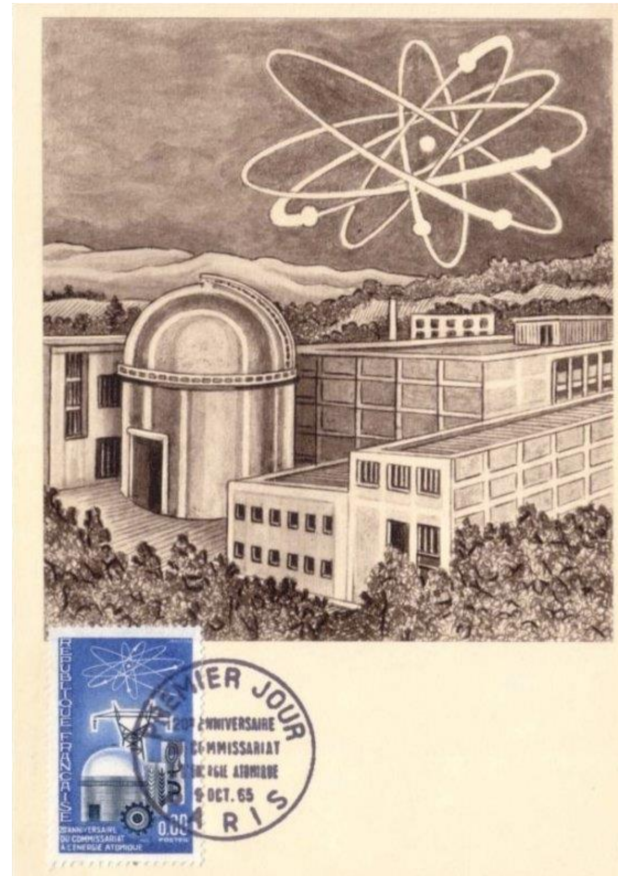
Les petites et la Grande Histoire de l'atome

Société Française d'Energie Nucléaire

"All science is either physics or stamp collecting"

Ernest Rutherford



Philatélie et nucléaire ?

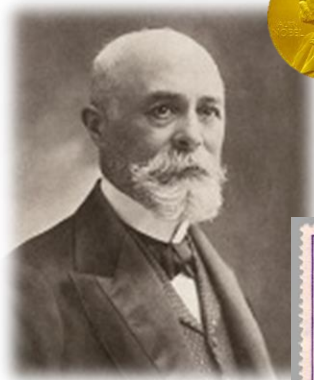
Yves MARGERIT, Aix en Provence 14 Janvier 2020

Institut Esope 21

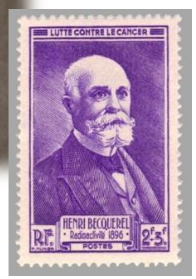
60 ans cea Cadarache

LMTE

LA RADIOACTIVITÉ … UNE IDÉE LUMINEUSE

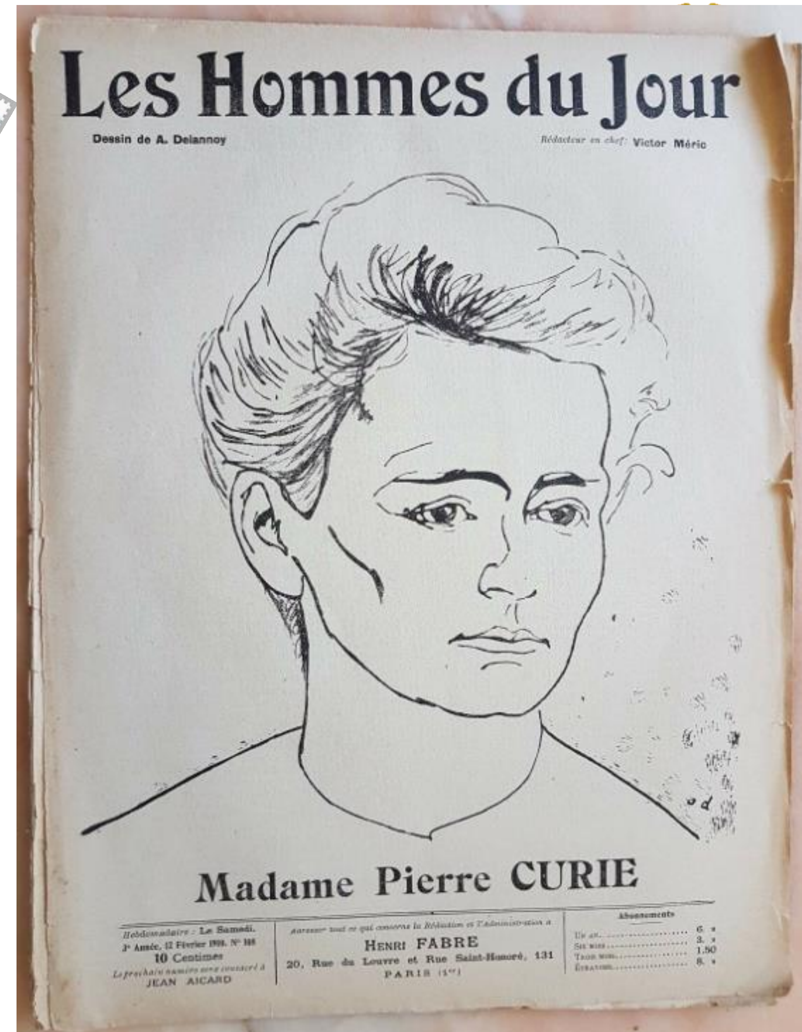


Henri Becquerel



Antoine Becquerel

Edmond Becquerel



Les Hommes du Jour

Dessin de A. Delannoy

Rédacteur en chef: Victor Méric

Madame Pierre CURIE

10 Centimes

JEAN AICARD

HENRI FABRE

20, Rue du Louvre et Rue Saint-Honoré, 131

PARIS (1er)

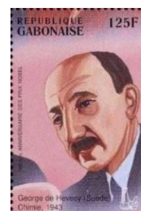
Yves MARGERIT, Aix en Provence 14 Janvier 2020

LE RADIUM ? NON ! LES RADIUMS …

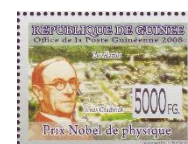
« The » Radium … ^{226}Rn (Papa …)

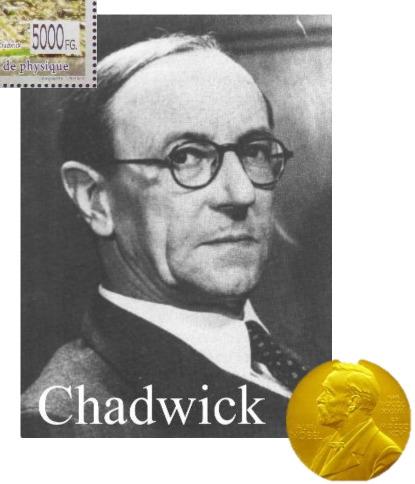
l'émanation	^{222}Rn
Radium A	^{218}Po
Radium B	^{214}Pb
Radium C	^{214}Bi
Radium C'	^{214}Po (164.3 µs)
Radium C''	^{210}Tl (1.3 mn)
$\boxed{\text{Radium D}}$	$\boxed{^{210}\text{Pb}}$
Radium E	^{210}Bi
Radium F	^{210}Po
Radium G	^{206}Pb

