn auch auf einem Umwege nach allen unseren bisherigen theoretischen Vorstellungen über die Natur schwerer Kerne auch eine tatsächliche Lösung des Uranproblems vom Standpunkte der Energieerzeugung aus in einem viel größeren Umfange gestattet, als dies auf dem Wege der Isotopentrennung möglich wäre. Denn bei allen denkbaren Apparaturen, die eine Kettenreaktion an isoliertem U^{235} gestatten, würde ja nur 1/139 der gesamten zur Verfügung stehenden Uranmenge als "Brennstoff" oder"Explosivstoff" benutzt werden, während bei der Isotopentrennung auch für die unverwertbaren Mengen von U^{238} Energie aufgewandt werden muß.

Um diesen Punkt näher zu verstehen, müssen wir uns die Frage stellen, was aus denjenigen Neutronen wird, die bei der hier behandelten Kettenreaktion (U - schwere Bremssubstanz bei tiefer Temperatur) entstehen und nicht nach außen entweichen. Wir sahen oben, daß durch Ausschaltung der Neutroneneinfangung durch den Wasserstoff der einzig noch vorhandene Konkurrenzprozess, der in der Tat einen großen Teil der Neutronen schluckt, die Resonanzeinfangung des U^{238} ist. Bei dieser Resonanzeinfangung entsteht bekanntlich zunächst der 23 min-Körper, ein U^{239}_{92}, aus dem durch ß-Zerfall zunächst Ek Re^{239}_{93} entsteht, das wahrscheinlich selbst wieder ß-aktiv ist und einen weiteren Körper der (4n + 3) - Reihe liefert. Es gibt jetzt nur zwei Möglichkeiten: entweder folgt eine Zerfallsreihe, die sich über eine größere Anzahl von aktiven Isotopen kleiner Lebensdauer fortsetzt, oder die Reihe führt früher oder später zu einem relativ langlebigen Produkt. Im ersteren Falle stellt das Gleichgewichtsgemisch dieser aktiven Substanzen, das sich ja im Reaktionsvolumen unserer Apparatur in ungefähr eben dem Masse bildet, in dem das U^{235} aufgebraucht wird, (die Zahl der resonanzverschluckten Neutronen ist von gleicher Größenordnung, wie die Zahl derjenigen, die die Kette fortsetzen), einen Energieakkumulator dar, der sich ebenso wie die Zerfallsprodukte chemisch abtrennen läßt. Im letzteren Falle aber muß das entstehende langlebige Isotop des Atomgewichts 239 selbst wieder Thermospaltung zeigen. Die Untersuchung der radioaktiven Elemente der verschiedenen Reihen, hat nämlich ergeben, wie auch theoretisch auf Grund des Modells von Bohr und Wheeler (2) zu erwarten ist, daß die zur Spaltung erforderliche Energie des Kerns in jeder Zerfallsreihe mit zunehmendem Atomgewicht abnimmt. In der (4n + 3) - Reihe ist nun schon bei U^{235} der Punkt erreicht, bei dem die Spaltungsenergie unter der Bindungsenergie des Neutrons liegt, also der Compound-Kern auch bei verschwindender kinetischer Energie des eingefangenen Neutrons gegen Spaltung instabil ist. Durch Aufnahme eines Neutrons kommt aber mit U^{239} wieder ein Kern dieser Reihe zustande, der sicher nicht stabiler gegen Spaltung sein kann, als U^{235}. Daher muß also ein entstehendes langlebiges Produkt der Masse 239 durch thermische Neutronen spaltbar sein. Jedes Neutron, das anstatt an U^{235} Spaltung zu bewirken von U^{238} eingefangen wird, schafft also einen neuen, durch thermische Neutronen spaltbaren Kern. Wir können daher eine Apparatur, die es gestattet, mit einem Energieumsatz an wägbaren Mengen U^{235} die Kettenreaktion ablaufen lassen, gleichzeitig als eine Isotopenumwandlungsapparatur ansehen. Der Vorteil gegenüber einer Isotopentrennungsapparatur ist aber der, daß das neugeschaffene Produkt, das ja eine Kernladung von 93 oder mehr hat, chemisch nicht mehr mit dem Uran identisch und daher mit gewöhnlichen chemischen Methoden abzutrennen ist. Da nun viel größere Mengen, nämlich das 139fache an U^{238} zur Verfügung stehen, so ist die Verwertbarmachung desselben als "Brennstoff" für eine Kettenreaktion ein für unsere Themenstellung viel wichtigerer Vorgang, als die Isotopentrennung, die bloß das U^{235} zu verwerten gestattet.

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Für die Anregung zu dieser Arbeit und deren Ermöglichung danke ich Baron Manfred von Ardenne.

Berlin-Lichterfelde-Ost, den August 1941

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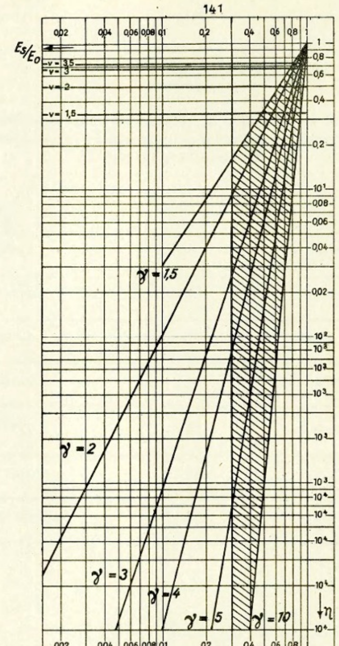

Fig. 1

Kernspaltung durch schnelle Neutronen. Wahrscheinlichkeit η eines Neutrons unter die kritische Energie der Kernspaltung abgebremst zu werden in Abhängigkeit vom Verhältnis E_s/E_0 (kritische Energie der Spaltung durch mittlere Primärenergie) sind die schrägen Geraden für verschiedene Werte von $\gamma = \sigma_s/\sigma_d \cdot \mu$. Das schraffierte Gebiet gibt die experimentellen Grenzen an, der eingezeichnete Punkt den wahrscheinlichen Wert. Die roten horizontalen Geraden geben den kritischen Wert an, für den gerade noch eine Kettenreaktion möglich ist, wenn die Zahl der Neutronen pro Spaltprozess zu angenommen wird. Damit die Kette nicht abreißt, muß der experimentelle Wert von unter der roten Geraden für den wahren Wert von v_s liegen. Je tiefer er darunter liegt, desto kleiner wird das kritische Volumen.

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Tabelle 1

Mittlerer relativer Energieverlust eines Neutrons pro Stoß beim Zusammenstoß mit einem Kern verschiedener Elemente. $\mu = (2\ M/M+1)^2$

Elemente		Masse	$\mu = \overline{\Delta E}/E$
Wasserstoff	H	1	0,500
Deuterium	D	2	0,444
Beryllium	Be	9	0,180
Kohlenstoff	C	12	0,142
Stickstoff	N	14	0,124
Sauerstoff	O	16	0,111
Uran	U	238	$0,833 \cdot 10^{-2}$

Figure D.355: The August 1941 report by Fritz Houtermans (working in collaboration with Manfred von Ardenne) explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-94].

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Tabelle 2

Relative Änderung ϑ des Einfangquerschnittes σ_e für Neutronen der C-Gruppe für verschiedene Absorber und Detektoren.

Silber als Detektor.

Absorber / Detektor	Ag / Ag 200 sec	Cd / Ag 200 sec	B / Ag 200	B / Ag 22	$T/290^{-1/2}$
Bremsmedium	ϑ	ϑ	ϑ	ϑ	ϑ
Wasser 290°K	1,00	1,00	1,00	1,00	1,00
Paraffin	1,3±0,2	1,3±0,1	1,31±0,05		1,94
Flüssiger Wasserstoff 20,4°K	2,2±0,14	1,32±0,15	1,72±0,06		3,76
Flüssiger Wasserstoff, Detektor umgeben mit einer 15 mm Schicht von Paraffin oder festem Methan, 20,4° K			1,76±0,08	1,80±0,1	3,76

2. Detektor: Borkammer mit Proportionalverstärker

Absorber: Bor, als Element, verschiedene Absorber bis etwa 5 % Durchlässigkeit, Geometrie: Ziemlich paralleles Bündel

Bremsmedium	Temp	ϑ	$T/300^{-1/2}$
Paraffinöl	463°K	0,78±0,04	0,81
"	300°K	1,00	1,00
Paraffin	300°K	1,00	1,00
"	77°K	1,53±0,04	1,98
"	20°K	1,58±0,05	3,84
Flüssiger Wasserstoff	20,4°K	2,13±0,07	3,84

