Annex G

LIST OF ABBREVIATIONS, UNITS AND GLOSSARY OF TERMS

1/v absorber	Nuclide (for example ^{10}B) whose effective neutron cross-section is only a function of 1/v, where v is the velocity of the neutron.
°C	Degree centigrade.
β_{eff}	Effective delayed neutron fraction.
μSv	Micro-sievert ($1\mu Sv = 10^{-6}$ Sv).
ABR	Actinide burner reactor.
Actinides	The 14 elements following actinium in the Periodic Table.
ADS	Accelerator-driven transmission system.
AFC	Advanced reprocessing fuel cycle with partitioning and/or transmutation.
AgI	Silver iodide
Al	Aluminum
ALI	Annual Limit of Intake
Al_2O_3	Aluminium oxide
ALARA	" As low as reasonably achievable"; a principal in radiation protection
ALMR	Advanced liquid metal reactor.
Am	Americium, the next (artificial) element after plutonium; atomic number 95.
AmN	Americium nitride.
AmO_2	Americium di-oxide.
An	Actinide.
$AnCl_3$	Actinide tri-chloride.
ANL	Argonne National Laboratory (USA).
AnN	Actinide nitride.
at%	Per cent in atom number.
Atomic number	The number of protons in an atomic nucleus, characteristic of an element.
ATW	Accelerator driven Transmutation of Waste. A project of Los Alamos National Laboratory (USA).
b	Barn; a unit of cross section ($1\ b = 10^{-24}\ cm^2$).
$BaCO_3$	Barium carbonate.
Bentonite	A clay mineral with strong ion-exchange properties.
Bi	Bismuth.
Bk	Berkelium.
BNFL	British Nuclear Fuels plc (UK).
Bq	Becquerel, a S.I. unit of radioactivity, one disintegration per second.
Biosphere	The sum of living things on Earth.
BR2	Belgian High Flux Reactor.

Breeder reactor	A reactor in which more fissile material is generated by neutron-induced transmutation of fertile nuclei than is consumed by fission.
BWR	Boiling water reactor which uses as coolant water which is allowed to boil and drive the turbines directly.
BOC	Beginning of cycle.
C	Carbon.
CaH_2	Calcium di-hydride.
CaI_2	Calcium di-iodide.
CANDU	A Canadian design reactor cooled by heavy water and capable of operating on natural uranium reactor.
CAPRA	"Consommation Accrue de Plutonium en Réacteur rApide".
Cd	Cadmium.
Ce	Cerium.
CEA	Commissariat à l'Énergie Atomique (France)
CeI_3	Cerium tri-iodide.
CERN	European Organisation for Nuclear Research.
Cf	Californium.
ChDMDP	1,4-cyclohexane- dimethanol-O,O'-diphenylphosphonic acid.
Ci	Curie; a pre-S.I. unit of radioactivity (1 Ci =3.7×10^{10} Bq).
Ci/tHM	Curie per metric ton of heavy metal.
CIEMAT	Centro de Investigaciones Energeticas MedioAmbientales y Tecnologicas (Spain).
Cl	Chlorine.
cm	Centimetre.
Cm	Curium; the next (artificial) element after americium; atomic number 96.
CMPO	N-octyl-phenyl-di-isobutyl-carbamoylmethyl-phosphine-oxide; an organic solvent extraction compound used for TRUEX process.
CNRS	(France).
COGEMA	Compagnie Générale des Matières Nucléaires (France).
Coolant	Fluid circulated through a reactor to transfer heat from the fuel to its destination.
Cooling	A period of delay following discharge of fuel from a reactor, allowing much of the initial radioactivity to decay.
Core	The region of a reactor containing the fuel. In a breeder reactor the term is normally restricted to the "driver" fuel, in distinction from a "breeder" zone of fertile material.
CRIEPI	Central Research Institute of Electric Power Industry (Japan).
Criticality	A fission chain reaction proceeding at a steady or increasing rate. In a reactor, the normal operating condition; elsewhere an accident to be strictly avoided.
Cross-section	The probability of interaction for instance between a nucleus and a neutron flux, measured in barns (10^{-24} cm^2).
Cs	Caesium.
CsCl	Caesium chloride.
CYANEX 301	Bis (2,4,4-trimethylpentyl) dithiophosphinic acid; an organic extractant.
CW	Continuous Wave: an operation mode of an accelerator
Daughter	A nuclide formed by spontaneous decay of another (the parent).