Frederick Soddy



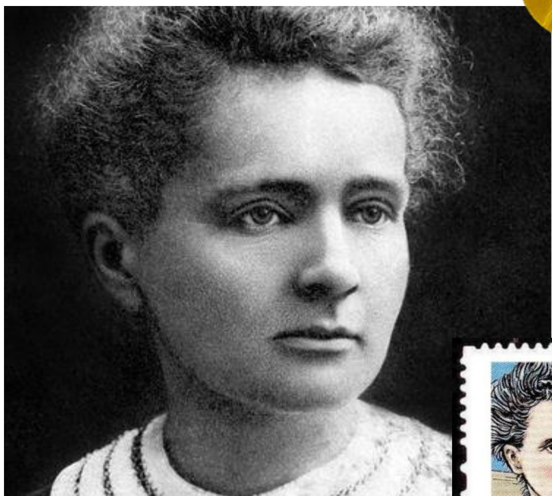
George de Hevezy

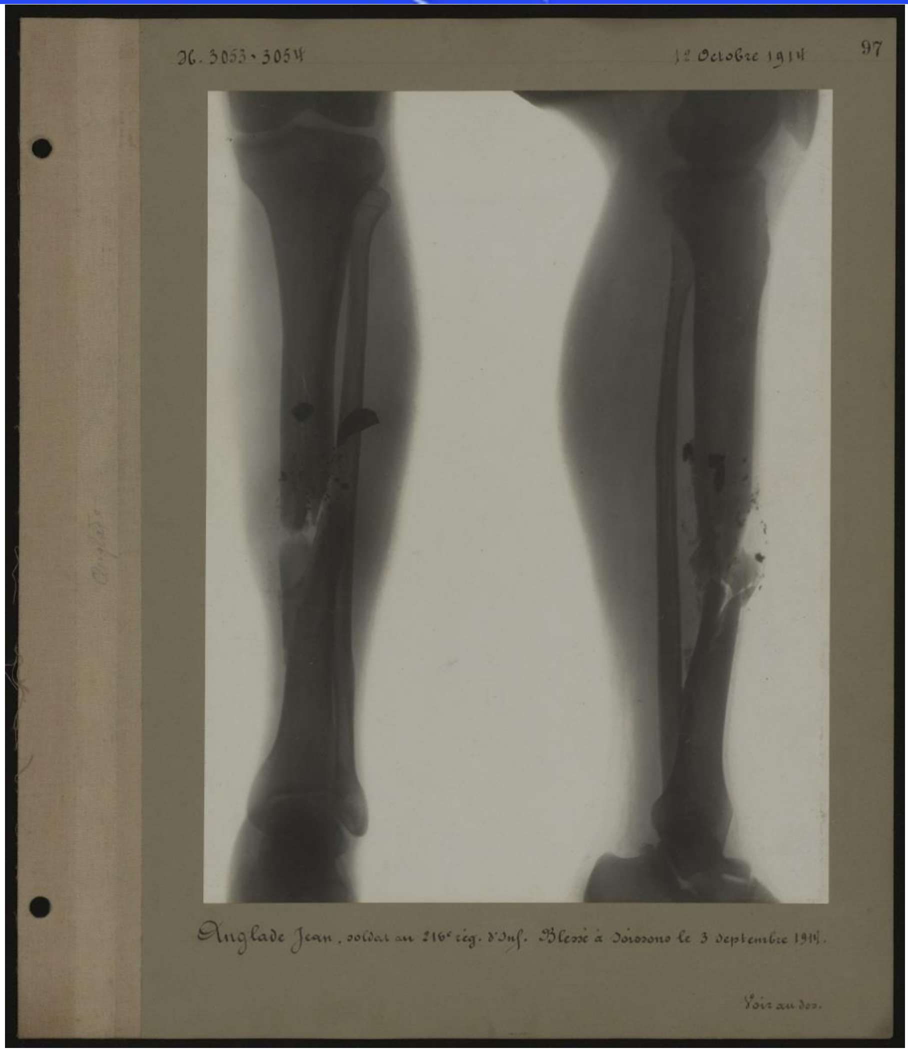




14-18 : LA GRANDE GUERRE …
… ET LES PETITES CURIES

Société Française d'Energie Nucléaire

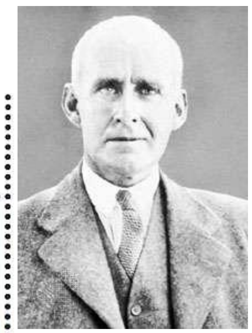


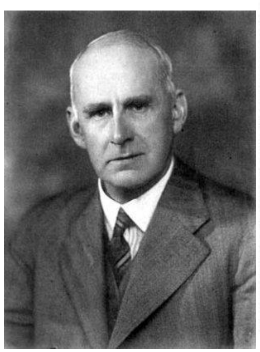


1920 : LA FUSION, L'ENERGIE DES ÉTOILES …

Société Française d'Energie Nucléaire

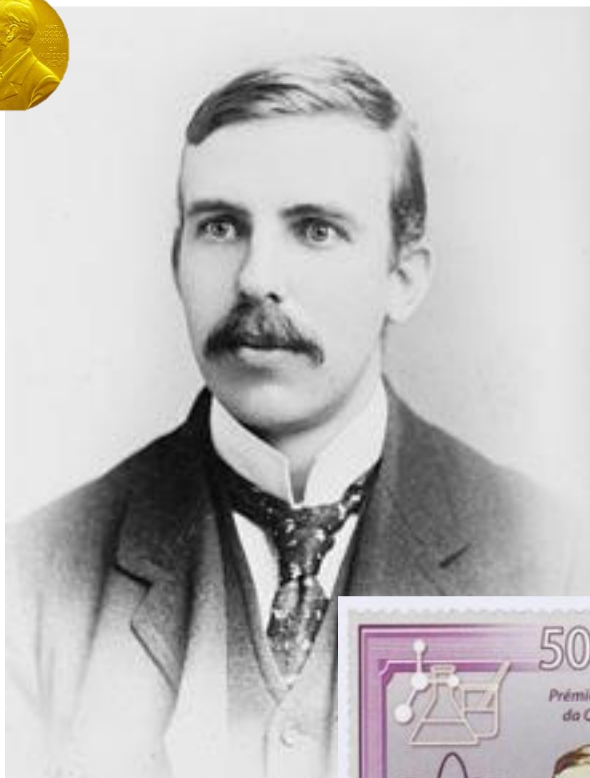
Arthur Stanley Eddington …

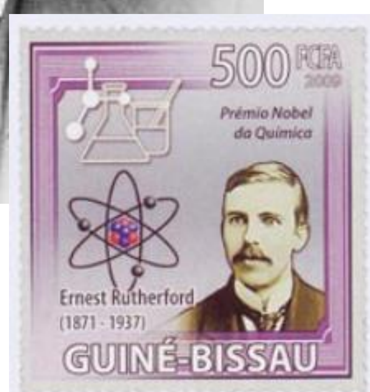


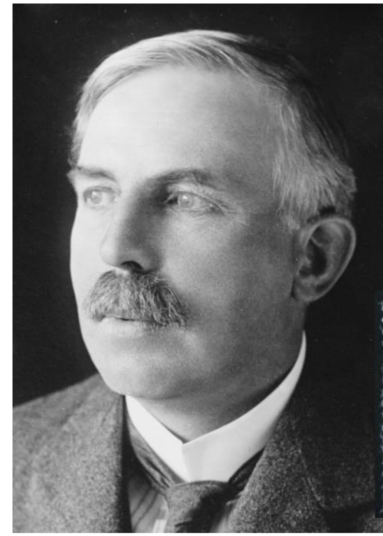


… avec Einstein

… SUR TERRE (1934)







“The energy produced by the atom is a very poor kind of thing. Anyone who expects a source of power from the transformation of these atoms is talking moonshine.”

Ernest Rutherford 1933

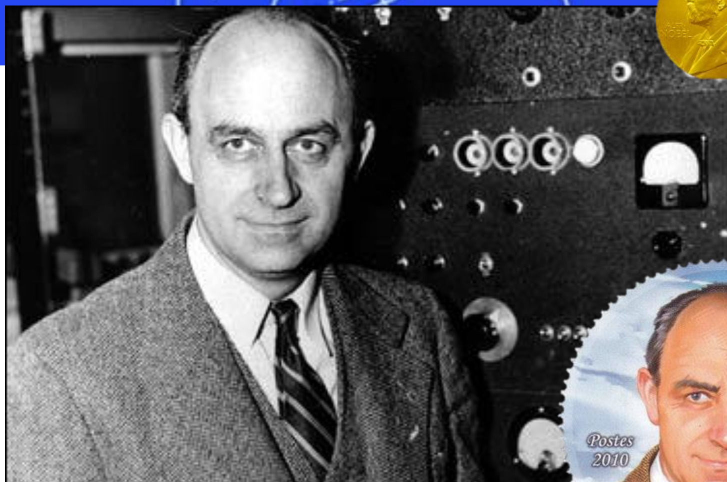
$$ {}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n + 3.27 MeV $$

$$ {}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{1}H + {}^{1}_{1}H + 4.03 MeV $$

$$ {}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + 17.59 MeV $$

$$ {}^{2}_{1}H + {}^{3}_{2}He \rightarrow {}^{4}_{2}He + {}^{1}_{1}H + 18.3 MeV $$

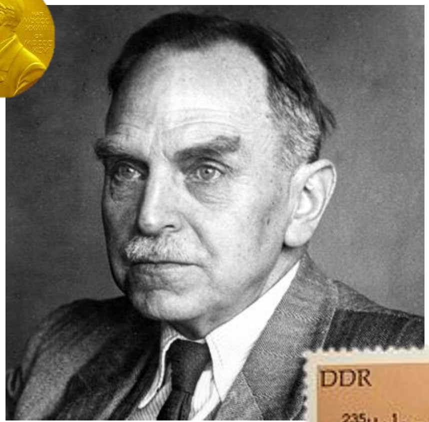
1MeV = 0.000 000 000 000 16 Joule



Enrico Fermi,
Nobel 1938
Ausonium et Hesperium

(Mussolinium et littorium)

Irène et Fréderic Joliot-Curie, Nobel 1935



Otto Hahn,
Nobel 1944

La fission (atomique)

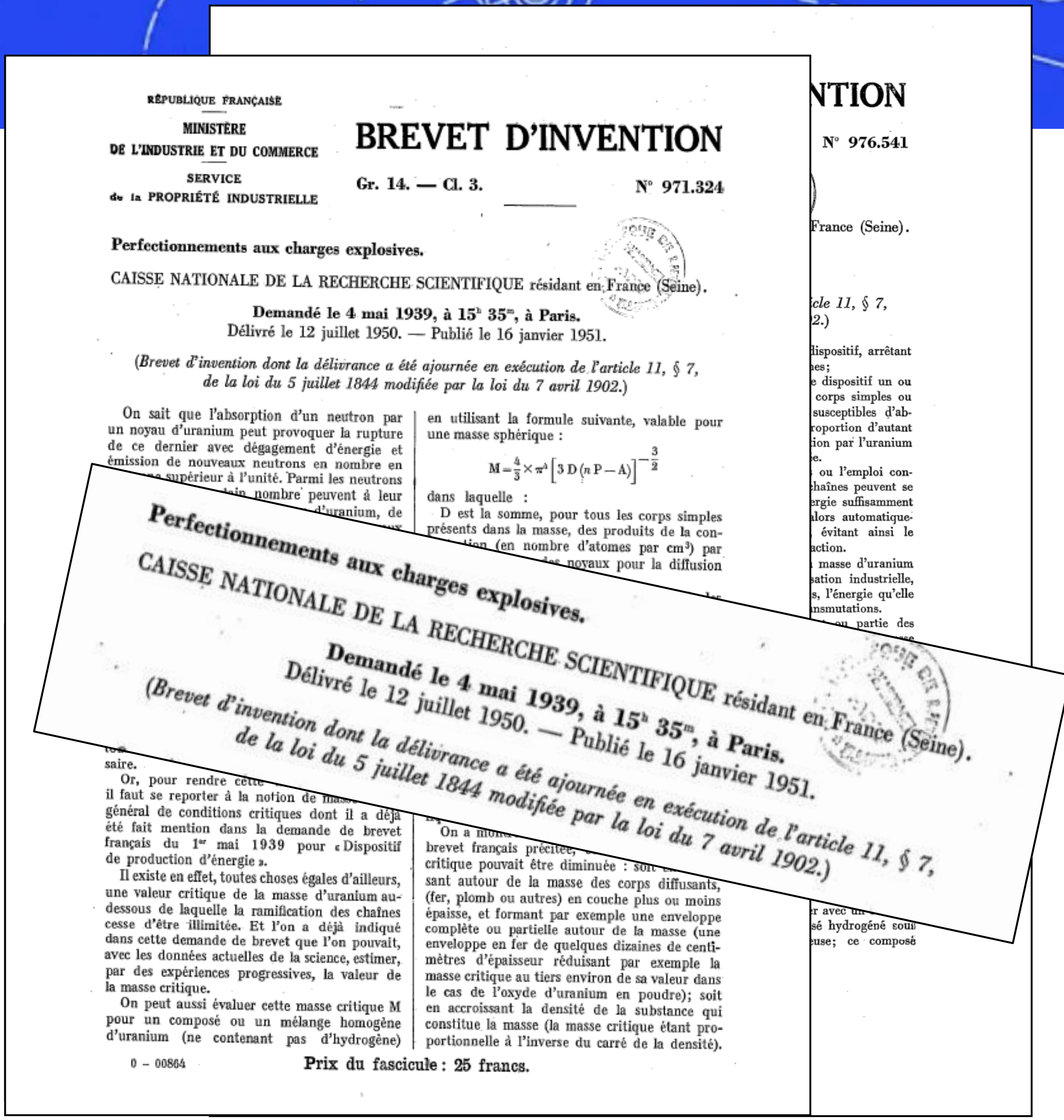
(17/12/1938, Otto Hahn, Fritz Strassmann)

$^{235}U + {}^{1}n \rightarrow Kr + Ba + 3\,{}^{1}n +$

<u>Energie</u>

Lise Meitner

LA REACTION EN CHAINE !


RÉPUBLIQUE FRANÇAISE

MINISTÈRE DE L'INDUSTRIE ET DU COMMERCE

SERVICE de la PROPRIÉTÉ INDUSTRIELLE

BREVET D'INVENTION

Gr. 14. — Cl. 3.

N° 971.324

Perfectionnements aux charges explosives.

CAISSE NATIONALE DE LA RECHERCHE SCIENTIFIQUE résidant en France (Seine).

Demandé le 4 mai 1939, à 15h 35m, à Paris.

Délivré le 12 juillet 1950. — Publié le 16 janvier 1951.

(Brevet d'invention dont la délivrance a été ajournée en exécution de l'article 11, § 7, de la loi du 5 juillet 1844 modifiée par la loi du 7 avril 1902.)

On sait que l'absorption d'un neutron par un noyau d'uranium peut provoquer la rupture de ce dernier avec dégagement d'énergie et émission de nouveaux neutrons en nombre en moyenne supérieur à l'unité. Parmi les neutrons ... nombre peuvent à leur ... d'uranium, de ...

... saire.

Or, pour rendre cette ... il faut se reporter à la notion de mas... général de conditions critiques dont il a déjà été fait mention dans la demande de brevet français du 1er mai 1939 pour « Dispositif de production d'énergie ».

Il existe en effet, toutes choses égales d'ailleurs, une valeur critique de la masse d'uranium au-dessous de laquelle la ramification des chaînes cesse d'être illimitée. Et l'on a déjà indiqué dans cette demande de brevet que l'on pouvait, avec les données actuelles de la science, estimer, par des expériences progressives, la valeur de la masse critique.

On peut aussi évaluer cette masse critique M pour un composé ou un mélange homogène d'uranium (ne contenant pas d'hydrogène) en utilisant la formule suivante, valable pour une masse sphérique :

$$M = \frac{4}{3} \times \pi^4 \left[3D(nP - A)\right]^{-\frac{3}{2}}$$

dans laquelle :

D est la somme, pour tous les corps simples présents dans la masse, des produits de la concentration (en nombre d'atomes par cm³) par ... noyaux pour la diffusion ...

On a mon... brevet français précité, ... critique pouvait être diminuée : soit ... sant autour de la masse des corps diffusants, (fer, plomb ou autres) en couche plus ou moins épaisse, et formant par exemple une enveloppe complète ou partielle autour de la masse (une enveloppe en fer de quelques dizaines de centimètres d'épaisseur réduisant par exemple la masse critique au tiers environ de sa valeur dans le cas de l'oxyde d'uranium en poudre); soit en accroissant la densité de la substance qui constitue la masse (la masse critique étant proportionnelle à l'inverse du carré de la densité).

0 – 00864 Prix du fascicule : 25 francs.

...NTION

N° 976.541

... France (Seine).

Perfectionnements aux charges explosives.