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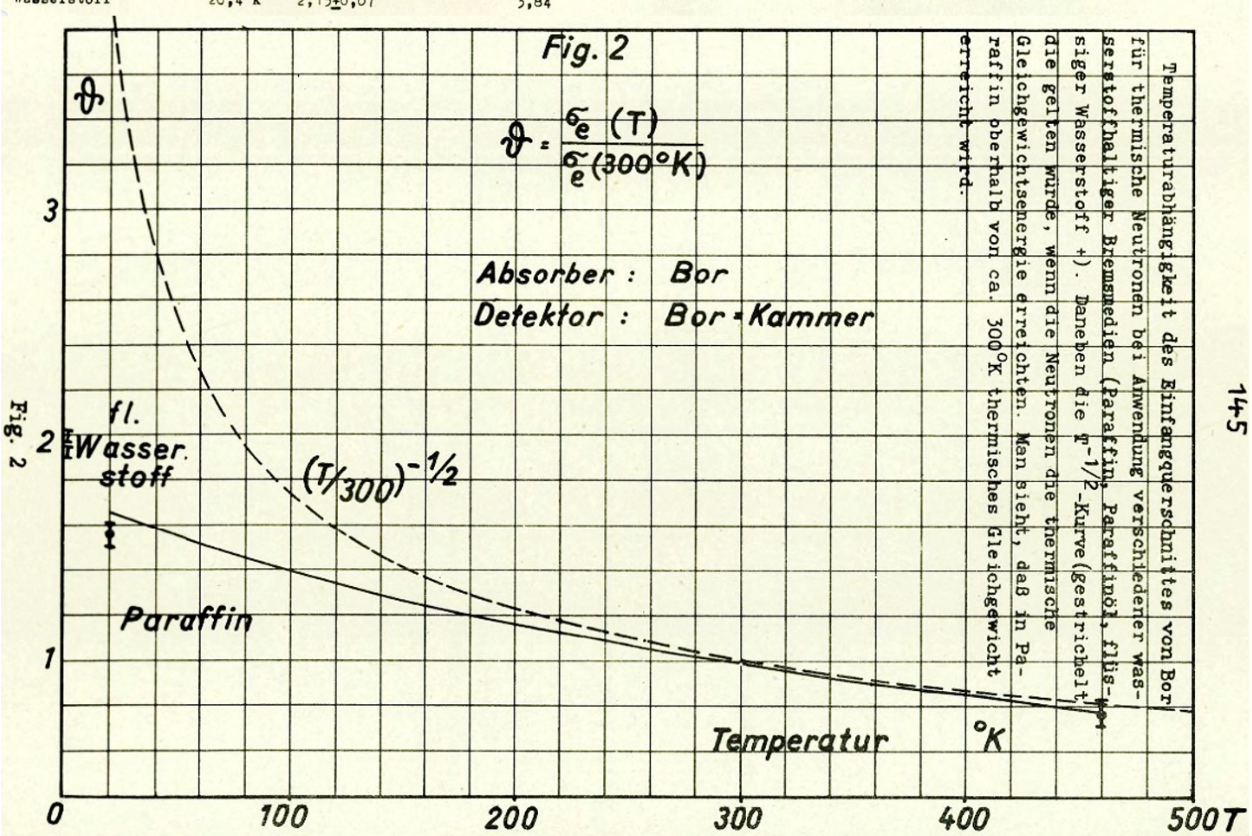
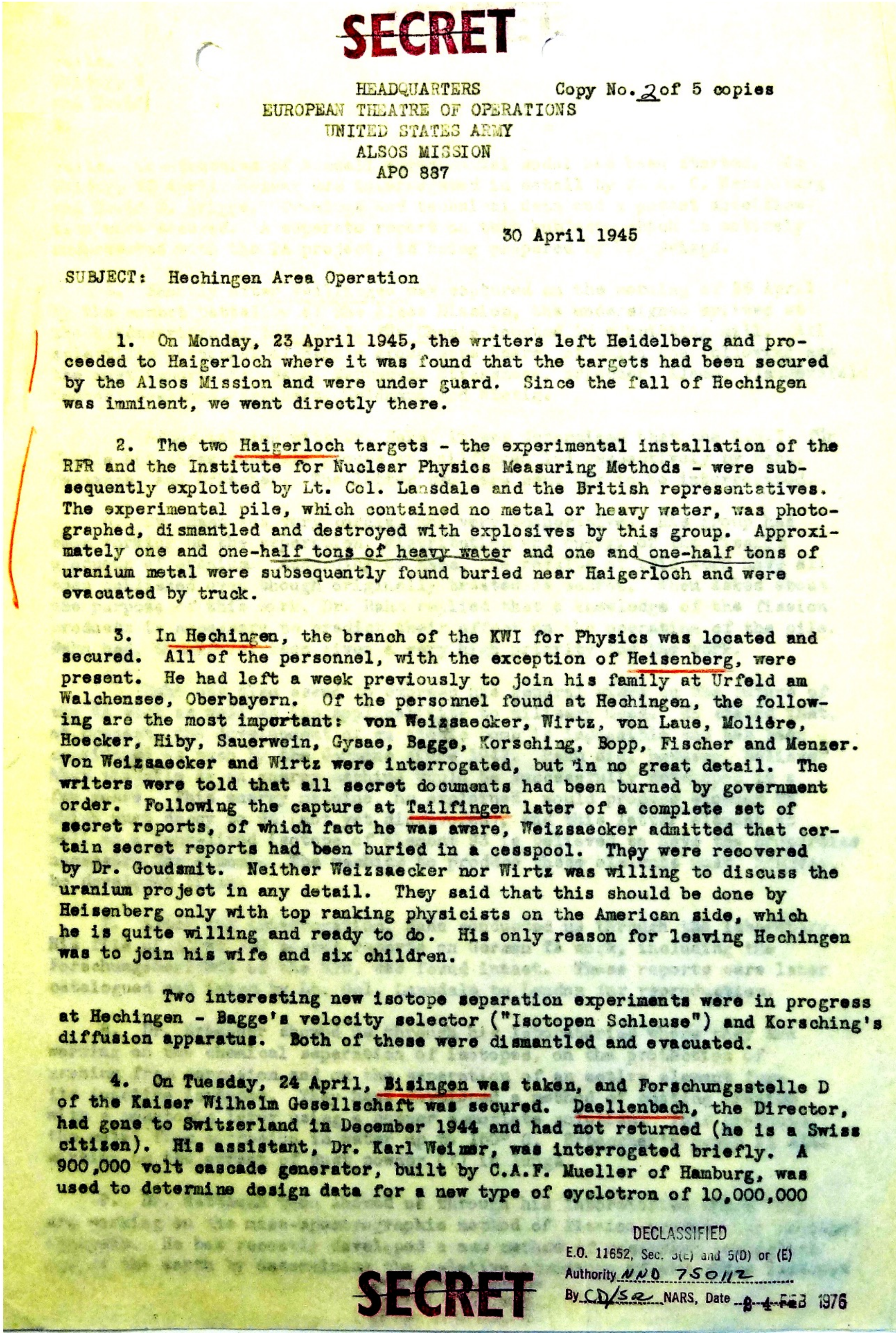


Figure D.356: The August 1941 report by Fritz Houtermans (working in collaboration with Manfred von Ardenne) explaining the feasibility of breeding plutonium-239 and using it to make fission bombs. [G-94].



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EUROPEAN THEATRE OF OPERATIONS
UNITED STATES ARMY
ALSOS MISSION
APO 887

30 April 1945

SUBJECT: Hechingen Area Operation

1. On Monday, 23 April 1945, the writers left Heidelberg and proceeded to Haigerloch where it was found that the targets had been secured by the Alsos Mission and were under guard. Since the fall of Hechingen was imminent, we went directly there.

2. The two Haigerloch targets - the experimental installation of the RFR and the Institute for Nuclear Physics Measuring Methods - were subsequently exploited by Lt. Col. Lansdale and the British representatives. The experimental pile, which contained no metal or heavy water, was photographed, dismantled and destroyed with explosives by this group. Approximately one and one-half tons of heavy water and one and one-half tons of uranium metal were subsequently found buried near Haigerloch and were evacuated by truck.

3. In Hechingen, the branch of the KWI for Physics was located and secured. All of the personnel, with the exception of Heisenberg, were present. He had left a week previously to join his family at Urfeld am Walchensee, Oberbayern. Of the personnel found at Hechingen, the following are the most important: von Weizsaecker, Wirtz, von Laue, Molière, Hoecker, Hiby, Sauerwein, Gysae, Bagge, Korsching, Bopp, Fischer and Menzer. Von Weizsaecker and Wirtz were interrogated, but in no great detail. The writers were told that all secret documents had been burned by government order. Following the capture at Tailfingen later of a complete set of secret reports, of which fact he was aware, Weizsaecker admitted that certain secret reports had been buried in a cesspool. They were recovered by Dr. Goudsmit. Neither Weizsaecker nor Wirtz was willing to discuss the uranium project in any detail. They said that this should be done by Heisenberg only with top ranking physicists on the American side, which he is quite willing and ready to do. His only reason for leaving Hechingen was to join his wife and six children.

Two interesting new isotope separation experiments were in progress at Hechingen - Bagge's velocity selector ("Isotopen Schleuse") and Korsching's diffusion apparatus. Both of these were dismantled and evacuated.

4. On Tuesday, 24 April, Bisingen was taken, and Forschungsstelle D of the Kaiser Wilhelm Gesellschaft was secured. Daellenbach, the Director, had gone to Switzerland in December 1944 and had not returned (he is a Swiss citizen). His assistant, Dr. Karl Weimer, was interrogated briefly. A 900,000 volt cascade generator, built by C.A.F. Mueller of Hamburg, was used to determine design data for a new type of cyclotron of 10,000,000

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Figure D.357: James A. Lane and Frederic A. C. Wardenburg. 30 April 1945. SUBJECT: Hechingen Area Operation [NARA RG 77, Entry UD-22A, Box 168, Folder 202.2 LONDON OFFICE: Combined Intell Disc.].

volts. Construction of a small experimental model had been started. On Friday, 27 April, Weimer was interrogated in detail by F. A. C. Wardenburg and David B. Griggs. Drawings and technical data and a patent specification were secured. A separate report on this subject, which is entirely unconnected with the TA project, is being prepared by Dr. Griggs.

5. Shortly after Tailfingen was captured on the morning of 25 April by the combat battalion of the Alsos Mission, the undersigned arrived at the headquarters of the K.W.I. für Chemie located in a knitting mill. All scientific personnel of Hahn's group were there, of which the following are the most important: Hahn, Mattauch, Strassmann, Erbacher, Klemm, Flammersfeld, Radoch, Seelmann-Eggebert, Waldmann and Wietig.

After talking with Dr. Hahn, it was determined that the K.W.I. für Chemie had three separate groups at Tailfingen led respectively by Hahn, Mattauch, and Erbacher. The latter two were sent for to be interrogated.

6. Dr. Hahn was very cordial and very cooperative. His group has been working on the separation, distribution and energy of the fission products of uranium. According to Hahn, the results of this work have all been published even though originally treated as secret. When asked about the purpose of this work, Dr. Hahn replied that a knowledge of the fission products is necessary to predict their effect on the operation of the pile. Hahn had, therefore, been given a very high priority for the work.

Hahn was also asked to express his general views on the future of the TA work as well as its applicability to military uses. He stated that, at present, the development of an atomic bomb is impossible and has been considered as such by the Germans since 1942. Hahn did, however, believe that the pile as an energy machine would be successfully developed in a few years. This energy machine, he explained, would produce element 93 which must decay to 94 (not yet discovered), and this latter element as well as a long-lived isotope of element 93 is believed to have the properties necessary for a bomb. The machine to produce these elements must, however, be developed first.

7. After the interrogation, Hahn conducted us through the laboratory. His file of about 150 secret reports on German TA work, including the Forschungsberichte of the RFR, was found intact. These reports were later catalogued and taken by Lt. Col. Lansdale to London for reproduction.

8. Dr. Erbacher showed us through his laboratories where they are working on the chemical separation of isotopes, on the protection of uranium from corrosion and on the separation of an active element from its inactive isotopes. They have developed a method of coating uranium with a monatomic layer using a copper ammoniate solution. This protects the metal from corrosion in water up to 150° C. Erbacher's group is also working on the effect of dust powder (?) in lungs.

9. Dr. Mattauch then showed us through his laboratories where they are working on the mass-spectrographic method of fission-product (or isotope) analysis. He has recently developed a new method of measuring geological age of the earth by determining the relative abundance of strontium isotopes

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in a mass spectrograph. One member of Mattauch's group, Dr. Klemm, has been working on a method of isotope separation by the electrolysis of a fused salt. It has not yet been proven feasible.

10. The following personnel have been evacuated to Heidelberg pending establishment of a permanent detention location: Hahn, Mattauch, von Weizsaecker, von Laue, Wirtz, Bagge and Korsching.

J. A. LANE

F. A. C. WARDENBURG

Expert Consultants

NARA RG 77, Entry UD-22A, Box 168, Folder 202.2 LONDON OFFICE: Combined Intell Disc.

Figure D.358: James A. Lane and Frederic A. C. Wardenburg. 30 April 1945. SUBJECT: Hechingen Area Operation [NARA RG 77, Entry UD-22A, Box 168, Folder 202.2 LONDON OFFICE: Combined Intell Disc.].

[German reports captured by the U.S. Alsos Mission also show that there was wartime work on chemical methods for processing irradiated fission fuel and purifying different components from it. Unless otherwise noted, text for G-series captured German nuclear reports cited here consists of the English-language abstracts prepared by American scientists who studied the German reports.]

G-259. Otto Hahn and Fritz Strassmann. The Chemical Separation of Elements and Atomic Species Produced by Uranium Fission (General Part). 1944.

Introductory considerations on separation of U fission products are given. Extraction of U as nitrate is possible if amounts larger than several 100 g are irradiated, the other method is more advisable for amounts smaller than that: three methods are proposed for extraction of the remaining smaller amounts of U from the fission products, separation of the U as sodium pyrouranate by precipitation with a solution of caustic soda, precipitation by ammonium to ammonium pyrouranate, dissolving of this by surplus ammonium carbonate to uranium carbonate, and precipitation as sodium uranylacetate.