Decay heat	Energy released by the radioactivity of fission products in reactor fuel after fission has ceased.
Dlayed neutrons	A small proportion of neutrons emitted slightly after fission.
Deuterium	The hydrogen isotope with mass number 2.
DF	Decontamination factor; the proportion of contaminant in a desired component before a separation process, divided by the same proportion afterwards.
DIAMEX	DIAMide EXtraction; a typical process flowsheet based on diamide extractants for MA separation.
DIDPA	Di-isodecylphosphoric acid; an organic extractant.
Diluent	A nominally inert carrier for the extractant in a solvent extraction process, added to improve characteristics e.g. by reducing density or viscosity.
Direct disposal	The consignment of discharged fuel in its entirety (apart perhaps from appendages) to a permanent repository. Contrast reprocessing.
Distribution ratio	The concentration of an element or compound in the organic phase divided by that in the aqueous phase when both are in equilibrium.
DMDBTDMA	Di-methyl-di-butyltetradecylmalonamide; a diamide-type extractant.
Doppler coefficient	In a reactor, the effect of temperature on the probability of fission in a reactor. A negative value is important for stable operation.
DOVITA	Dry reprocessing, Oxide fuel, Vibropac, Integral, Transmutation of Actinides.
dpa NRT	Displacements per atom at normal reactor temperature: the amount of displacements induced by radiation per atom of the irradiated material.
DTPA	Diethylenetriaminopentaacetic acid.
EA	Energy Amplifier.
EC	European Commission.
ECN	Netherlands Energy Research Foundation.
ECU	European Currency Unit.
EDF	Électricité de France.
Effluent	A liquid or gaseous discharge of waste.
EFPD	Effective Full Power Days
EFR	European Fast Reactor.
EFTTRA	Experimental Feasibility of Targets for Transmutation; an international collaboration among CEA, ECN, EDF, FZK, IAM and ITU.
Electrolysis	Process depending on the passage of electric current through a conducting “electrolyte”.
ENEA	Ente per la Nuove Tecnologie l’Energia e l’Ambiente, Italy
ENRESA	Empresa Nacional de Residuos Radiactivos S.A. (Spain)
Enrichment	An artificial increase in the proportion of one isotope of an element (usually uranium) by partial separation from others, leaving depleted “tails”.
EOC	End of cycle.
EOLE	A critical experiment facility for UO_2 and MOX fuelled light water reactor core configurations, located in CEA-Cadarache (France).
Eu	Europium.
eV	Electron volt (= 1.6×10^{-19} J).
Extractant	The effective component in a solvent extraction process.
FBR	Fast breeder reactor; fissions sustained by fast neutrons, and producing at least as much fissile material as it consumes by transmutation of fertile nuclides.

FBuR	Fast burner reactor.

Fissile	Capable of undergoing nuclear fission induced by thermal neutrons (c.f. "fissionable" – subject to fission only when induced by higher energy neutrons).
Fission	The splitting of a heavy atomic nucleus into two very roughly equal fragments plus a few neutrons and sometimes a light nucleus such as of tritium.
FFTF	Fast Flux Test Facility (a reactor at Idaho).
Flowsheet	A diagram showing a sequence of processes in outline with the nature and amount of materials passing through them, but no detail of the actual plant.
FNR	Fast Neutron Reactor.
FP	Fission product; the main fragments from nuclear fission or products of their decay, whether radioactive or stable.
FR	Fast reactor; a reactor based on the use of fast neutrons.
Fusion (nuclear)	The union of two light nuclei (for instance of hydrogen isotopes, forming helium) with release of energy; the process that powers the stars once gravitational collapse of precursor material has sufficiently raised the density and temperature.
FZK	Forschungszentrum Karlsruhe (Germany).
g	Gram.
GEDEON	Gestion des Déchets par des Options Nouvelles.
GeV	Giga-electron volt (1 GeV $=10^9$ eV).
MWd	Giga-watt day (1 GWd $=10^9$ Wd).
GWe	Giga-watt electric (1 GWe $=10^9$ We).
Gy	Gray (1 Gy = 1 J/kg).
Half-life	The time taken for half of any amount of a specified radionuclide to decay.
HAN	Hydroxylamine nitrate.
HDEHP	Di-2-ethyl-hexyl-phosphoric; an extractant used in TALSPEAK process.
HDNNS	Di-nonylnaphthalenesulfonic acid.
Heavy water	Deuterium oxide, in which the hydrogen of ordinary water is replaced by the heavier isotope. Used as a moderator because of its particularly low neutron absorption.
HFR	High-Flux Reactor in Petten (The Netherlands).
HLLW	High level liquid waste resulting from fuel reprocessing operation.
HLW	High level waste in solidified form.
HM	Heavy Metal
HMR	High moderation reactor.
HMTA	Hexamethylenetetramine.
HNO_3	Nitric acid.
hull	Cludding.
HWR	Heavy water reactor.
I	Iodine.
IAEA	International Atomic Energy Agency.
IAM	Institute for Advanced Materials (The Netherlands).
ICRP	International Commission on Radiation Protection.
IFR	Integrated Fast Reactor, a research programme at ANL.