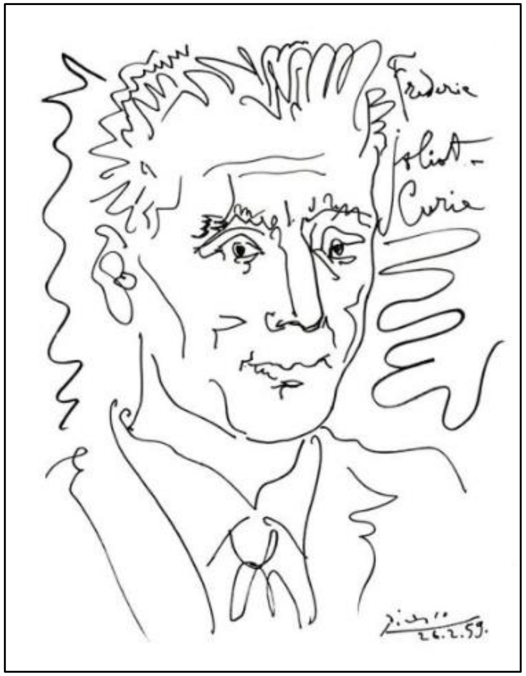
CAISSE NATIONALE DE LA RECHERCHE SCIENTIFIQUE résidant en France (Seine).

Demandé le 4 mai 1939, à 15h 35m, à Paris.

Délivré le 12 juillet 1950. — Publié le 16 janvier 1951.

(Brevet d'invention dont la délivrance a été ajournée en exécution de l'article 11, § 7, de la loi du 5 juillet 1844 modifiée par la loi du 7 avril 1902.)

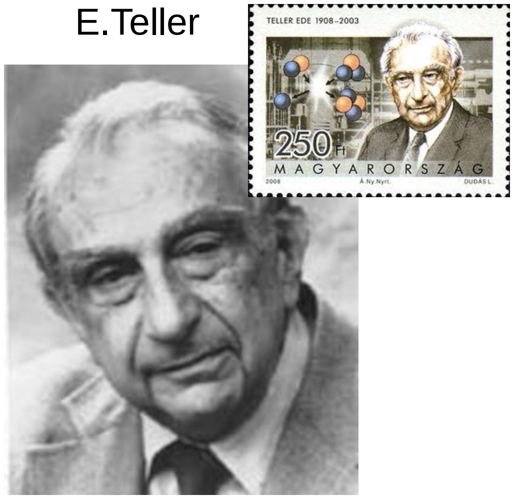
Frédéric Joliot Curie



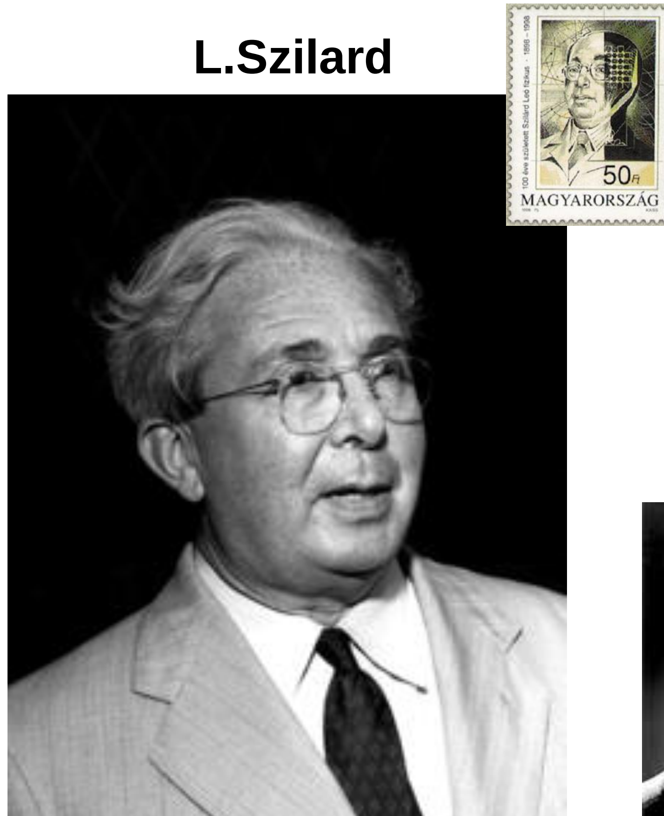
Société Française d'Energie Nucléaire

LA MAFIA DES … EXTRATERRESTRES !

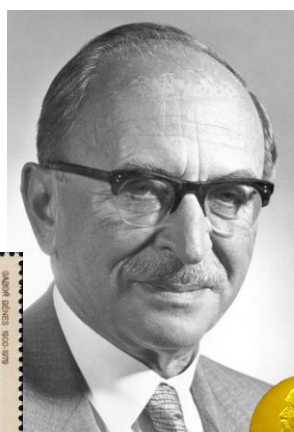
E.Teller



L.Szilard



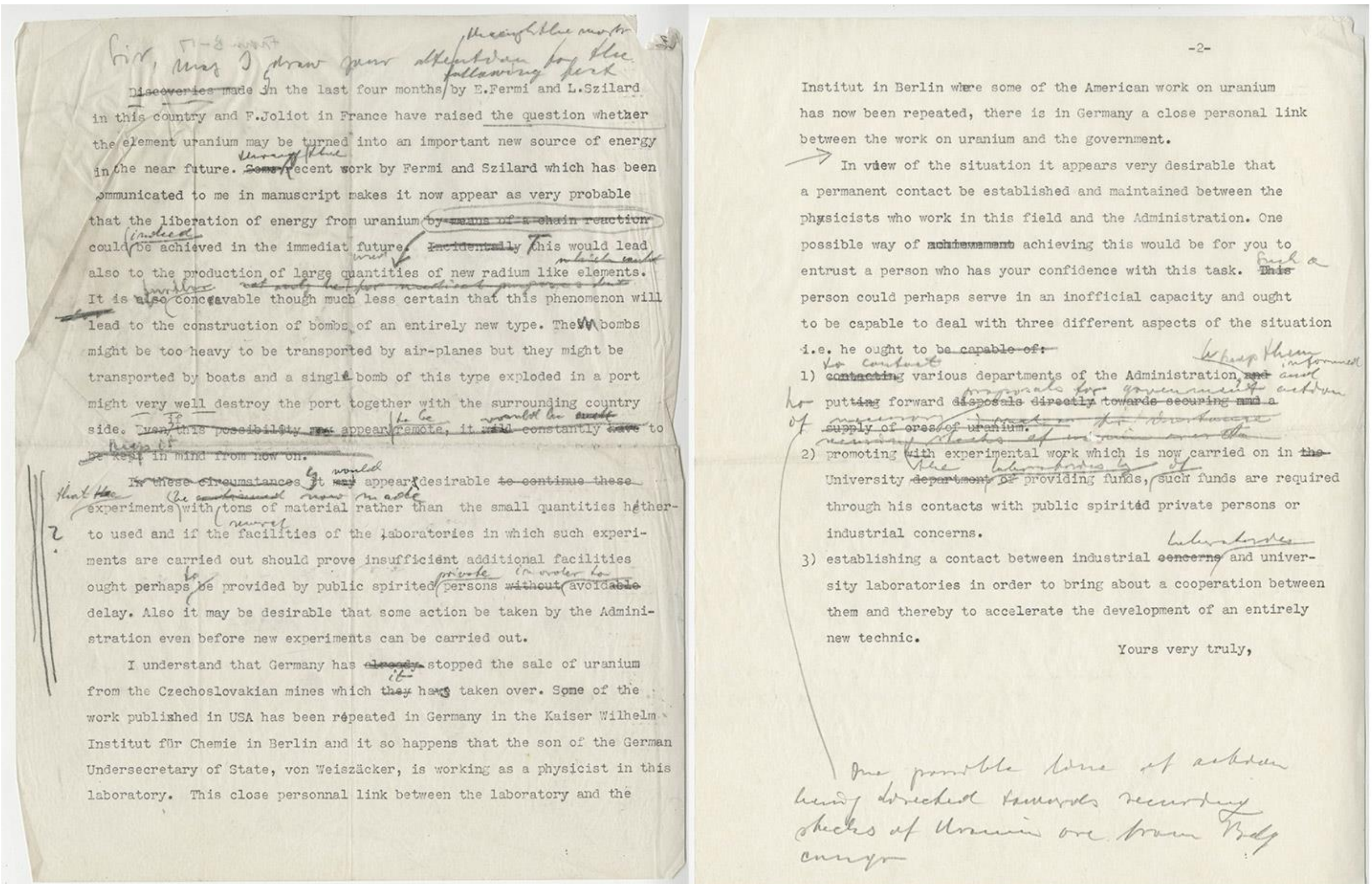
E.Wigner



D.Gabor

J.Von Neumann

BROUILLON



Sir, may I draw your attention to the following facts

~~Discoveries made~~ in the last four months by E.Fermi and L.Szilard in this country and F.Joliot in France have raised the question whether the element uranium may be turned into an important new source of energy in the near future. ~~Some~~ recent work by Fermi and Szilard which has been communicated to me in manuscript makes it now appear as very probable that the liberation of energy from uranium ~~by means of a chain reaction~~ could be achieved in the immediat future. ~~Incidentally~~ this would lead also to the production of large quantities of new radium like elements. It is also conceivable though much less certain that this phenomenon will lead to the construction of bombs of an entirely new type. The bombs might be too heavy to be transported by air-planes but they might be transported by boats and a single bomb of this type exploded in a port might very well destroy the port together with the surrounding country side. ~~Even this possibility may~~ appear remote, it ~~would~~ constantly ~~have~~ to ~~be kept in mind from now on.~~

~~In these circumstances~~ it ~~may~~ appear desirable ~~to continue these~~ experiments with tons of material rather than the small quantities hetherto used and if the facilities of the laboratories in which such experiments are carried out should prove insufficient additional facilities ought perhaps be provided by public spirited persons ~~without~~ avoidable delay. Also it may be desirable that some action be taken by the Administration even before new experiments can be carried out.

I understand that Germany has ~~already~~ stopped the sale of uranium from the Czechoslovakian mines which they have taken over. Some of the work published in USA has been repeated in Germany in the Kaiser Wilhelm Institut für Chemie in Berlin and it so happens that the son of the German Undersecretary of State, von Weiszäcker, is working as a physicist in this laboratory. This close personnal link between the laboratory and the

-2-

Institut in Berlin where some of the American work on uranium has now been repeated, there is in Germany a close personal link between the work on uranium and the government.

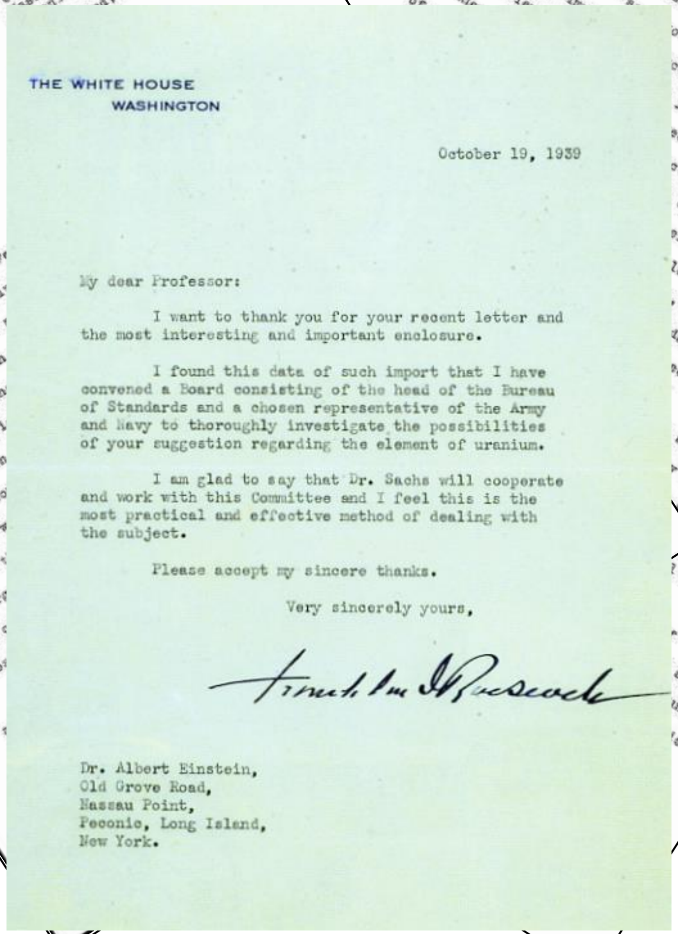
In view of the situation it appears very desirable that a permanent contact be established and maintained between the physicists who work in this field and the Administration. One possible way of ~~achievement~~ achieving this would be for you to entrust a person who has your confidence with this task. ~~This~~ person could perhaps serve in an inofficial capacity and ought to be capable to deal with three different aspects of the situation i.e. he ought to ~~be capable of:~~

1) ~~contacting~~ various departments of the Administration~~, and~~
putting forward ~~disposals directly towards securing and a supply of ores of uranium.~~
2) promoting ~~with~~ experimental work which is now carried on in ~~the~~ University ~~department~~ ~~of~~ providing funds, such funds are required through his contacts with public spirited private persons or industrial concerns.
3) establishing a contact between industrial ~~concerns~~ and university laboratories in order to bring about a cooperation between them and thereby to accelerate the development of an entirely new technic.