G-260. Otto Hahn and Fritz Strassmann. Chemical Separation of Uranium Fission Products. Halogens, Rare Gases, Earth Metals and Alkaline Earth Metals. 1944.

Distillation methods, precipitation by Ag ions, and solvent extraction for I and Br separation are reported in detail. Indirect identification of Xe and Kr proved less reliable than their direct identification in specially constructed counting tubes. Different tubes and methods of operation are illustrated. Indirect identification of halogens by determination of noble gases formed by halogen decay are given for Rb and Cs, Sr and Ba. Detailed extraction methods for the single elements are given for Zr, Nb, Mo, Tc, Sn, Sb, Te, Se, As, Ge, Ga, Zn, Co, and Ni. Isotopes intermediary between Br^{35} and Br^{39} could not be identified. A procedure to separate all fission products from a single sample of irradiated U concludes the report.

G-111. Josef Schintlmeister. The Placing in the Periodic Table of the Element with Alpha Rays of 1.8 cm Range. 1941.

See reports G-55 and G-112 for chemical identification of this element. Element can be atomic number 93 or 94 but its alpha decay energy and stability as regard beta decay shows it is not 93. It mass number is most likely 244 but it could be 246, or 242. This can be determined, for 244 and 242 can be split by thermal neutrons while 246 will require faster neutrons.

This element is precipitated by H_2S from strongly acid solutions and it does not form compounds in strongly oxidizing solutions (HNO_3 and H_2SO_4).

G-112. Josef Schintlmeister and Friedrich Hernegger. Further Chemical Investigation of an Element with Alpha Rays of 1.8 cm Range. 1941.

Some chemical properties of new element. Ammonia and sodium hydroxide precipitate about half the element. Carbonate precipitates it quantitatively. In distillation with nitric acid or hydrochloric acid the element is not distilled, but with sulfuric acid a high percentage of the element is distilled over. Hydrogen sulfide precipitates it quantitatively from strong acid solutions. Other chemical properties listed.

Josef Schintlmeister to Hermann Mark. 7. August 1945. [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45–Dec 45)] **See document photos on pp. 3828–3829.**

Die heute Nacht erfolgte Veroffentlichung der ersten technischen Anwendung der Uranspaltung nehme ich zum Anlass, Ihnen mitzuteilen, dass auch am II. Physikalischen Institut wahrend des Krieges an diesem Problem gearbeitet wurde. Ich selbst war aus diesem Grunde nie zur Wehrmacht eingeruckt. [...]

Die technische Ausnutzung der Atomkernenergien bei der Uranspaltung setzt sehr schwierige und sehr kostspielige Arbeiten voraus. Mit einigen Kilogrammen der neuen Elemente, die such unvergleichlich einfacher und billiger gewinnen lassen, wird sich aller Voraussicht nach ohne den bisher notigen Aufwand eine Atomkernmaschine bauen lassen, da zu erwarten ist, dass die Kernspaltung leichter als bei Uran eintritt und auch erheblich mehr Neutronen bei der Spaltung freiwerden, sodass die Kettenreaktion gut ablauft.

I would like to take tonight's publication of the first technical application of uranium fission [Hiroshima] as an opportunity to inform you that work on this problem was also carried out at the [Vienna] Second Physics Institute during the war. I myself was never drafted into the Wehrmacht for this reason. [...]

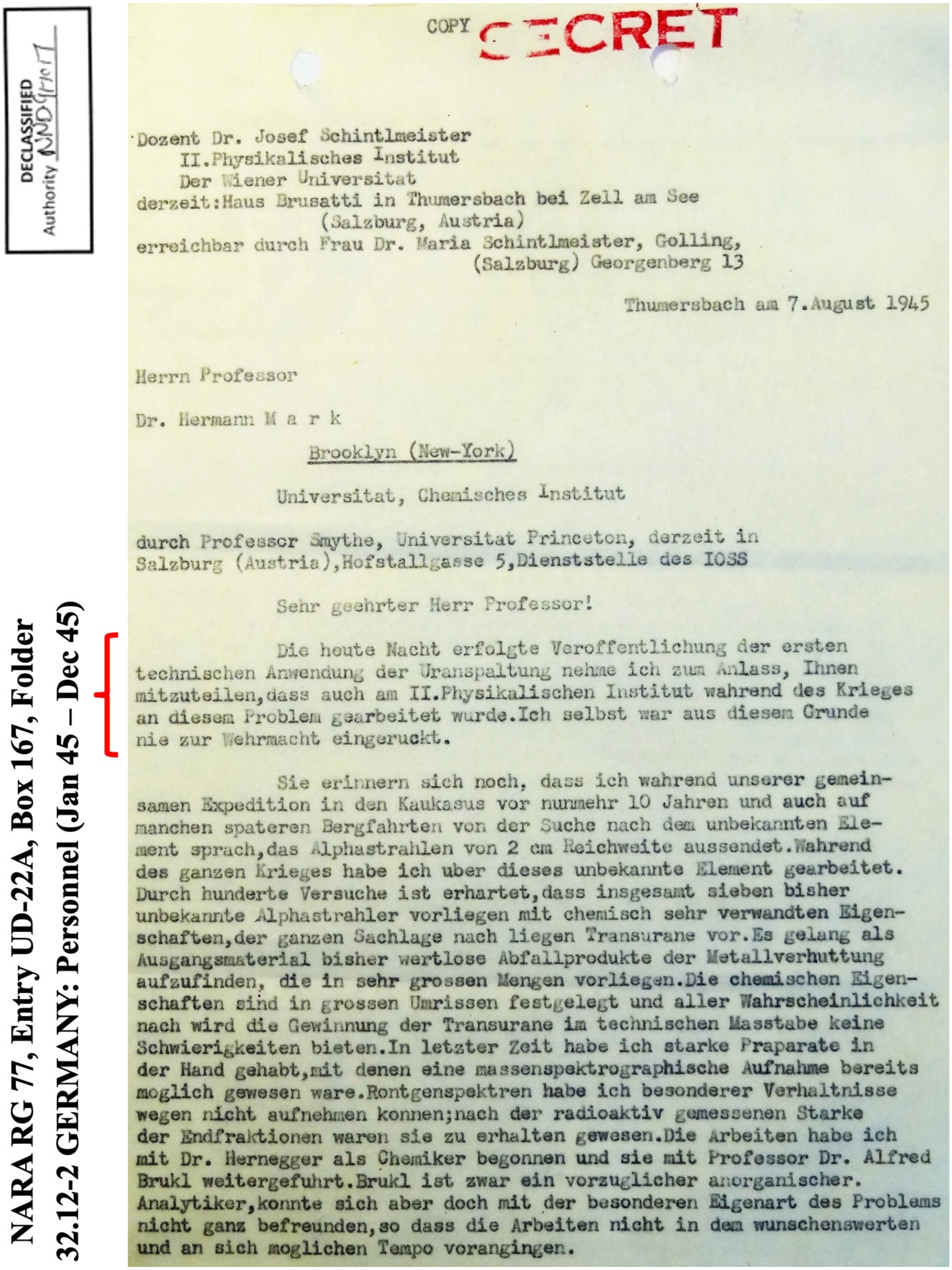
The technical utilization of nuclear energy in uranium fission requires very difficult and very expensive work. With a few kilograms of the new element [plutonium], which is incomparably easier and cheaper to obtain, it will in all likelihood be possible to build a nuclear device without the effort required to date, since it is to be expected that nuclear fission will occur more easily than with uranium and also that considerably more neutrons will be released during fission, so that the chain reaction will proceed smoothly.

Samuel A. Goudsmit to Horace K. Calvert. 5 September 1945. [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45–Dec 45)] **See document photo on p. 3830.**

1. Enclosed is a letter from a Dr. Schintlmeister who worked with Stetter in Vienna. I think that the contents of this letter should be called to the attention of the scientists working on the project back home just as soon as possible. There are some statements there which make it come nearer to the real thing than any other report that I have seen so far, even though it is mere speculation on his part and does not refer to any conclusive experiments. He seems to be aware of the importance of the transuranic elements.

2. The letter was given to Dr. [Charles P.] Smyth for the purpose of transmitting it to Professor H. Mark who is now at the Brooklyn Polytechnic Institute. It is, of course, not recommended that this letter be transmitted. A copy of this letter was given to the Military Government at Zell am See with the request that it be sent to Smyth. They, however, considered it unimportant and destroyed the letter. Smyth received this copy on a subsequent visit.

[Immediately after hearing the news of Hiroshima, Josef Schintlmeister wrote that throughout the war he had worked on a similar project involving a new element (plutonium), of which just a few kilograms would be sufficient for a nuclear device. He offered to help restart that work for postwar sponsors, alarming Samuel Goudsmit and other U.S. officials.]



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Dozent Dr. Josef Schintlmeister
II.Physikalisches Institut
Der Wiener Universitat
derzeit:Haus Brusatti in Thumersbach bei Zell am See
(Salzburg, Austria)
erreichbar durch Frau Dr. Maria Schintlmeister, Golling,
(Salzburg) Georgenberg 13

Thumersbach am 7.August 1945

Herrn Professor

Dr. Hermann M a r k

Brooklyn (New-York)

Universitat, Chemisches Institut

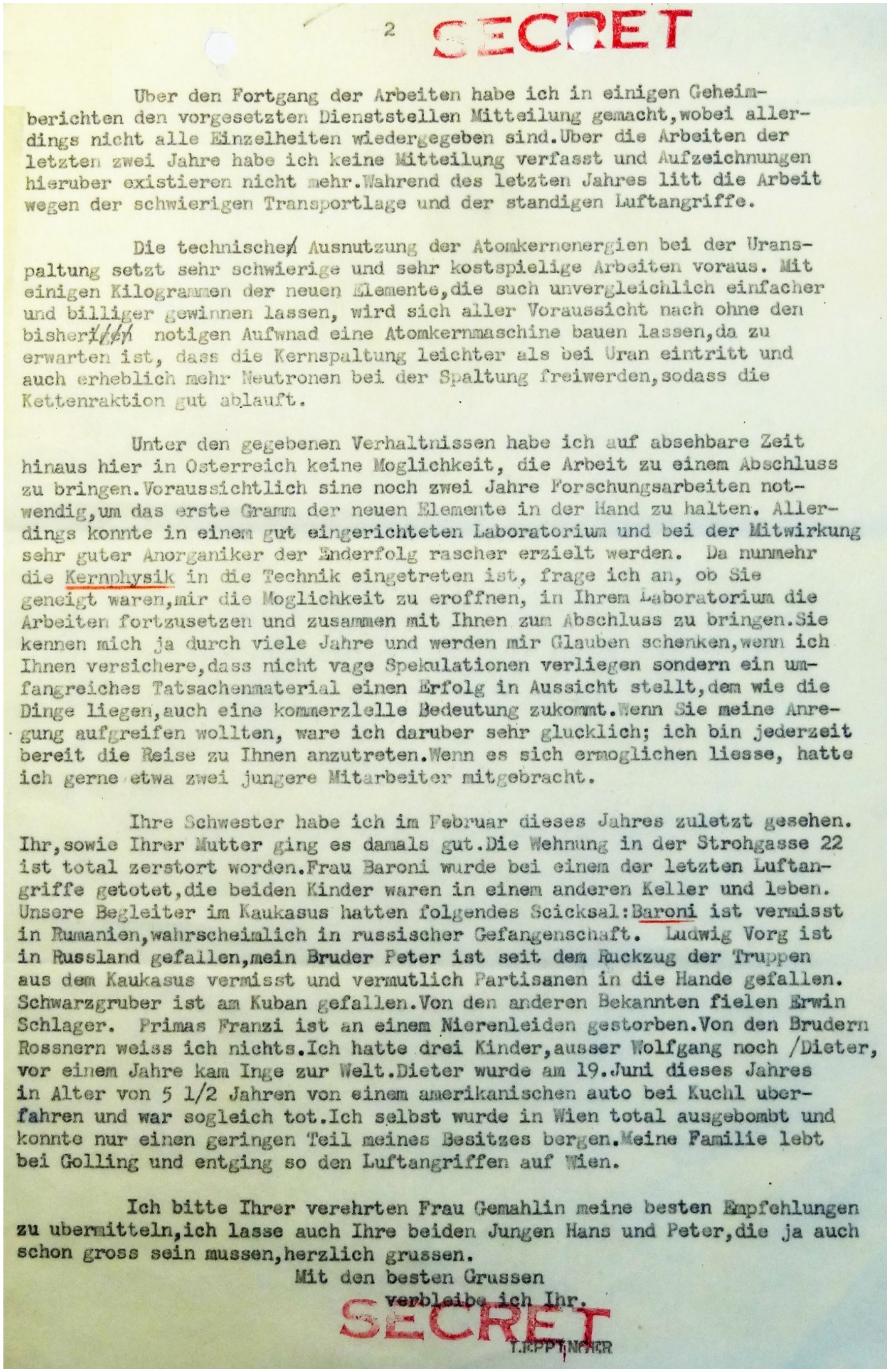
durch Professor Smythe, Universitat Princeton, derzeit in
Salzburg (Austria),Hofstallgasse 5,Dienststelle des IOSS

Sehr geehrter Herr Professor!