ILW	Intermediate level waste; materials such as fuel cladding that have gained a substantial measure of radioactivity by contact with the fuel proper or by exposure to the neutron flux, but do not generate significant heat levels.
Irradiation	In general, exposure to ionising radiation; of fuel, use in a reactor, as commonly measured by the gross energy in GWd/tHM obtained from it.
Isotope	One of perhaps several varieties of an element with different numbers of neutrons per nucleus.
ISTC	International Science and Technology Center (Russia).
ITU	Institute for Transuranium Elements in Karlsruhe (Germany).
J	Joule.
JAERI	Japan Atomic Energy Research Institute.
JNC	Japan Nuclear Cycle Development Institute
JOYO	An experimental fast reactor (Japan).
KAERI	Korea Atomic Energy Research Institute.
KCl	Potassium chloride.
k_{eff}	Effective neutron multiplication factor
kg	Kilogramm.
km	Kilometre.
Kr	Krypton.
l/tHM	Liter per metric ton of heavy metal.
LANL	Los Alamos National Laboratory (USA).
Li	Lithium.
Li_3N	Lithium nitride.
LiCl	Lithium chloride.
LINEX	Lithium Nitrate Extraction of Actinides.
LLFP	Long-lived fission product.
LMFBR	Liquid metal fast breeder reactor.
Ln	Lanthanide; the 14 “rare earth” elements following lanthanum in the Periodic Table.
lp	Mean prompt neutron life time.
LWR	Light water reactor; a reactor uses ordinary water as both moderator and coolant, whether boiling or pressurised.
m	Metre.
M	Molarity (Mol/litter, $Mol \times dm^{-3}$)
mA	Milli-ampere.
MA	Minor actinide; Np, Am and Cm.
MABR	Minor actinide burner reactor.
MASURCA	“MAquette de SURgénérateur à Cadarache”, a critical experiment facility for fast reactor core configurations, located in CEA-Cadarache (France).
Mg	Magnesium.
MINATOM	Ministry of the Russian Federation of Atomic Energy (Russia).
MINERVE	A critical experiment facility for UO_2 and MOX fuelled light water reactor core configurations, located in CEA-Cadarache (France).