Yours very truly,

One possible line of action being directed towards securing stocks of Uranium ore from Belg Congo

ALBERT S'EN MÊLE …



THE WHITE HOUSE
WASHINGTON

October 19, 1939

My dear Professor:

I want to thank you for your recent letter and the most interesting and important enclosure.

I found this data of such import that I have convened a Board consisting of the head of the Bureau of Standards and a chosen representative of the Army and Navy to thoroughly investigate the possibilities of your suggestion regarding the element of uranium.

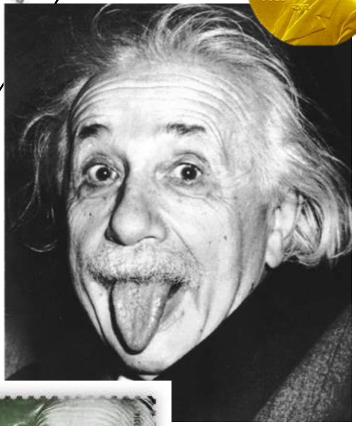
I am glad to say that Dr. Sachs will cooperate and work with this Committee and I feel this is the most practical and effective method of dealing with the subject.

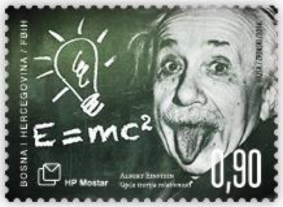
Please accept my sincere thanks.

Very sincerely yours,

Franklin D Roosevelt

Dr. Albert Einstein,
Old Grove Road,
Nassau Point,
Peconic, Long Island,
New York.

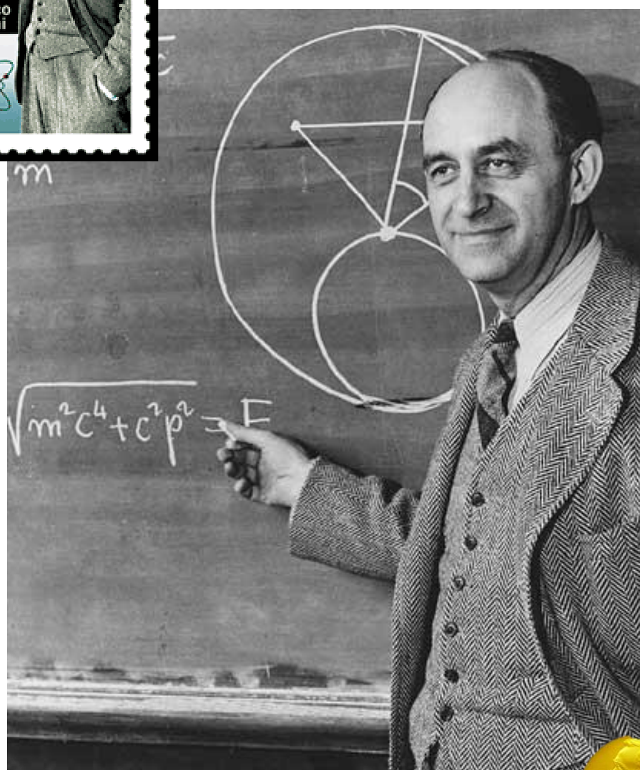


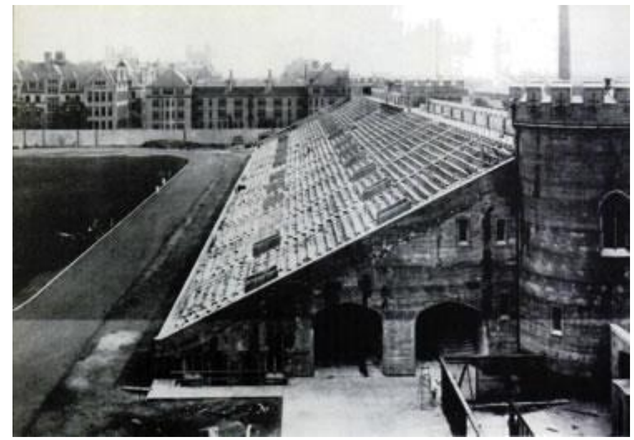


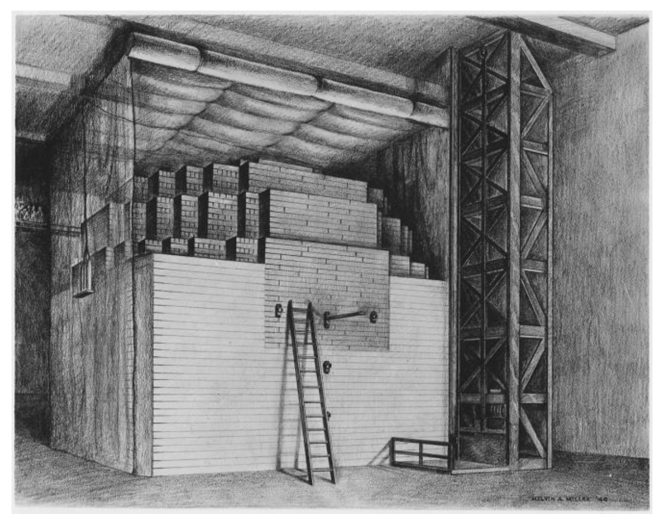
« Je dois ma vie à ma collection de timbres. L'intérêt que l'on manifeste dans sa jeunesse à la philatélie ne cesse de s'accroître. C'est un passe-temps qui chasse l'ennui, élargit nos connaissances et, d'une façon générale, enrichit notre vie » (Franklin D. Roosevelt).

UN RÉACTEUR SUR UN TERRAIN DE SQUASH

Enrico Fermi

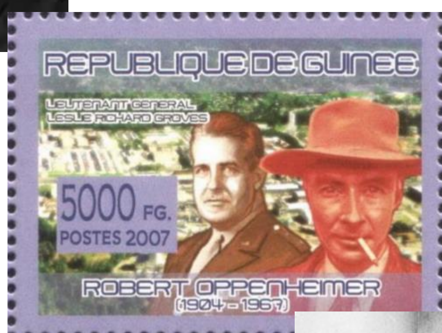




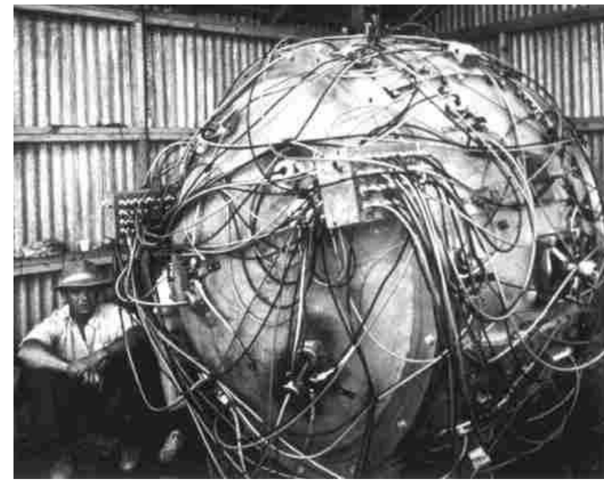


UN GADGET QUI FAIT DU BRUIT …

Leslie GROVES

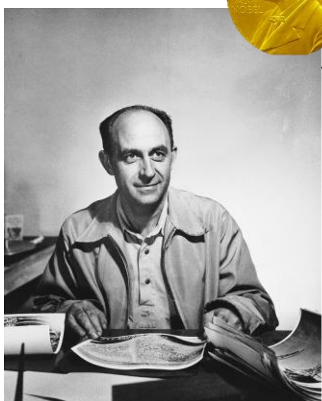


Robert OPPENHEIMER



Le Gadget
(16/07/1945)

EYEWITNESS



~~SECRET~~

~~This document consists of ... Page(s)~~
~~No. ... of ... Copies, Series ...~~

<u>My Observations During the Explosion at Trinity on July 16, 1945</u> — E. Fermi

On the morning of the 16th of July, I was stationed at the Base Camp at Trinity in a position about ten miles from the site of the explosion.

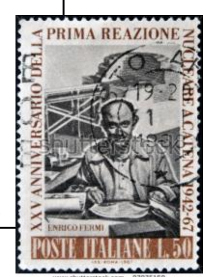
The explosion took place at about 5:30 A.M. I had my face protected by a large board in which a piece of dark welding glass had been inserted. My first impression of the explosion was the very intense flash of light, and a sensation of heat on the parts of my body that were exposed. Although I did not look directly towards the object, I had the impression that suddenly the countryside became brighter than in full daylight. I subsequently looked in the direction of the explosion through the dark glass and could see something that looked like a conglomeration of flames that promptly started rising. After a few seconds the rising flames lost their brightness and appeared as a huge pillar of smoke with an expanded head like a gigantic mushroom that rose rapidly beyond the clouds probably to a height of the order of 30,000 feet. After reaching its full height, the smoke stayed stationary for a while before the wind started dispersing it.

About 40 seconds after the explosion the air blast reached me. I tried to estimate its strength by dropping from about six feet small pieces of paper before, during and after the passage of the blast wave. Since, at the time, there was no wind I could observe very distinctly and actually measure the displacement of the pieces of paper that were in the process of falling while the blast was passing. The shift was about $2\frac{1}{2}$ meters, which, at the time, I estimated to correspond to the blast that would be produced by ten thousand tons of T.N.T.

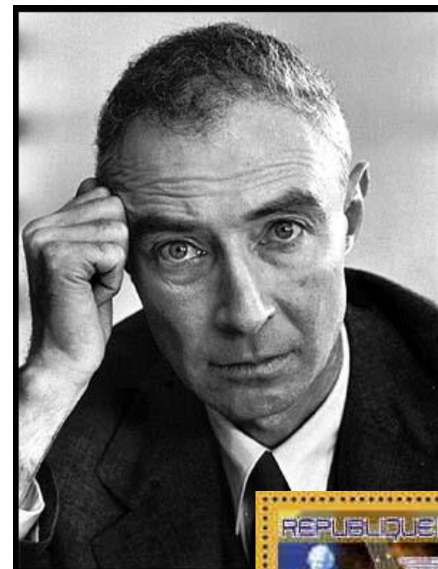
CLASSIFICATION ... OR CHANGED TO Unclassified
BY AUTHORITY OF H. T. Carroll
BY B. Wie... DATE 1-27-65

~~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~~



Robert Oppenheimer

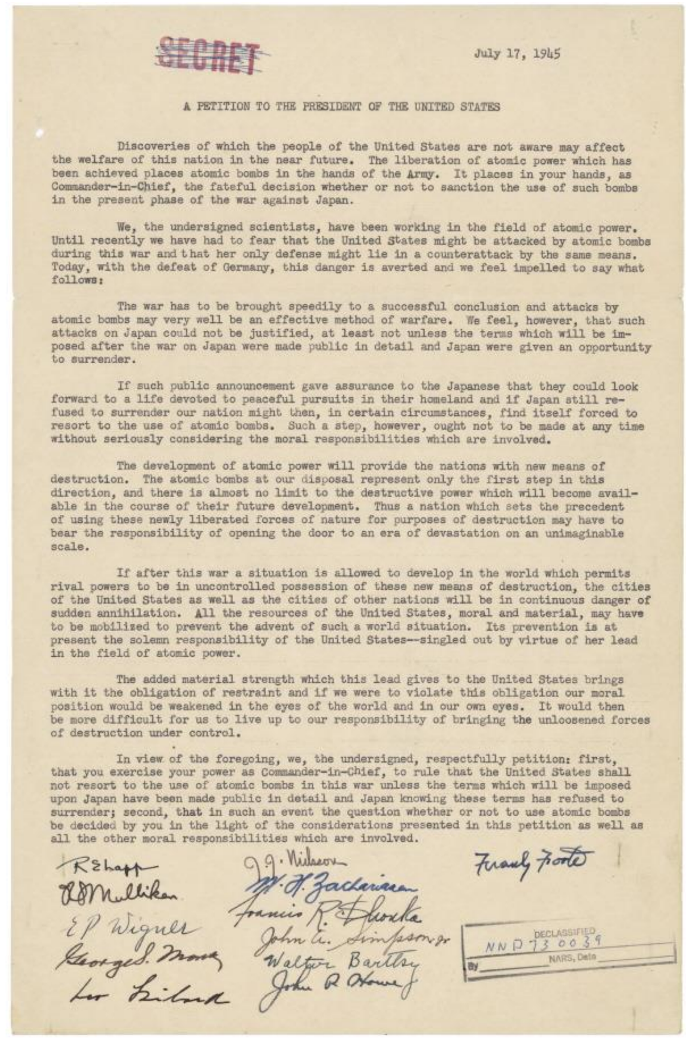


« I am become death, the destoyer of worlds »

http://www.dannen.com/

17 JUILLET 1945

Léo Szilard



SECRET

July 17, 1945

A PETITION TO THE PRESIDENT OF THE UNITED STATES

Discoveries of which the people of the United States are not aware may affect the welfare of this nation in the near future. The liberation of atomic power which has been achieved places atomic bombs in the hands of the Army. It places in your hands, as Commander-in-Chief, the fateful decision whether or not to sanction the use of such bombs in the present phase of the war against Japan.