Die heute Nacht erfolgte Veroffentlichung der ersten technischen Anwendung der Uranspaltung nehme ich zum Anlass, Ihnen mitzuteilen,dass auch am II.Physikalischen Institut wahrend des Krieges an diesem Problem gearbeitet wurde.Ich selbst war aus diesem Grunde nie zur Wehrmacht eingeruckt.

Sie erinnern sich noch, dass ich wahrend unserer gemeinsamen Expedition in den Kaukasus vor nunmehr 10 Jahren und auch auf manchen spateren Bergfahrten von der Suche nach dem unbekannten Element sprach,das Alphastrahlen von 2 cm Reichweite aussendet.Wahrend des ganzen Krieges habe ich uber dieses unbekannte Element gearbeitet. Durch hunderte Versuche ist erhartet,dass insgesamt sieben bisher unbekannte Alphastrahler vorliegen mit chemisch sehr verwandten Eigenschaften,der ganzen Sachlage nach liegen Transurane vor.Es gelang als Ausgangsmaterial bisher wertlose Abfallprodukte der Metallverhuttung aufzufinden, die in sehr grossen Mengen vorliegen.Die chemischen Eigenschaften sind in grossen Umrissen festgelegt und aller Wahrscheinlichkeit nach wird die Gewinnung der Transurane im technischen Masstabe keine Schwierigkeiten bieten.In letzter Zeit habe ich starke Praparate in der Hand gehabt,mit denen eine massenspektrographische Aufnahme bereits moglich gewesen ware.Rontgenspektren habe ich besonderer Verhaltnisse wegen nicht aufnehmen konnen;nach der radioaktiv gemessenen Starke der Endfraktionen waren sie zu erhalten gewesen.Die Arbeiten habe ich mit Dr. Hernegger als Chemiker begonnen und sie mit Professor Dr. Alfred Brukl weitergefuhrt.Brukl ist zwar ein vorzuglicher anorganischer. Analytiker,konnte sich aber doch mit der besonderen Eigenart des Problems nicht ganz befreunden,so dass die Arbeiten nicht in dem wunschenswerten und an sich moglichen Tempo vorangingen.

Figure D.359: Immediately after hearing the news of Hiroshima, Josef Schintlmeister wrote that throughout the war he had worked on a similar project involving a new element (plutonium), of which just a few kilograms would be sufficient for a nuclear device. He offered to help restart that work for postwar sponsors, alarming Samuel Goudsmit and other U.S. officials [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45–Dec 45)].



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Uber den Fortgang der Arbeiten habe ich in einigen Geheimberichten den vorgesetzten Dienststellen Mitteilung gemacht,wobei allerdings nicht alle Einzelheiten wiedergegeben sind.Uber die Arbeiten der letzten zwei Jahre habe ich keine Mitteilung verfasst und Aufzeichnungen hieruber existieren nicht mehr.Wahrend des letzten Jahres litt die Arbeit wegen der schwierigen Transportlage und der standigen Luftangriffe.

Die technische/ Ausnutzung der Atomkernenergien bei der Uranspaltung setzt sehr schwierige und sehr kostspielige Arbeiten voraus. Mit einigen Kilogrammen der neuen Elemente,die such unvergleichlich einfacher und billiger gewinnen lassen, wird sich aller Voraussicht nach ohne den bisher/// notigen Aufwnad eine Atomkernmaschine bauen lassen,da zu erwarten ist, dass die Kernspaltung leichter als bei Uran eintritt und auch erheblich mehr Neutronen bei der Spaltung freiwerden,sodass die Kettenraktion gut ablauft.

Unter den gegebenen Verhaltnissen habe ich auf absehbare Zeit hinaus hier in Osterreich keine Moglichkeit, die Arbeit zu einem Abschluss zu bringen.Voraussichtlich sine noch zwei Jahre Forschungsarbeiten notwendig,um das erste Gramm der neuen Elemente in der Hand zu halten. Allerdings konnte in einem gut eingerichteten Laboratorium und bei der Mitwirkung sehr guter Anorganiker der Enderfolg rascher erzielt werden. Da nunmehr die Kernphysik in die Technik eingetreten ist, frage ich an, ob Sie geneigt waren,mir die Moglichkeit zu eroffnen, in Ihrem Laboratorium die Arbeiten fortzusetzen und zusammen mit Ihnen zum Abschluss zu bringen.Sie kennen mich ja durch viele Jahre und werden mir Glauben schenken,wenn ich Ihnen versichere,dass nicht vage Spekulationen verliegen sondern ein umfangreiches Tatsachenmaterial einen Erfolg in Aussicht stellt,dem wie die Dinge liegen,auch eine kommerzlelle Bedeutung zukommt.Wenn Sie meine Anregung aufgreifen wollten, ware ich daruber sehr glucklich; ich bin jederzeit bereit die Reise zu Ihnen anzutreten.Wenn es sich ermoglichen liesse, hatte ich gerne etwa zwei jungere Mitarbeiter mitgebracht.

Ihre Schwester habe ich im Februar dieses Jahres zuletzt gesehen. Ihr,sowie Ihrer Mutter ging es damals gut.Die Wehnung in der Strohgasse 22 ist total zerstort worden.Frau Baroni wurde bei einem der letzten Luftangriffe getotet,die beiden Kinder waren in einem anderen Keller und leben. Unsere Begleiter im Kaukasus hatten folgendes Scicksal:Baroni ist vermisst in Rumanien,wahrscheimlich in russischer Gefangenschaft. Ludwig Vorg ist in Russland gefallen,mein Bruder Peter ist seit dem Ruckzug der Truppen aus dem Kaukasus vermisst und vermutlich Partisanen in die Hande gefallen. Schwarzgruber ist am Kuban gefallen.Von den anderen Bekannten fielen Erwin Schlager. Primas Franzi ist an einem Nierenleiden gestorben.Von den Brudern Rossnern weiss ich nichts.Ich hatte drei Kinder,ausser Wolfgang noch /Dieter, vor einem Jahre kam Inge zur Welt.Dieter wurde am 19.Juni dieses Jahres in Alter von 5 1/2 Jahren von einem amerikanischen auto bei Kuchl uberfahren und war sogleich tot.Ich selbst wurde in Wien total ausgebombt und konnte nur einen geringen Teil meines Besitzes bergen.Meine Familie lebt bei Golling und entging so den Luftangriffen auf Wien.

Ich bitte Ihrer verehrten Frau Gemahlin meine besten Empfehlungen zu ubermitteln,ich lasse auch Ihre beiden Jungen Hans und Peter,die ja auch schon gross sein mussen,herzlich grussen.

Mit den besten Grussen
verbleibe ich Ihr.

SECRET

I.EPPINGER

NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45 – Dec 45)

Figure D.360: Immediately after hearing the news of Hiroshima, Josef Schintlmeister wrote that throughout the war he had worked on a similar project involving a new element (plutonium), of which just a few kilograms would be sufficient for a nuclear device. He offered to help restart that work for postwar sponsors, alarming Samuel Goudsmit and other U.S. officials [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45–Dec 45)].

NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45 – Dec 45)

SECRET

S E C R E T

HEADQUARTERS
U. S. FORCES, EUROPEAN THEATER
ALSOS MISSION, G-2

APO 887 - Rear

5 September 1945

MEMORANDUM:

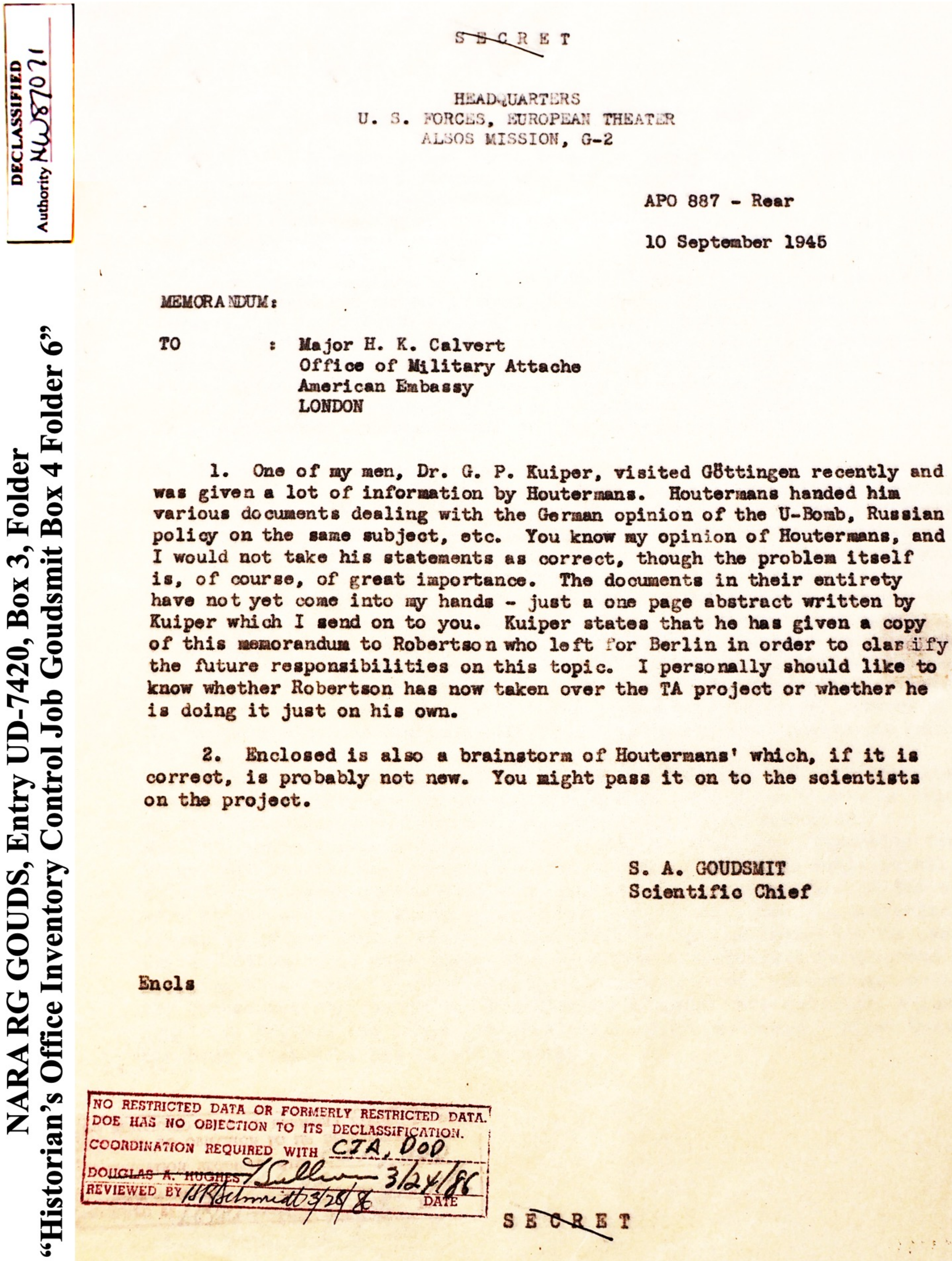
TO : Major H. K. Calvert
Office of Military Attache
American Embassy
London

1. Enclosed is a letter from a Dr. Schintlmeister who worked with Stetter in Vienna. I think that the contents of this letter should be called to the attention of the scientists working on the project back home just as soon as possible. There are some statements there which make it come nearer to the real thing than any other report that I have seen so far, even though it is mere speculation on his part and does not refer to any conclusive experiments. He seems to be aware of the importance of the trans-uranic elements.

2. The letter was given to Dr. Smyth for the purpose of transmitting it to Professor H. Mark who is now at the Brooklyn Polytechnic Institute. It is, of course, not recommended that this letter be transmitted. A copy of this letter was given to the Military Government at Zell am See with the request that it be sent to Smyth. They, however, considered it unimportant and destroyed the letter. Smyth received this copy on a subsequent visit.

S. A. GOUDSMIT
Scientific Chief

Figure D.361: Immediately after hearing the news of Hiroshima, Josef Schintlmeister wrote that throughout the war he had worked on a similar project involving a new element (plutonium), of which just a few kilograms would be sufficient for a nuclear device. He offered to help restart that work for postwar sponsors, alarming Samuel Goudsmit and other U.S. officials [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45–Dec 45)].



DECLASSIFIED
Authority NW87071

NARA RG GOUDS, Entry UD-7420, Box 3, Folder
"Historian's Office Inventory Control Job Goudsmit Box 4 Folder 6"

~~SECRET~~

HEADQUARTERS
U. S. FORCES, EUROPEAN THEATER
ALSOS MISSION, G-2

APO 887 - Rear

10 September 1945

MEMORANDUM:

TO : Major H. K. Calvert
Office of Military Attache
American Embassy
LONDON

1. One of my men, Dr. G. P. Kuiper, visited Göttingen recently and was given a lot of information by Houtermans. Houtermans handed him various documents dealing with the German opinion of the U-Bomb, Russian policy on the same subject, etc. You know my opinion of Houtermans, and I would not take his statements as correct, though the problem itself is, of course, of great importance. The documents in their entirety have not yet come into my hands - just a one page abstract written by Kuiper which I send on to you. Kuiper states that he has given a copy of this memorandum to Robertson who left for Berlin in order to clarify the future responsibilities on this topic. I personally should like to know whether Robertson has now taken over the TA project or whether he is doing it just on his own.

2. Enclosed is also a brainstorm of Houtermans' which, if it is correct, is probably not new. You might pass it on to the scientists on the project.

S. A. GOUDSMIT
Scientific Chief

Encls

NO RESTRICTED DATA OR FORMERLY RESTRICTED DATA.
DOE HAS NO OBJECTION TO ITS DECLASSIFICATION.
COORDINATION REQUIRED WITH CIA, DOD
~~DOUGLAS A. HUGHES~~ 3/24/86
REVIEWED BY HRSchmidt 3/28/86 DATE

~~SECRET~~

Figure D.362: Samuel Goudsmit to Horace K. Calvert. 10 September 1945 [NARA RG GOUDS, Entry UD-7420, Box 3, Folder "Historian's Office Inventory Control Job Goudsmit Box 4 Folder 6"]. "You know my opinion of Houtermans, and I would not take his statements as correct."

[The following document demonstrates that scientists in Germany understood how to convert Th-232 to make a U-233 bomb.]

Fritz Houtermans. 3 September 1945. How to use thorium for nuclear energy from fission. Typographical errors in the original document have been retained below. [NARA RG 77, Entry UD-22A, Box 173, Folder 60.22-1 RUSSIA: Research—TA (43–Jun 46)]

How to use Thorium for nuclear energy from fission.

Take pure thorium or thoriumoxide, mix to it some U 235 or Pu 239 separated from U238. The amount of U235 or 239 necessary will presumably be lower than 0.7%, because resonance capture in Th seems to be stronger than in U238. By neutron capture Th233 is formed. The mixture should be such that in heavy water, possibly also in metallic beryllium, or even BeO, or in graphite the chain reaction is just started, retarded only by resonance capture of Th232. It may be that the chain reaction will work only at low temperatures, if the width of the Th-resonance capture is given by Doppler-broadening. This will be true especially, the heavier the material is for slowing down the neutrons, i.e for graphite. It might be necessary to cool away even at low temperatures the energy released by the chain reaction, but any neutron lost will form an atom of Th 233, which decays with T=23 min to Pa 233, a body known to emit β-rays also and to decay into U 233. U 233 seems to have rather a long half life, and may be α-active. But from general considerations similar to those of Bohr-Wheeler, I should be rather think that U 233 has a fission treshold low enough that thermal neutrons will be able to make thermofission. Since you get weighable quantities of neutrons from the chain reaction in the separeted isotope U235 or 239 you will thus be able to enrich either U 233 to such an extent, that the chain reaction will start at normal temperatures or else to separete U 233 chemicall from the thorium mixture and use it as U235 or 239 as fuel for the machine.

September 3rd, 1945 F.G. Houtermans

P.S. by Gerard P. Kuiper, Frankfurt-Hochst, 7 Sept., 1945.

This is Prof. Houtermans' prediction of how the Russians will make the atomic bomb. No copy of it has been made; this is the original. If any "profit" or "credit" will result from his proposal its author requests that the benefits will go to his wife, Mrs. Houtermans, Physics Department, Radcliffe College, Cambridge, Mass.

Gerard P. Kuiper
Alsos Mission
G2, HQ, USFET

SECRET

COPY

How to use Thorium for nuclear energy from fission.

Take pure thorium or thoriumoxide, mix to it some U 235 or U 239 separated from U238. The amount of U235 or 239 necessary will presumably be lower than 0.7%, becuase resonance capture in Th seems to be stronger than in U238. By neutron capture Th233 is formed. The mixture should be such that in heavy water, possibly also in metallic beryllium, or even BeO, or in graphite the chain reaction is just started, retarded only by resonance capture of Th232. It may be that the chain reaction will work only at low temperatures, if the width of the Th-resonance capture is given by Doppler-broadening. This will be true especially, the heavier the material is for slowing down the neutrons, i.e. for graphite. It might be necessary to cool away even at low temperatures the energy released by the chain reaction, but any neutron lost will form an atom of Th 233, which decays with T= 23 min to Pa 233, a body known to emit β-rays also and to decay into U 233. U 233 seems to have rather a long half life, and may be α-active. But from general considerations similar to those of Bohr-Wheeler, I should be rather think that U 233 has a fission treshold low enough that thermal neutrons will be able to make thermofission. Since you get weighable quantities of neutrons from the chain reaction in the separeted isotope U235 or 239 you will thus be able to enrich either U 233 to such an extent, that the chain reaction will start at normal temperatures or else to separete U 233 chemicall from the thorium mixture and use it as U235 or 239 as fuel for the machine.

September 3rd, 1945. F.G. Houtermans

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This is Prof. Houtermans' prediction of how the Russians will make the atomic bomb. No copy of it has been made; this is the original. If any "profit" or or "credit" will result from his proposal its author requests that the benefits will go to his wife, Mrs. Houtermans, Physics Department, Radcliffe College, Cambridge, Mass.

Gerard P. Kuiper
Alsos Mission
G2, HQ, USFET

Figure D.363: Fritz Houtermans. 3 September 1945. How to use thorium for nuclear energy from fission [NARA RG 77, Entry UD-22A, Box 173, Folder 60.22-1 RUSSIA: Research—TA (43–Jun 46)].

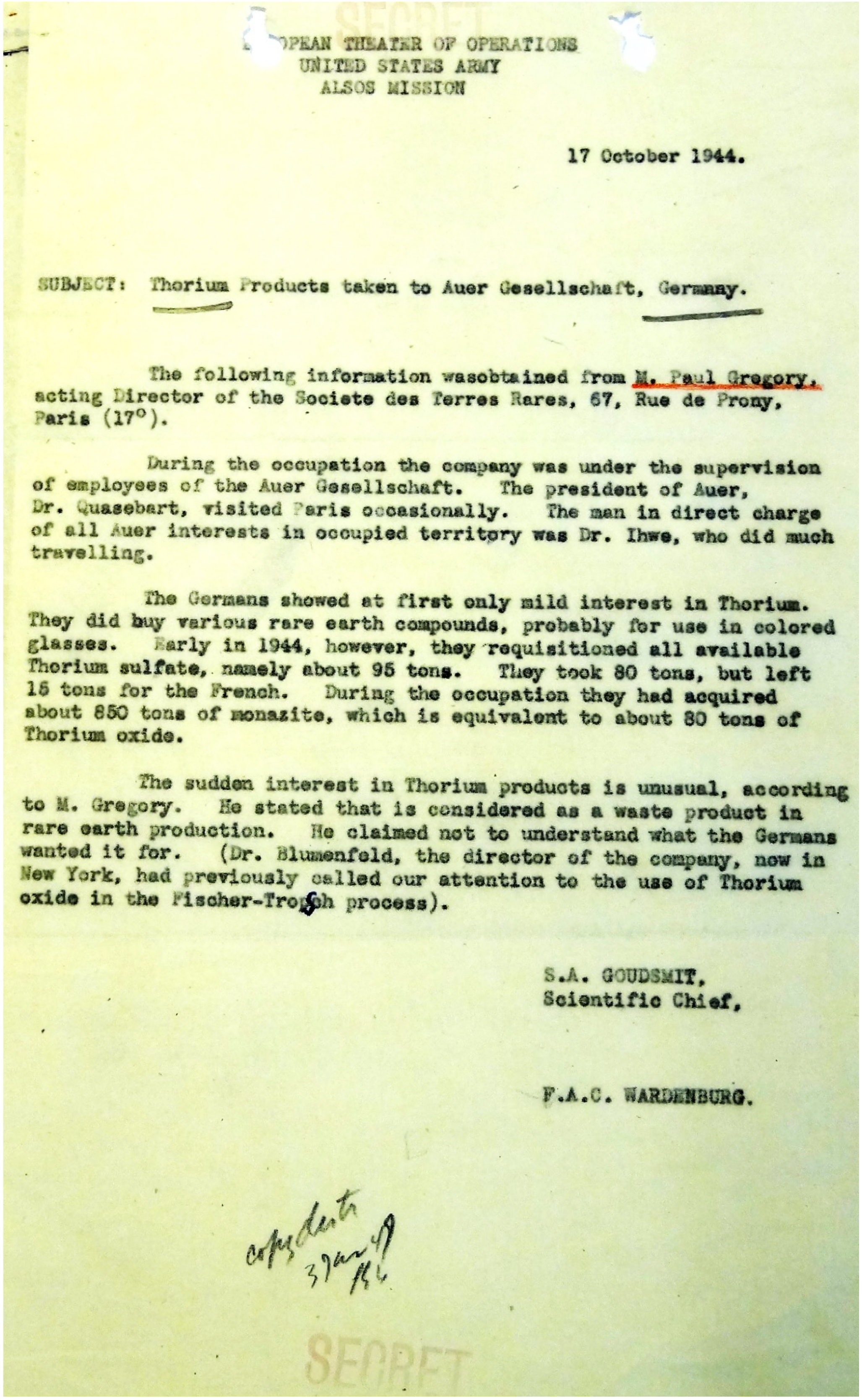
Samuel Goudsmit and Frederic A. C. Wardenburg. 17 October 1944. Subject: Thorium Products taken to Auer Gesellschaft, Germany [NARA RG 77, Entry UD-22A, Box 163, Folder Australia]

The following information was obtained from M. Paul Gregory, acting Director of the Societé des Terres Rares, 67, Rue de Preny, Paris (17^o).