We, the undersigned scientists, have been working in the field of atomic power. Until recently we have had to fear that the United States might be attacked by atomic bombs during this war and that her only defense might lie in a counterattack by the same means. Today, with the defeat of Germany, this danger is averted and we feel impelled to say what follows:

The war has to be brought speedily to a successful conclusion and attacks by atomic bombs may very well be an effective method of warfare. We feel, however, that such attacks on Japan could not be justified, at least not unless the terms which will be imposed after the war on Japan were made public in detail and Japan were given an opportunity to surrender.

If such public announcement gave assurance to the Japanese that they could look forward to a life devoted to peaceful pursuits in their homeland and if Japan still refused to surrender our nation might then, in certain circumstances, find itself forced to resort to the use of atomic bombs. Such a step, however, ought not to be made at any time without seriously considering the moral responsibilities which are involved.

The development of atomic power will provide the nations with new means of destruction. The atomic bombs at our disposal represent only the first step in this direction, and there is almost no limit to the destructive power which will become available in the course of their future development. Thus a nation which sets the precedent of using these newly liberated forces of nature for purposes of destruction may have to bear the responsibility of opening the door to an era of devastation on an unimaginable scale.

If after this war a situation is allowed to develop in the world which permits rival powers to be in uncontrolled possession of these new means of destruction, the cities of the United States as well as the cities of other nations will be in continuous danger of sudden annihilation. All the resources of the United States, moral and material, may have to be mobilized to prevent the advent of such a world situation. Its prevention is at present the solemn responsibility of the United States--singled out by virtue of her lead in the field of atomic power.

The added material strength which this lead gives to the United States brings with it the obligation of restraint and if we were to violate this obligation our moral position would be weakened in the eyes of the world and in our own eyes. It would then be more difficult for us to live up to our responsibility of bringing the unloosened forces of destruction under control.

In view of the foregoing, we, the undersigned, respectfully petition: first, that you exercise your power as Commander-in-Chief, to rule that the United States shall not resort to the use of atomic bombs in this war unless the terms which will be imposed upon Japan have been made public in detail and Japan knowing these terms has refused to surrender; second, that in such an event the question whether or not to use atomic bombs be decided by you in the light of the considerations presented in this petition as well as all the other moral responsibilities which are involved.

R E Lapp
R S Mulliken
E P Wigner
George S. Monk
Leo Szilard
J. J. Nickson
W. H. Zachariasen
Francis R. Shonka
John A. Simpson Jr
Walter Bartky
John R Howe Jr
Frank Foote

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By ______ NARS, Date ______

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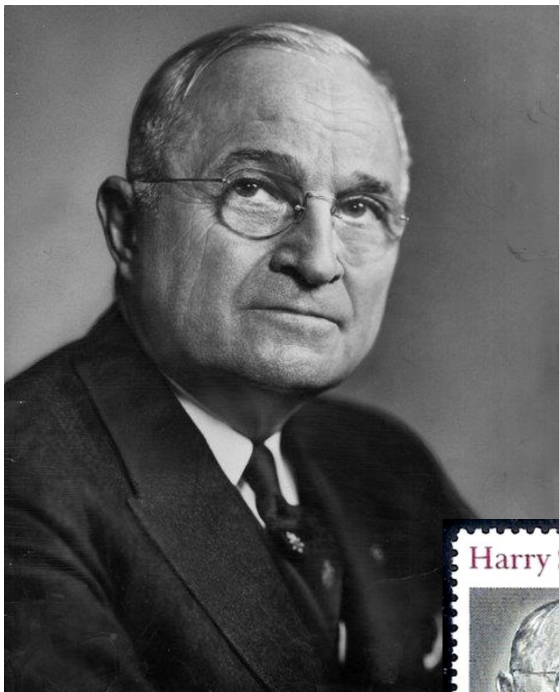
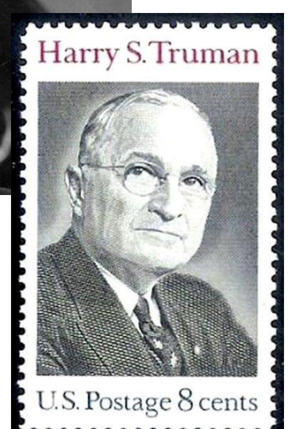
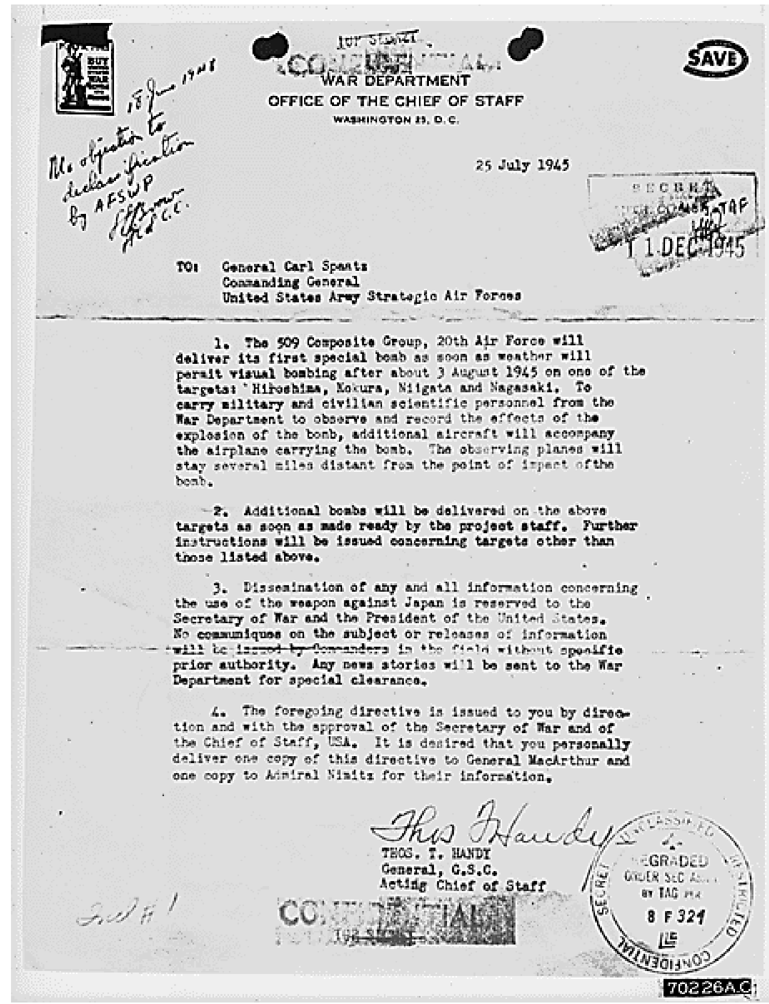
25 JUILLET 1945







WAR DEPARTMENT
OFFICE OF THE CHIEF OF STAFF
WASHINGTON 25, D. C.

SAVE

18 June 1948
No objection to declassification by AFSWP

25 July 1945

SECRET
1 DEC 1945

TO: General Carl Spaatz
Commanding General
United States Army Strategic Air Forces

1. The 509 Composite Group, 20th Air Force will deliver its first special bomb as soon as weather will permit visual bombing after about 3 August 1945 on one of the targets: Hiroshima, Kokura, Niigata and Nagasaki. To carry military and civilian scientific personnel from the War Department to observe and record the effects of the explosion of the bomb, additional aircraft will accompany the airplane carrying the bomb. The observing planes will stay several miles distant from the point of impact of the bomb.

2. Additional bombs will be delivered on the above targets as soon as made ready by the project staff. Further instructions will be issued concerning targets other than those listed above.

3. Dissemination of any and all information concerning the use of the weapon against Japan is reserved to the Secretary of War and the President of the United States. No communiques on the subject or releases of information will be issued by Commanders in the field without specific prior authority. Any news stories will be sent to the War Department for special clearance.

4. The foregoing directive is issued to you by direction and with the approval of the Secretary of War and of the Chief of Staff, USA. It is desired that you personally deliver one copy of this directive to General MacArthur and one copy to Admiral Nimitz for their information.

Thos T Handy
THOS. T. HANDY
General, G.S.C.
Acting Chief of Staff

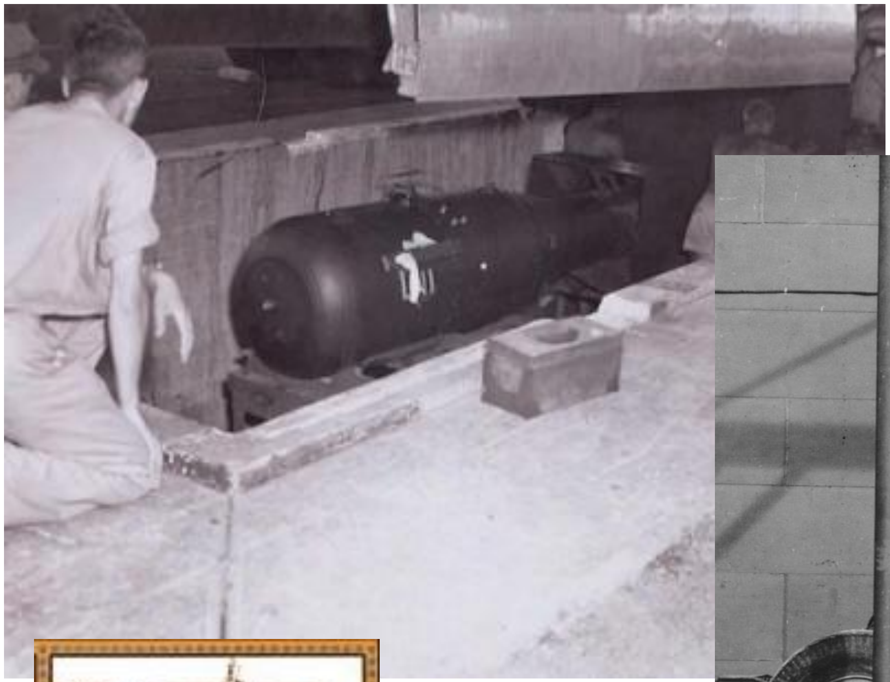
CONFIDENTIAL

REGRADED
8 F 321

70226A.C.