During the occupation the company was under the supervision of employees of the Auer Gesellschaft. The president of Auer, Dr. Quadebert, visited Paris occasionally. The man in direct charge of all Auer interests in occupied territory was Dr. Ihwe, who did much travelling.

The Germans showed at first only mild interest in Thorium. They did buy various rare earth compounds, probably for use in colored glasses. Early in 1944, however, they requisitioned all available Thorium sufate, namely about 95 tons. They took 85 tons, but left 10 tons for the French. During the occupation they had acquired about 850 tons of monazite, which is equivalent to about 86 tons of Thorium oxide.

The sudden interest in Thorium products is unusual, according to M. Gregory. He stated that is considered as a waste product in rare earth production. He claimed not to understand what the Germans wanted it for. (Dr. Blumenfeld, the director of the company, now in New York, had previously called our attention to the use of Thorium oxide in the Fischer-Tropsch process).



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EUROPEAN THEATER OF OPERATIONS
UNITED STATES ARMY
ALSOS MISSION

17 October 1944.

SUBJECT: Thorium Products taken to Auer Gesellschaft, Germnny.

The following information wasobtained from M. Paul Gregory, acting Director of the Societe des Terres Rares, 67, Rue de Prony, Paris (17°).

During the occupation the company was under the supervision of employees of the Auer Gesellschaft. The president of Auer, Dr. Quasebart, visited Paris occasionally. The man in direct charge of all Auer interests in occupied territory was Dr. Ihwe, who did much travelling.

The Germans showed at first only mild interest in Thorium. They did buy various rare earth compounds, probably for use in colored glasses. Early in 1944, however, they requisitioned all available Thorium sulfate, namely about 95 tons. They took 80 tons, but left 15 tons for the French. During the occupation they had acquired about 850 tons of monazite, which is equivalent to about 80 tons of Thorium oxide.

The sudden interest in Thorium products is unusual, according to M. Gregory. He stated that is considered as a waste product in rare earth production. He claimed not to understand what the Germans wanted it for. (Dr. Blumenfeld, the director of the company, now in New York, had previously called our attention to the use of Thorium oxide in the Fischer-Tropsh process).

S.A. GOUDSMIT,
Scientific Chief,

F.A.C. WARDENBURG.

SECRET

Figure D.364: Samuel Goudsmit and Frederic A. C. Wardenburg. 17 October 1944. Subject: Thorium Products taken to Auer Gesellschaft, Germany [NARA RG 77, Entry UD-22A, Box 163, Folder Australia].

Frederic A. C. Wardenburg. Interrogation of Dr. Ing. Ernest Nagelstein. 2 November 1944. [NARA RG 77, Entry UD-22A, Box 169, Folder 32.7002 GERMANY—ALSOS MISSION Administrative Matters (1940–1945)]

[...] The atomic bomb is made of either thorium or uranium, Nagelstein is not sure which. He was told by Doering, however, that Auer is making metal thorium and no uses of thorium in the metallic state are known. [...]

David C. G. Gattiker to L. E. Seeman. 2 October 1946. Subject: Thorium metal made by the Germans [NARA RG 77, Entry UD-22A, Box 163, Folder Australia].

Some time ago I asked the London office whether they could locate an alleged quantity of about 13 tons of thorium metal which we believe was made by the Germans during the last years of the war.

The London office now advises me that they have been entirely unable to trace this material and do not know for what purpose metal was manufactured, although it is believed that it was in connection with experiments in various types of electronic valves (tubes).

[See document photo on p. 3837.]

BIOS 675. *The Production of Thorium and Uranium in Germany.*

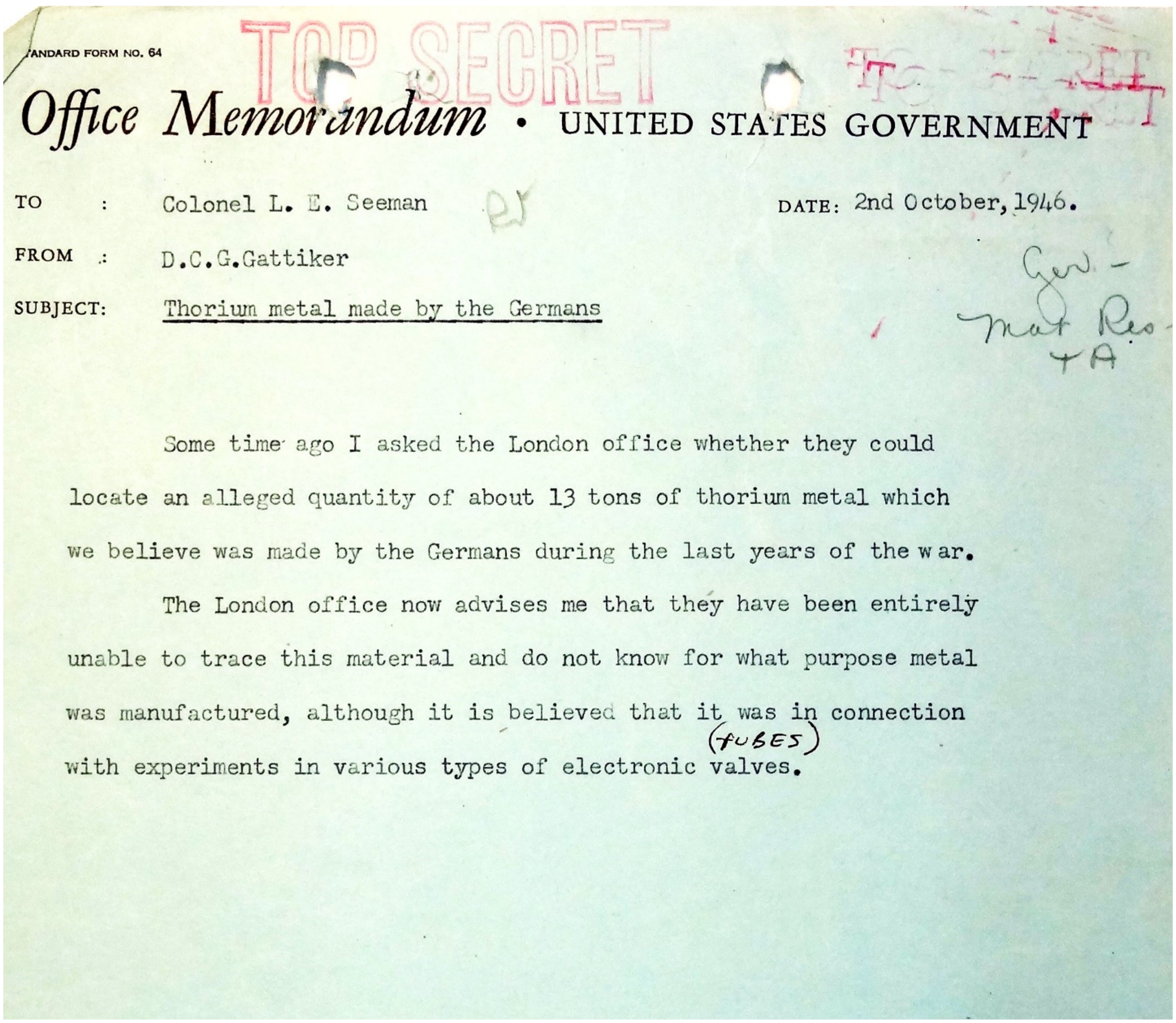
Metallic thorium and uranium were produced on a large scale in Germany by the reduction of their respective oxides with calcium using a calcium chloride flux. The major part of the production during the war came from Werk II of the Deutsche Gold- und Silber-Scheide-Anstalt (Degussa)[...]

Thorium oxide was supplied by Auer Gesellschaft, Berlin, which had large stock piles of Monazite sand, i.e., an enriched sand consisting mostly of Monazite, Magnetite, Zirconia, Thoria and Quartz. After reduction of the oxide, the thorium metal was returned to Auer Gesellschaft or in some cases sent under their control directly to the consumers[...] The uranium ore was coming from Czecho-Slovakia and Belgium Congo and was supplied from their stock piles by the Auer Gesellschaft for reproduction. [...]

Raw calcium, obtained under the form of large ingots, was melted under special conditions to obtain a pure metal free from oxide or nitride contamination. [...]

DECLASSIFIED
Authority 917017

NARA RG 77, Entry UD-22A, Box 163, Folder Australia



STANDARD FORM NO. 64

TOP SECRET

Office Memorandum • UNITED STATES GOVERNMENT

TO : Colonel L. E. Seeman

DATE: 2nd October, 1946.

FROM : D.C.G.Gattiker

SUBJECT: Thorium metal made by the Germans

Gen. – Mat Res + A

Some time ago I asked the London office whether they could locate an alleged quantity of about 13 tons of thorium metal which we believe was made by the Germans during the last years of the war.

The London office now advises me that they have been entirely unable to trace this material and do not know for what purpose metal was manufactured, although it is believed that it was in connection with experiments in various types of electronic valves (tubes).

Figure D.365: David C. G. Gattiker to L. E. Seeman. 2 October 1946. Subject: Thorium metal made by the Germans [NARA RG 77, Entry UD-22A, Box 163, Folder Australia].

December 1943–February 1944 letters to and from Arthur H. Compton. [NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)]

[See document photos on p. 3839.

These documents demonstrate serious wartime concern by senior scientists from the U.S. Manhattan Project that Germany was breeding uranium-233 from thorium-232.

These documents also discuss some of the technical details, advantages, and disadvantages of ^{233}U relative to ^{235}U and ^{239}Pu.]

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Metallurgical Laboratory

MUC-GTS-#425
This document consists of 2 pages and 0 figures.
No. 2 of 4 Copies.
Series B

January 27, 1944

To: A. H. Compton

From: G. T. Seaborg

In re: Possibility of the Utilization of U-233 by the Enemy

As you requested after our discussion of the above subject a month or so ago, I am summarizing some of the reasons which make it seem probable that the Germans may be able to produce at least one U-233 device within the near future. I believe this possibility should be considered since, if it is probable, it seems important that our High Command should be made cognizant of the fact in order that steps may be taken to distribute the governmental facilities of the Allied Powers in such a way that a single device alone could not deal a fatal blow. The possibility that plans for the utilization of U-233 may be near culmination by the enemy also makes it seem highly desirable that we should have enough work going on this problem so that we will be able to evaluate any developments which they may either employ or profess to be ready to employ.

Reasons which make it seem probable that the Germans may be preparing to use a U-233 device may be summarized as follows:

(1) We know that the Germans are making strenuous efforts to continue heavy water production in Norway, and there seems to be no other possible use for this material other than a nuclear power program. Likewise, we can infer that such efforts would not continue unless they had in mind an overall heavy water production program, in other places as well as Norway, calculated to make or have made an amount sufficient for their final objective within a reasonable length of time.

(2) U-233 can be separated from its parent thorium by relatively well known chemical processes. The isolation of U-233 may be very simple compared to that of Pu-239 or U-235. This is in part due to the fact that essentially only one radioactive species (Pa-233) is involved in the separation. I believe that the Germans could hand this separation problem to one of their large industrial chemical companies, who in turn would isolate the U-233 with only slight modifications in their existing equipment.

(3) The tolerance for light element impurities (which must be removed to prevent neutron production by the α,n reaction) is some ten-fold greater than that of Pu-239. Furthermore such purification as must be obtained can be tested with uranium, which, in contrast with Pu-239, would have been available for experiments during production of the actual U-233. Our own present knowledge of the

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Metallurgical Laboratory

A. H. Compton - 2 - January 27, 1944

purification and metal production of uranium leads us to the practically certain conclusion that this problem is rather easily solvable for U-233. If we should run into serious difficulties in the final processing of Pu-239 it is conceivable that the Germans might produce a final U-233 device before we produce one from Pu-239 even if their program were not very far along today.

(4) Raw materials for U-233 production are probably available to the Germans. Using a uranium-heavy water pile in conjunction with thorium, it is quite probable that they would not need to meet the high purity standards for these raw materials that we have been required to meet for use in the uranium-graphite pile. It may even be that they have not needed to make either uranium or thorium metal, but can employ compounds of these elements in the system. The construction of a heavy water pile and its operation and attendant chemical extraction work for the preparation of the U-233 device might be carried out without requiring a serious drain on the manpower or natural resources of the enemy.

The extent of U-233 production by the Germans may be and probably is limited by the supply of heavy water. The fact that the Norway output, from their strenuous efforts to continue it, may be inferred to be a significant fraction of their total output leads to the speculation that they may be aiming for one or only a few devices. However, the hydride approach may lead to relatively small critical masses for U-233 devices. Furthermore, one device can be extremely dangerous if used properly in conjunction with other materials, and there is no reason to expect that the Germans will not know how to make such a use of it.

The conclusion seems inescapable that the enemy must be at least carrying out this relatively small program unless they simply failed to think of it in time. Even if the Germans were late in getting started (a fact which would probably be very difficult to establish) so that it seems likely that they will collapse militarily before the program might be completed, one must consider the possibility that such a program could be continued by the Japanese with the help of the German scientists and material.

In considering the importance of obtaining further knowledge on the potentialities of U-233, the possibility comes to mind that the achievement of this end might be greatly helped if the Canadian group under von Halban were to put a significant portion of its time on such work.

cc: A. H. Compton
T. R. Hogness

G. T. Seaborg /signed/

DECLASSIFIED
Authority NND 917017

NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)

Metallurgical Laboratory
COPY

December 15, 1943

UNIVERSITY OF CALIFORNIA

MB EDE-14

A. H. Compton
Metallurgical Laboratory
University of Chicago
Chicago, Illinois

Dear Dr. Compton:

The advantages possessed by 23 as compared with 49 from the standpoints of extraction, decontamination and purification are so noteworthy, as pointed out to me on previous occasions by Seaborg and more recently by Hogness, that it seems to me essential that work on those phases of the project related to 23 should be strengthened rather than abandoned. In my opinion, a well conceived process of the kind in question would be of inestimable value as an alternative in case of the possibility of failure with 49, which is not out of the question, or as a supplement if the latter is successful. It seems to me that the possibility that the entire project might be rescued by the availability of this alternative is good enough to make it necessary to develop it. In view of the proposed directive for discontinuance of this work I feel constrained to make this opinion known to you, even though I am not directly concerned.

There is one other subject, somewhat fantastic, upon which I should like to sound off. If it may be assumed that the Germans have or will have a weapon like ours, an answer to the question as to the most effective first use of it becomes pretty important. It seems quite possible to me that they could use it first against this country, daringly but successfully, say at Chicago. If so, this might be the most damaging thing they could do with it, in the long run. This possibility should, in my opinion, be canvassed by somebody competent to decide its feasibility and having the information necessary to do so. If it appears to be a real danger, steps should be taken to avoid being caught flat-footed.

Sincerely,

(signed) E. D. Eastman

SECRET

MT 2-AC-674

Metallurgical Laboratory

THIS DOCUMENT CONSISTS 1 PAGES
COPIES 2 OF 8 COPIES

February 29, 1944

To: Glen T. Seaborg

From: Arthur H. Compton

In re: Possibility of the Utilization of U-233 by the Enemy

I am transmitting to General Groves and others in the Army who are concerned, copies of your memorandum on the possibility of utilization of 233 by the enemy. I want to thank you for bringing this matter to our attention.

I must say, however, that it is my own judgment that the U-233 program probably will require more time and industrial effort to develop to a conclusion than the 49 program upon which we are engaged. Also I do not see any strong reason to believe that the Germans are actually engaged upon a program of U-233 production.

With regard to the time and effort required, although it is probable that each unit will require less U-233 than 49, as you know roughly five times as much power must be dissipated per kilogram of U-233 as per kilogram of 49. To produce U-233 on an adequate scale would require also large quantities of heavy water whose preparation is a slow and expensive process. It is evident that the chemical separation process for U-233 will be somewhat simpler than for 49. It would, nevertheless require remote control shielded equipment and because of the long life of the radioactive protoactinium would presumably require a longer time than the separation of the 49.

Because of the real advantages of U-233, the desirability of keeping work alive on its investigation is clear. Your suggestion of encouraging the Canadians to follow this line is well worth following up. We also shall want to come back to its study when time permits.

L. H. C.

CLASSIFIED FILE SECTIONS
MANHATTAN ENGINEER DISTRICT
CHICAGO AREA OFFICE
MAR 3- 1944
AM 7 8 9 10 11 12 1 2 3 4 5 6 PM

KT
cc: Major A. V. Peterson (3)
S. K. Allison
T. Hogness
E. D. Eastman

This document contains information affecting the national defense of the United States within the meaning of the Espionage Act, U. S. C. 50, 31 and 32. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

~~SECRET~~

Figure D.366: December 1943–February 1944 letters to and from Arthur H. Compton, demonstrating high-level U.S. concerns that Germany was breeding uranium-233 from thorium-232 [NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)].

D.5.2 Known and Suspected Fission Reactors

[Pu-239 or U-233 could have been bred in a fission reactor. Np-237 [Sanchez et al. 2008] could also have been bred in a reactor (e.g., by knocking a neutron out of U-238), although it probably would have been more difficult to produce in quantity than Pu-239 or U-233 [Benedict et al. 1981].

There is evidence for several potential reactors in German-controlled territory, and one or more of those reactors may have been operational during the war (see map on p. 3841):

1. The reactor of Werner Heisenberg's group, first located at the Kaiser Wilhelm Institute for Physics in Berlin-Dahlem, and later moved to Haigerloch (pp. 3843–3853). This is by far the best known of the German fission reactors. With proper support and operation, it could have achieved criticality (a self-sustaining neutron chain reaction) during the war, but it never did [Goudsmit 1947; Groves 1962; Irving 1967; Pash 1969; Powers 1993; Walker 1989].

2. The reactor of Kurt Diebner's group, first located at Gottow/Kummersdorf, and later moved to Stadtilm (pp. 3854–3868). According to official histories, this reactor never achieved criticality during the war. In fact, there is some evidence that it may have achieved criticality in late 1944 in Gottow, and/or in March 1945 in Stadtilm [Karlsch 2005].

3. A reactor built and operated by the SS, likely in an underground facility in Thuringia, that was reported to have been operational in March 1945 (pp. 3865–3868).

4. A possible reactor and fuel reprocessing facility in the Bergkristall tunnel complex at St. Georgen/Gusen near Linz, Austria, that may have been operational during the war (pp. 3874–3920 and 4962–4970).

5. A possible reactor at Unterraderach near Friedrichshafen (on the coast of the Obersee Bodensee) that was reported to have been operational in 1944 (pp. 3921–3925).

6. A possible reactor at an underground facility in Berlin-Lichterfelde that was reported to have been operational in 1944 (pp. 3926–3928).

7. "Atomic reactors" that were reportedly located in East Prussia and that may have been operational until they were bombed by the Royal Air Force at the end of August 1944 (pp. 3928–3933).

8. A tightly guarded, heavy concrete installation at the I.G. Farben Leverkusen plant that might have been a fission reactor (pp. 3934–3935).