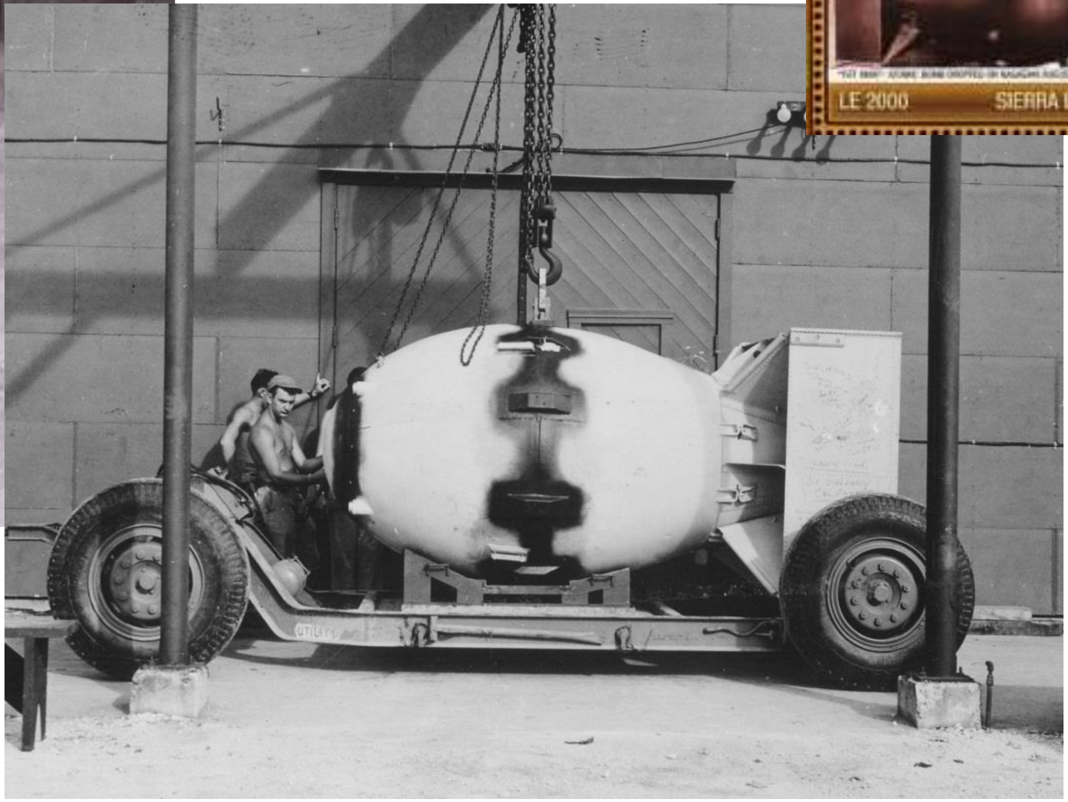
http://www.dannen.com/

6 ET 9 AOÛT 1945



Little Boy

Fat Man



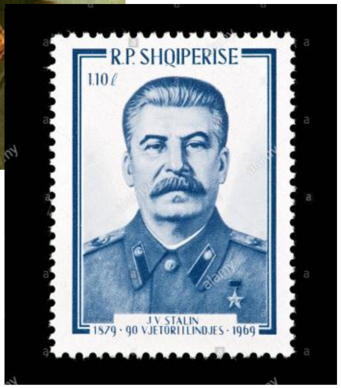
UN MOTEUR À RÉACTION (TRÈS) SPÉCIAL

Игорь Васильевич Курчатов

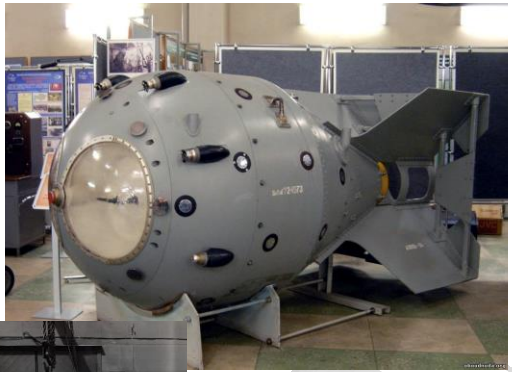
« La Barbe »

Реактивный двигатель специальный

Первая молния



« Joe one »



Klaus Fuchs

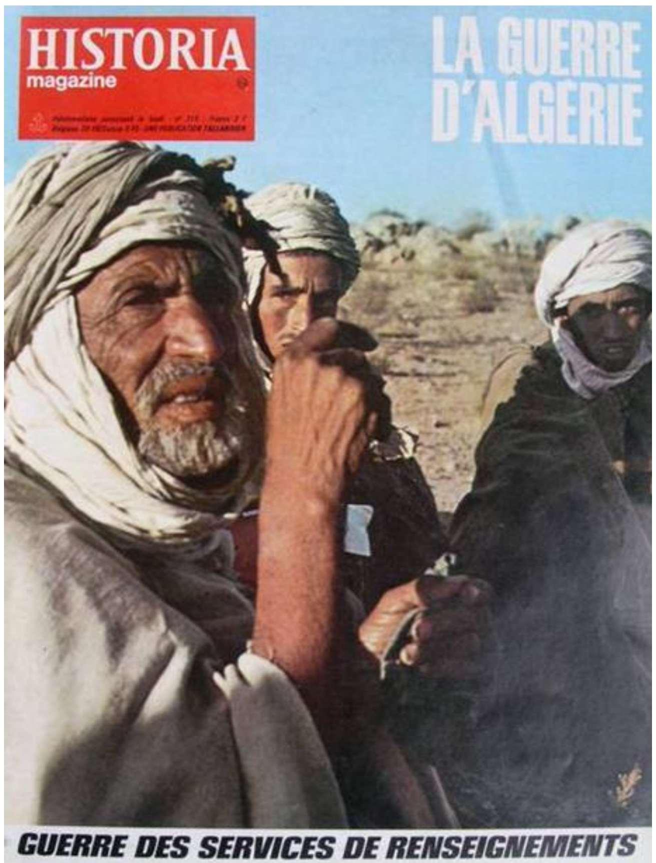
LA BOMBE H (LA SUPER)

Edward Teller

Isaac Rabi

Андрей Дмитриевич Сахаров

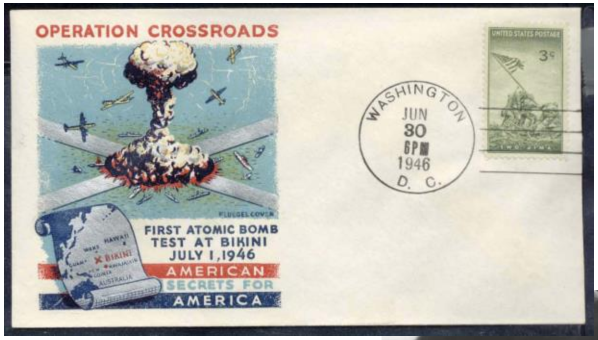
ET LA FRANCE …



1960 : Gerboise Bleue (70 kT)
1968 : Canopus (2.6 MT)

QUI A LA PLUS GROSSE ?
OU PLEIN DE PETITES !

Tsar bomba (57 Mt)



Essai
Baker
25/07/46

Davy Crockett Weapon System (env. 15T)

- 478 essais atmosphériques
- 17 en haute atmosphère
- 1521 souterrains
- 5 sous marins

Société Française d'Energie Nucléaire

AUJOURD'HUI :

Etats unis : 7 700

Russie : 8 500

Royaume Uni : 225

France : 300

Chine : 250

Inde : 90-110

Pakistan : 100-120

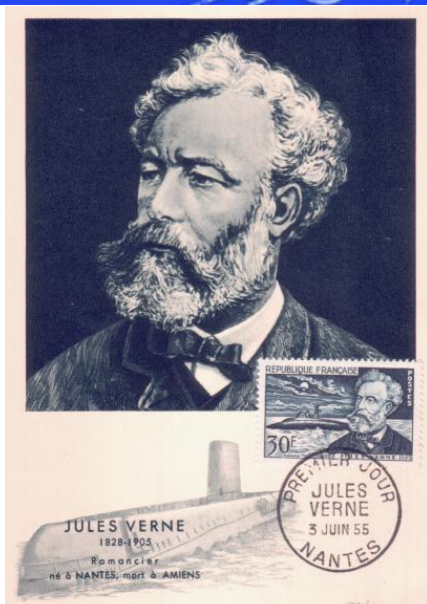
Israël : 80

Corée du Nord : <10

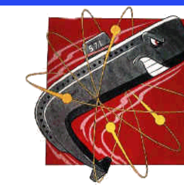
Source ICAN, Nobel de la Paix 2017

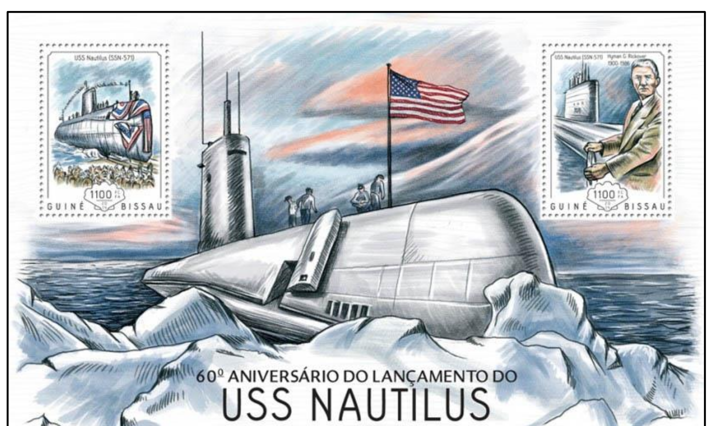
20 000 LIEUX … SOUS LA GLACE

SFEN Société Française d'Energie Nucléaire



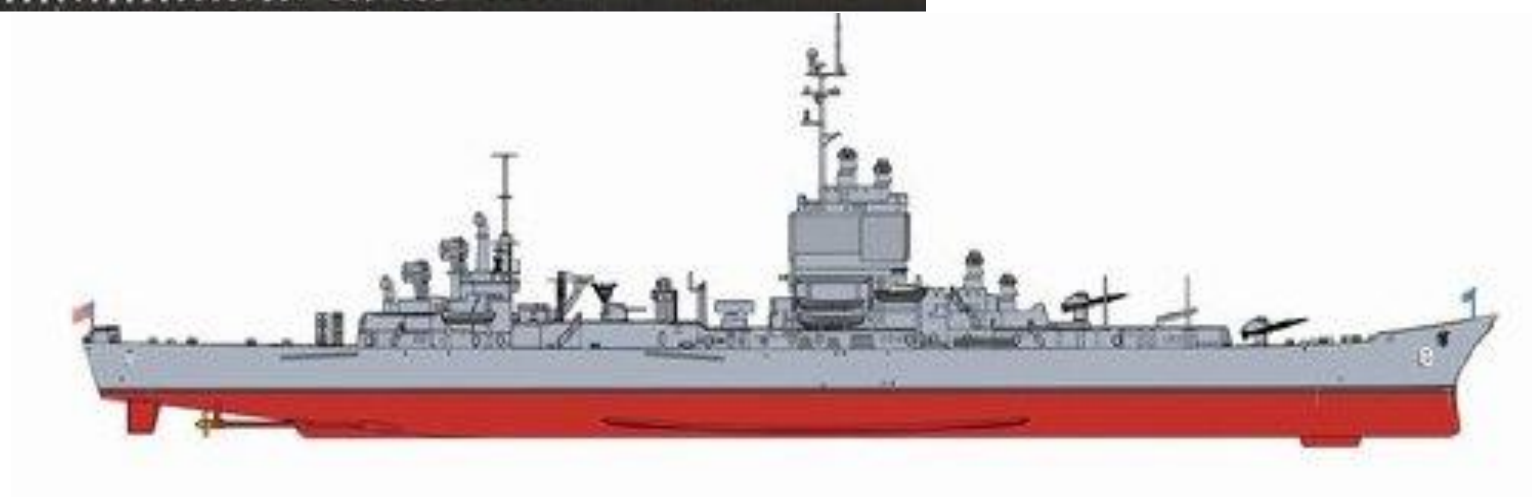
1954-1980



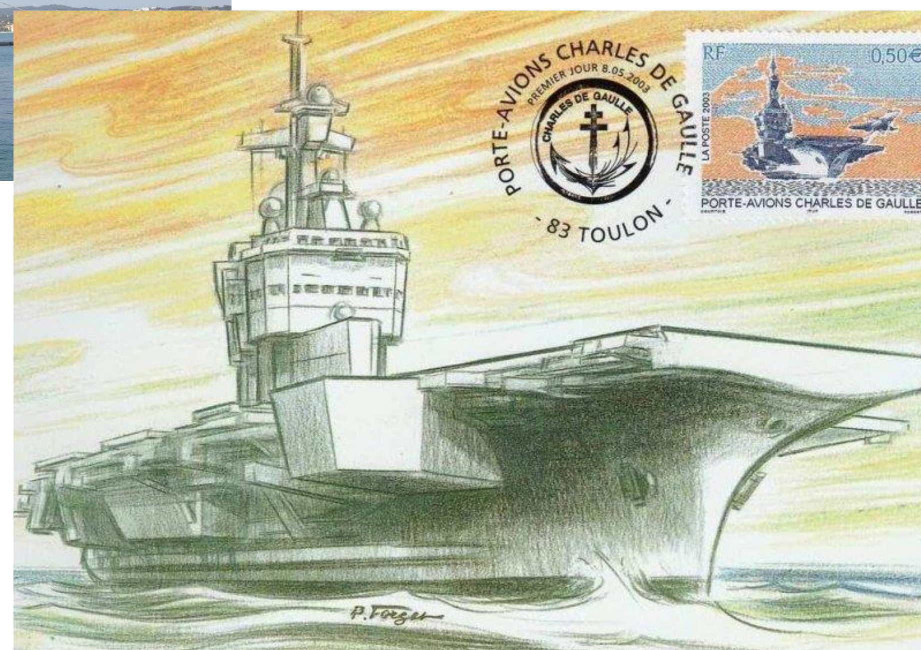


LE LONG BEACH

Construction : 1957-59-61

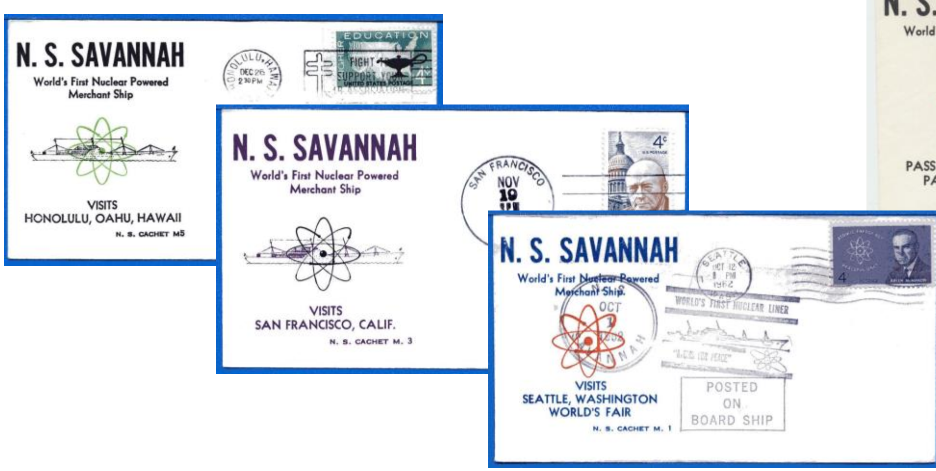


LE CHARLES DE GAULLE

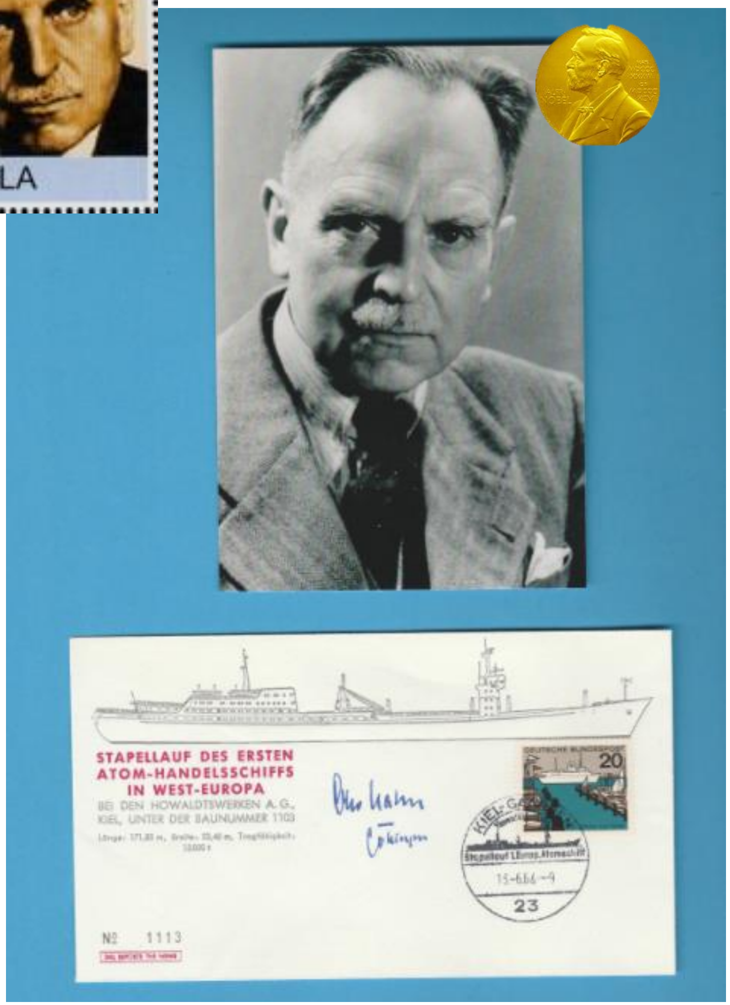


NS SAVANNAH : BUREAU DE POSTE …

1962-1972



LE OTTO HAHN

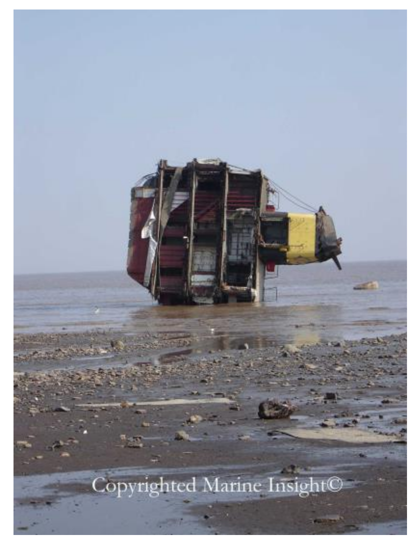


1968-1979-2009

1972 : 463 000 km avec 22kg d'uranium

1979 : 1 200 000 km

2009 : Alang …



AU JAPON LE MUTSU

1972-1992

BRISES GLACE

www.alamy.com - G8G3JD

www.alamy.com - B7F251

LE PREMIER COURANT

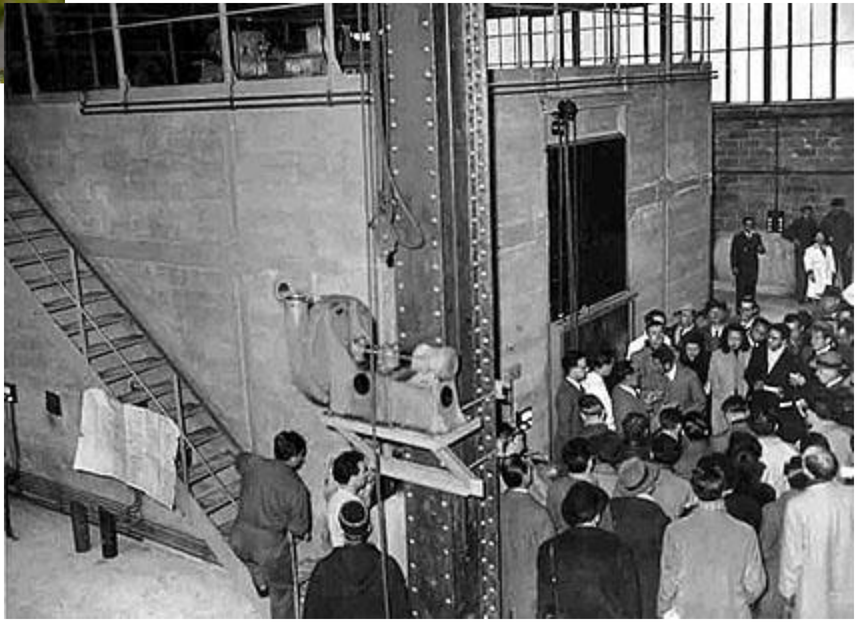
Le premier réacteur producteur d'électricité

EBR 1 (Idaho)

20 Décembre 1951

EN FRANCE …

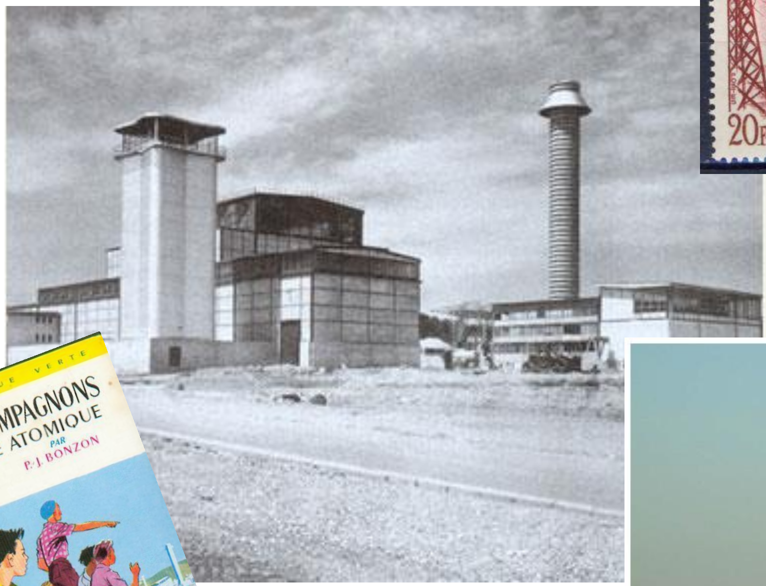
ZOÉ (1947)
Fort de Chatillon
(Fontenay Aux Roses)