9. A possible fission reactor at Bodenbach/Krizik-Werke/Weser-Werke/Podmokly (pp. 3936–3937, 3987–3998).

10. Other possible sites for fission reactors (pp. 3938–3953)?

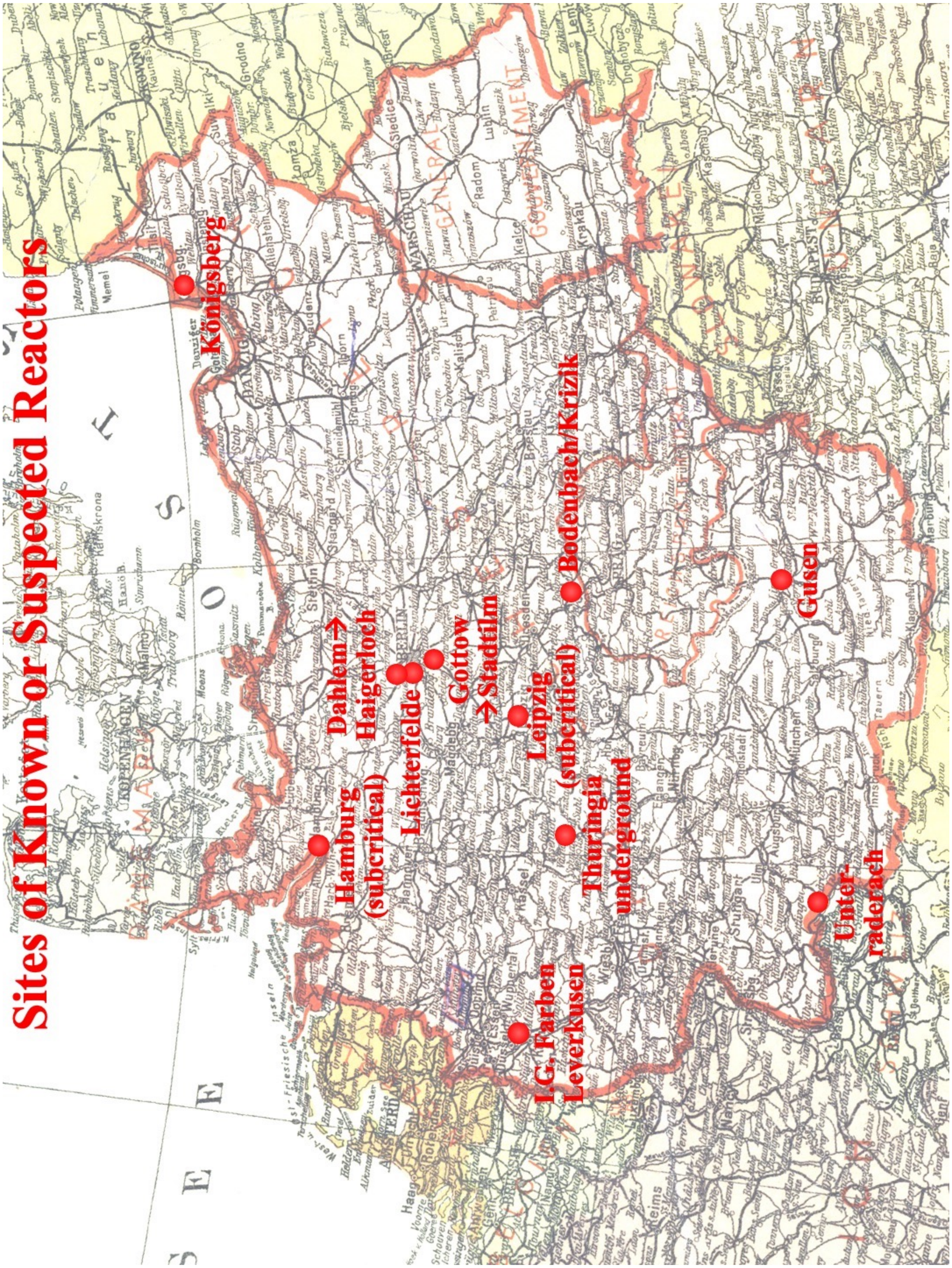

Figure D.367: Sites of known or suspected reactors for the German nuclear program.

If one or more fission reactors were functioning during the war, that could help explain the high priority that Germany placed on producing heavy water (an excellent neutron moderator for fission reactors) at numerous locations (p. 4027).

The Soviet Union demonstrated its first fission reactor (F-1) on 25 December 1946, only about 12 months after its captured German nuclear scientists were able to begin setting up the captured German nuclear materials (including at least 300 tons of German-produced uranium oxide, which fueled both F-1 and the larger second Soviet reactor for breeding Pu-239). If German scientists and German materials accomplished that feat so quickly after starting over in the Soviet Union after the war, they certainly could have done it in German territory during the war.

In addition to the potential reactors listed above, there were also a few small, subcritical fission piles that appear to have been used purely for experimental purposes, such as those built by Robert Döpel's team in Leipzig and Paul Harteck's team in Hamburg.]

1. The fission reactor of Werner Heisenberg's group

G-371. Alvin M. Weinberg and Lothar W. Nordheim. Memorandum on the state of knowledge in nuclear science reached by the Germans in 1945. 8 November 1945. [Note: This was a U.S. report analyzing some of the German G-reports. The U.S. code name "P-9" meant heavy water; "P-9U" meant a heavy-water-moderated uranium reactor.]

We have just had an opportunity to read a few of the German Kernphysikalische Forschungsberichte. We are writing in order to correct what we believe to be a very prevalent misconception concerning the state of the art as known to the Germans in 1945. We will proceed by posing a number of relevant questions and then answering them insofar as we can from the few reports we have been allowed to see. Presumably when more reports are made available we will be able to document our statements more fully.

I. Did the Germans know the correct lattice dimensions for a P-9U system?

Via the grapevine we have heard rumors that the Germans were experimenting with plate lattices far too rich in U. Apparently these rumors were based on very early reports which are not yet available to us. At present, however, the answer to the above question is an unequivocal yes. The March 1944 "Forschungsberichte" contain a description of experiments on various lattice arrangements performed by Bothe and Fünfer. The experiments are integral ones in which the strength of a source is measured with and without the lattice in place. The main conclusion drawn from these experiments is "eine Kombination von 20 cm D_2O und 1 cm U-Metall der Dichte 18 (wird) etwas die günstigste sein . . . Bisher hat man wohl mit einem grösseren U-Bedarfgerechnet." This conclusion is exactly the same as that reached by us, on the basis of calculations in August 1943 (CP-923). The German work apparently was done at the same time as ours.

Plates seem to have been preferred because they were most convenient for experiments. The advantage of cubes was recognized as early as June 1943 (Höcker), and the use of cylinders had been suggested on technical grounds.

II. Did the Germans know the critical dimensions of the P-9 machine?

We have not had access to the reports in which critical size calculations are made. However, there are repeated references, in the reports available to us, of about 4 tons as the required amount of P-9. This figure is essentially correct.

The Laplacians measured by the Germans are of the order 1000×10^{-6} cm^{-2}. This value is in excellent agreement with ours. It indicates, and this is important, that the U metal used by them was about as pure as ours.

III. What was the state of German theory of the chain reaction?

Here we are badly hampered by the unavailability of the reports. What we do have shows:

(1) Calculation of optimal lattice dimensions was understood and followed pretty much the same lines as ours. The calculated results on P-9 spheres agree well with ours.

(2) The group model for reflector calculations was introduced in early 1944. This was a little later than the time we began to use it extensively.

(3) Generally we would say their approach was in no wise inferior to ours; in some respects it was superior.

IV. Why didn't the Germans succeed in establishing a chain reaction with P-9?

The answer is simple; they did not have sufficient P-9. The latest reference is to a 1.5 ton P-9 experiment. According to our estimates, with the volume ratio they used (20:1), they would have needed somewhat less than 4 tons.

V. Are there any "scientific secrets" concerning the design of the chain reaction which the Germans do not seem to have understood?

From the general state of the art as deduced from the few reports we have seen, we would say their understanding of the principles is comparable to ours. The only non-engineering "secrets" we can think of which might affect the design of a chain reaction is the poisoning by Xe^{135}, and possibly, the properties of Pu^{240}.

VI. What bearing does this have on publication of the parts of the PPR [Performance Progress Report (?)] dealing with principles of the chain reaction?

The Germans knew how to design a lattice which will work. From the practical standpoint this is all that matters. The details of elegant perturbation theory or transport theory (which would be contained in Vol. III) or the details of heat transfer calculations (Vol. IV) would tell them nothing essential to the determination of lattice dimensions. They already know how to calculate the optimum dimensions.

A question of ethics is raised by the existence of the German reports. In many cases useful information is contained therein. It is certainly extraordinary, in a scientific treatise, to attribute a given result to an American author without at the same time giving due credit to his German counterpart who is known to have also done the work. Such a situation will arise for example, in Vol. III in the discussion of the multi-group methods where the Germans have duplicated our work.

VII. What bearing does this have on the general question of our "secrets"?

On this we can presume to speak only as individuals.

The general impression from the German reports is that they were on the right track and that their thinking and developments paralleled ours to a surprising extent. The fact that they did not achieve the chain reaction is primarily due to their lack of sufficient amounts of heavy water.

In one of the reports a vivid description is given of the German efforts in this respect. The heavy water factories in Norway were designed for a capacity of 3–4 tons a year and were successfully operating during part of 1942 and 1943. This capacity would have been sufficient for the construction of a pile. However, the production was interrupted by sabotage and finally the main factory was destroyed by a bombing attack. Toward the end of 1944 plans were made to initiate production of heavy water in Germany and to use enriched uranium in order to reduce the material requirements.

It is also fairly clear that the total German effort was on a very considerably smaller scale than the American effort. This may be due to the strained German economy or to the less favorable attitude of their government. The fact remains that an independent group of scientists, of much smaller size than ours, operating under much more adverse conditions achieved so much.

We must proceed therefore on the basis that anyone knowing what is in the German reports can establish a chain reaction, provided he has sufficient materials. The Smyth report will give additional very helpful hints. The time when others can establish a chain reaction is therefore no longer a matter of scientific research but mostly a matter of procurement. The policies of our authorities must, it seems to us, be formulated with a clear realization of these facts.

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2-A

MONSANTO CHEMICAL COMPANY

Clinton Laboratories

To: A. H. Compton   Date: November 8, 1945

From: A. M. Weinberg and L. W. Nordheim

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Figure D.368: Alvin M. Weinberg and Lothar W. Nordheim. Memorandum on the state of knowledge in nuclear science reached by the Germans in 1945. 8 November 1945 [G-371].

A. H. Compton - 2 - November 8, 1945

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Figure D.369: Alvin M. Weinberg and Lothar W. Nordheim. Memorandum on the state of knowledge in nuclear science reached by the Germans in 1945. 8 November 1945 [G-371].

A. H. Compton - 3 - November 8, 1945

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A. M. Weinberg

L. W. Nordheim

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Figure D.370: Alvin M. Weinberg and Lothar W. Nordheim. Memorandum on the state of knowledge in nuclear science reached by the Germans in 1945. 8 November 1945 [G-371].

[Alvin Weinberg and Lothar Nordheim were experts in the U.S. fission reactor program. There are several important points regarding their memo:

- Even among the well-informed personnel of the U.S. Manhattan Project and over half a year after the war ended in Europe, there was a "very prevalent misconception" that the Germans had a poor understanding of applied nuclear physics. That misconception was apparently propagated by people such as Samuel Goudsmit, and has remained widespread ever since, despite this authoritative U.S. scientific memo stating that that misconception was entirely false.

- Weinberg and Nordheim, two high-ranking people in the U.S. Manhattan Project writing 6–12 months after the U.S. Alsos Mission had retrieved the relevant reports from Europe, repeatedly protested about the "few [German] reports we have been allowed to see," and that "we have not had access to the reports." Do those statements indicate that the United States was concealing German reports even from its leading Manhattan Project scientists, or that the United States was taking over 6–12 months before finally getting those reports to its leading scientists? If so, why was the United States suppressing information about the German nuclear program? Alternatively, if Weinberg and Nordheim had all the German reports that Alsos captured, their complaints suggest that a large number of relevant reports had been destroyed or hidden by the Germans.

- "The Germans knew how to design a [fission reactor] lattice which will work," "the German work apparently was done at the same time as" the U.S. work, "their approach was in no wise inferior to" the U.S. approach, and "in some respects it was superior."

- That equivalent work was achieved by a German group (apparently meaning the Kaiser Wilhelm Institute group led by Werner Heisenberg) that was much smaller than the corresponding American program. That shows great ability on the part of the German scientists, but it also demonstrates that Weinberg, Nordheim, and other high-ranking U.S. officials were unaware of all of the other parts of the German nuclear program—the large majority of the program.

- Allied sabotage and bombing of the heavy water factories in Norway (not any German lack of scientific ability) greatly delayed operation of a fission reactor in Germany.

- Weinberg and Nordheim were aware of heavy water production in Norway, and of German plans to produce heavy water elsewhere. Since their knowledge was admittedly very incomplete, it is possible that significant amounts of heavy water were actually produced elsewhere.

- Although Weinberg and Nordheim were unaware of a German pile that achieved a chain reaction, they admitted that their knowledge was very incomplete; it is possible that there was a German chain reaction that was unknown to these and perhaps even all U.S. officials.

- Weinberg and Nordheim essentially stated that it would be unethical for the United States to give public credit for applied nuclear physics innovations to scientists working in the wartime U.S. program but not to scientists from the wartime German program who were documented to have made the same (or better) innovations. That is in fact what the United States did and has continued to do.]

Figure D.371: The former Kaiser Wilhelm Institute for Physics, the original site of the Heisenberg group's fission reactor experiments, now houses the archive of the Max Planck Institute.