26 JUIN 1954, OBNINSK

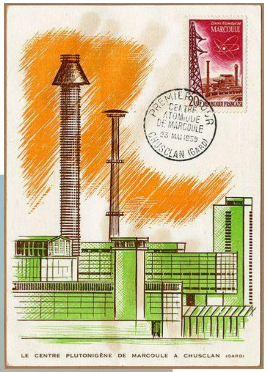
1951-2002, 5 MWe

G1, 28 SEPTEMBRE 1956



G1 à Marcoule (1956)
Construit en 18 mois …

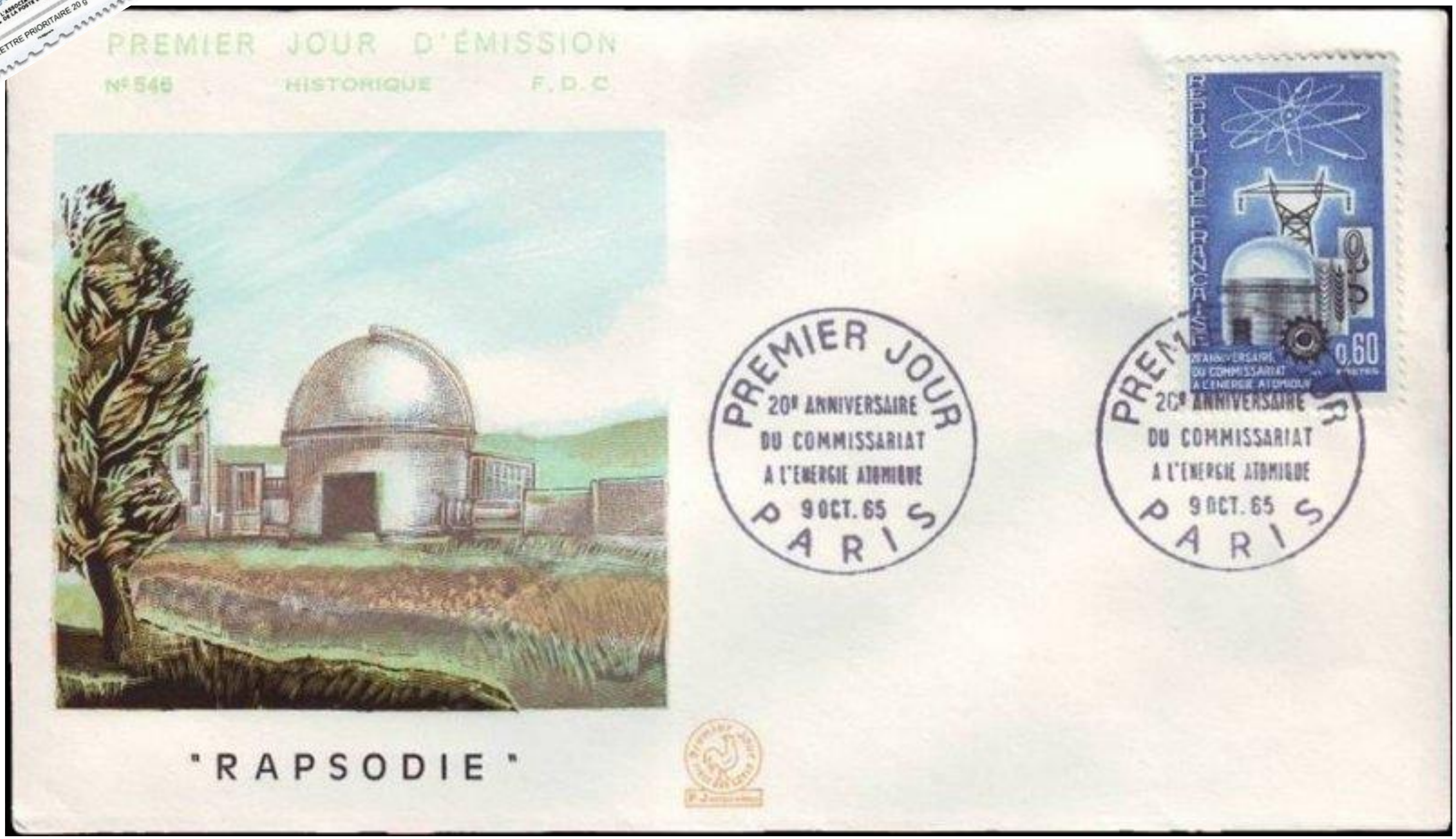
46 MWth



… 3 ans pour détruire la cheminée.

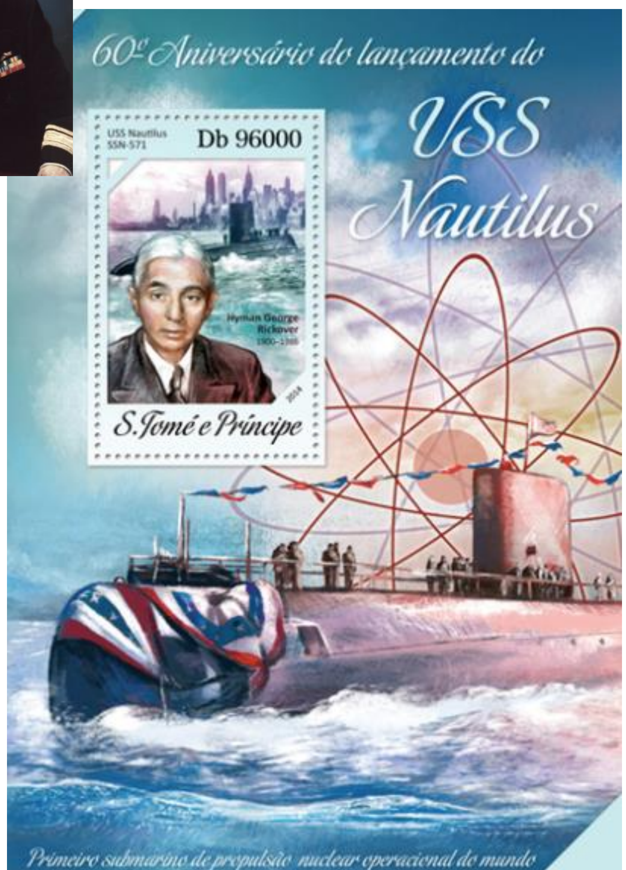
14 OCTOBRE 1959 : CADARACHE !

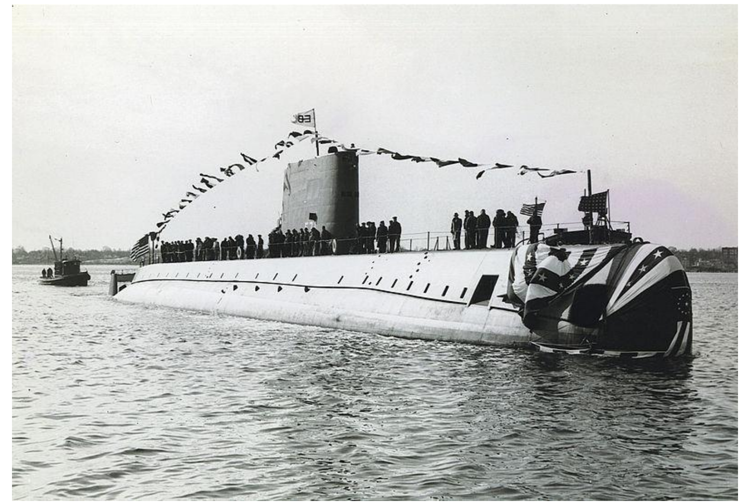
Société Française d'Energie Nucléaire

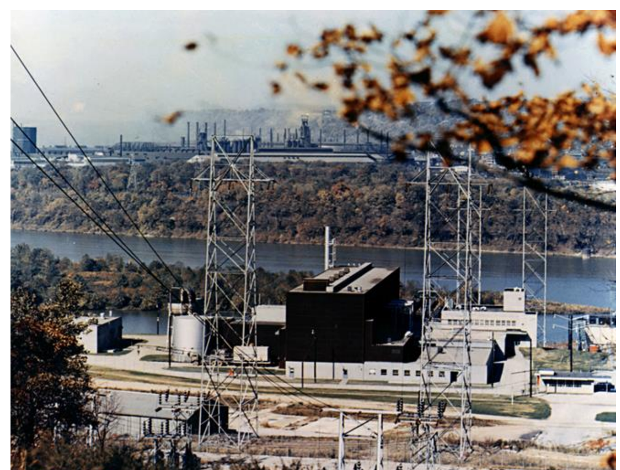


REVENONS AU NAUTILUS …

Hyman G. Rickover







2 décembre 1957, Shippingport

DEPUIS 60 ANS ...

Société Française d'Energie Nucléaire

681 réacteurs construits
442 « opérationnels »
58 en France

53 en construction
(9 en Chine, 7 en Inde, 6 Russie)
Env.150 en projets « avancés »

Source : Word Nuclear Association database (world-nuclear.org)

AUJOURD'HUI :

Société Française d'Energie Nucléaire

SFEN

Connexions au réseau les plus récentes

Nom du réacteur	Modèle	Processus	Capacité nette (MWe)	Connexion au réseau	Emplacement
Akademik Lomonosov 1	KLT-40S «flottant»	PWR	32	2019-12-19	Russie
Akademik Lomonosov 2	KLT-40S «flottant»	PWR	32	2019-12-19	Russie
Yangjiang 6	ACPR-1000	PWR	1000	2019-06-29	Chine
Taishan 2	EPR-1750	PWR	1660	2019-06-23	Chine
Novovoronezh 2 2	VVER V-392M	PWR	1114	2019-05-01	Russie
Shin Kori 4	APR-1400	PWR	1340	2019-04-22	Corée du Sud
Tianwan 4	VVER V-428M	PWR	1045	2018-10-27	Chine
Haiyang 2	AP-1000	PWR	1170	2018-10-13	Chine
Sanmen 2	AP-1000	PWR	1157	2018-08-24	Chine
Haiyang 1	AP-1000	PWR	1170	2018-08-17	Chine

Début de la construction la plus récente

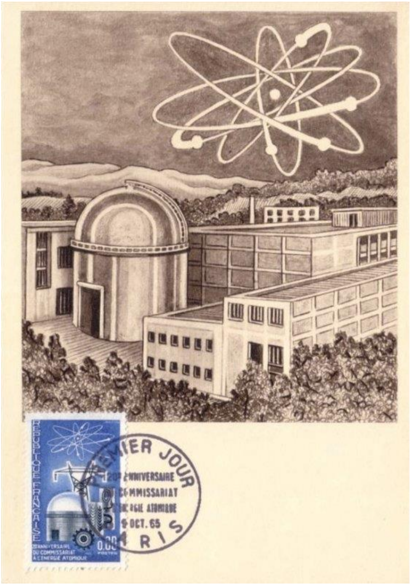
Nom du réacteur	Modèle	Processus	Capacité nette (MWe)	Début de la construction	Emplacement
Bushehr-2	VVER-1000	PWR	915	2019-11-10	J'ai couru
Zhangzhou 1	HPR1000	PWR	1126	2019-10-16	Chine
Koursk 2-2	VVER-TOI	PWR	1115	2019-04-15	Russie
Hinkley Point C 1	EPR-1750	PWR	1630	2018-12-11	Royaume-Uni
Shin Kori 6	APR-1400	PWR	1340	2018-09-20	Corée du Sud
Rooppur 2	VVER V-523	PWR	1080	2018-07-14	Bangladesh
Koursk 2 1	VVER V-510K	PWR	1115	2018-04-29	Russie
Akkuyu 1	VVER V-509	PWR	1114	2018-04-03	dinde
Xiapu	CFR-600	FBR		2017-12-29	Chine
Rooppur 1	VVER V-523	PWR	1080	2017-11-30	Bangladesh

QUELQUES RECORDS :

SFEN Société Française d'Energie Nucléaire

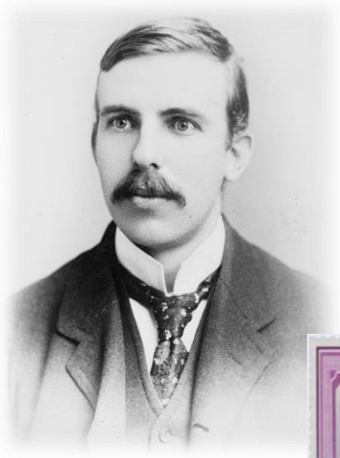
Top Generation (2018)

Reactor Name	Model	Process	Net Capacity (MWe)	Total Generation (2018) (TWh)	Location
Chooz B 2	N4 REP 1450	PWR	1500	12.0	France
Isar 2	Konvoi	PWR	1410	11.5	Germany
Palo Verde 1	CE (2-loop) DRYAMB	PWR	1311	11.2	United States Of America
Susquehanna 2	BWR-4 (Mark 2)	BWR	1257	10.9	United States Of America
Emsland	Konvoi	PWR	1335	10.9	Germany
Peach Bottom 3	BWR-4 (Mark 1)	BWR	1309	10.9	United States Of America
Peach Bottom 2	BWR-4 (Mark 1)	BWR	1308	10.8	United States Of America
Millstone 3	W (4-loop) DRYSUB	PWR	1229	10.8	United States Of America
Comanche Peak 1	W (4-loop) DRYAMB	PWR	1218	10.7	United States Of America
Perry 1	BWR-6 (Mark 3)	BWR	1256	10.7	United States Of America



Top Lifetime Generation (up to 2018)

Reactor Name	Model	Process	Net Capacity (MWe)	Total Generation (to end 2018) (TWh)	Location
Grohnde	PWR	PWR	1360	357.0	Germany
Philippsburg 2	PWR	PWR	1402	347.3	Germany
Isar 2	Konvoi	PWR	1410	332.7	Germany
Brokdorf	PWR	PWR	1410	332.0	Germany
Peach Bottom 2	BWR-4 (Mark 1)	BWR	1308	330.8	United States Of America
Peach Bottom 3	BWR-4 (Mark 1)	BWR	1309	328.0	United States Of America
Emsland	Konvoi	PWR	1335	326.6	Germany
Gundremmingen C	BWR-72	BWR	1288	314.6	Germany
Neckarwestheim 2	Konvoi	PWR	1310	308.2	Germany
Grand Gulf 1	BWR-6 (Mark 3)	BWR	1401	304.4	United States Of America



« *All of physics is either impossible or trivial. It is impossible until you understand it, and then it becomes trivial* »

Ernest Rutherford

Merci de votre attention !

Société Française d'Energie Nucléaire

Lewebpedagogique/institutesope21.com

Institut Esope 21