MINOX	Homogeneous mixing of minor actinide in MOX fuel.
MLW	Medium level waste.
Mo	Molybdenum.
Moderation ratio	Ratio of moderator volume to fuel volume. Typical value for PWR is 1.7. Undermoderation indicates lower values of moderation ratio (range 1-1.5), overmoderation indicates higher values (range 2-3)
Moderator	A material used to slow down neutrons by elastic collisions; should have mass number and absorption cross-section as low as is compatible with other requirements.
Modifier	Component added to a solvent extraction system, e.g. to prevent separation of extracted species from diluent.
MOX	Mixed oxide fuel contains plutonium instead of an enhanced ^{235}U content as the main fissile material.
MW	Mega-watt (= 10^6 watt).
MWd	Mega-watt day (1 MWd =10^6 Wd).
MWe	Mega-watt electric (1 MWe =10^6 We).
MWt	Mega-watt thermal
N	Nitrogen.
Na	Sodium.
NaCl	Sodium chloride.
NaI	Sodium iodide.
$NaNO_3$	Sodium nitrate.
nCi	Nano-curie (1 nCi = 10^{-9} Ci).
Nd	Neodymium.
NDE	Non-destructive examination.
NEA	OECD Nuclear Energy Agency.
Neutron	Neutral particle with a mass of 1·008665 on the atomic scale. Unstable in isolation with a half-life of 10.4 minutes, decaying to a proton and β-particle.
Neutron spectrum	The energy distribution in the neutron flux of a reactor.
Np	Neptunium; the first transuranic element, atomic number 93.
NpO_2	Neptunium dioxide.
NPP	Nuclear power plant.
Nuclide	A particular isotope.
ODP	1,8-octanediol-O,O'-diphenyl phosphonic acid.
OECD	Organisation for Economic Co-operation and Development.
OMEGA	Options Making Extra Gains from Actinides and fission products; Japanese research programme on partitioning and transmutation.
ORNL	Oak Ridge National Laboratory (USA).
OTC	Once-through cycle.
Pa	Protactinium.
Parent	See daughter.
Pb	Lead.
PbI_2	Lead di-iodide.
pcm	Per cent mille (1/100 000).

Pd	Palladium.
PGM	Plutinum-group metal.
pH	A measure of acidity or alkalinity, formally the common logarithm of the reciprocal of the hydrogen-ion activity. A value of 7 represents neutrality, while lower values indicate acid conditions and higher, alkaline.
Pin (fuel)	A tube packed with fuel pellets – used in suitably spaced groups of up to several hundred, variously termed clusters, elements, sub-assemblies etc.
PNC	Power Reactor and Nuclear Fuel Development Corporation (Japan). Former body of JNC.
Poison	A particularly powerful absorber of neutrons; may be introduced deliberately into equipment to prevent an accidental criticality, or into fuel to reduce the initial reactivity and so the range of control required during residence (in which case it is chosen to be "burnable," i.e. converted by the absorption into a low-absorbing nuclide); alternatively, it may be an undesirable by-product of other processes.
Prompt neutrons	Emitted immediately from a fission reaction (a small proportion is slightly delayed).
Pr	Praseodymium.
PSI	Paul Scherrer Institute (Switzerland).
P&T	Partitioning and Transmutation
Pu	Plutonium; the second transuranic element, atomic number 94.
PuO_2	Plutonium dioxide.
PUREX	A most commonly used process flowsheet based on TBP for fuel reprocessing.
PWR	Pressurised water reactor cooled by water kept under enough pressure to prevent boiling, with a secondary steam circuit to which it transfers the heat drawn from the reactor.
Pyrolysis	Decomposition by heat, usually intense.
Ra	Radium.
Radioactivity	The spontaneous disintegration of an atomic nucleus with the emission of ionising radiation. May be natural or artificially induced.
Radionuclide	A radioactive isotope.
Raffinate	The residue after removal of valuable components in a solvent extraction process.
RE	Rare earth element; see lanthanide.
Reactor	The complex of equipment to maintain and control a fission chain reaction. "thermal" – has a neutron flux more or less equilibrated with the core in general; "fast" – has a very much more energetic neutron spectrum; "breeder" –generates at least as much fissile material as it consumes by transmuting fertile isotopes, e.g. ^{238}U.
Reprocessing	The separation of fuel discharged from a reactor into potentially useful products and waste.
REP U	Reprocessed uranium.
Resonance	An enhanced probability of interaction between certain nuclei and neutrons of a particular energy.
RFC	Reprocessing fuel cycle.
Rh	Rhodium.

RIAR	Research Institute of Atomic Reactor (Russia.)
Ru	Ruthenium.
σ_c	Capture cross-sections.
Salt-free process	A process leaving no involatile or indestructible residues in solution (desirable to allow high degrees of volume reduction in wastes that have to be stored).
SCK-CEN	Studiecentrum voor Kernenergie – Centre d'Étude de l'Énergie Nucléaire (Belgium).
Se	Selenium.
SESAME	"Séparation Extraction Sélective de l'Américium par Moyens Électrochimiques", Selective Extracting Separation of Americium by Means of Electrolysis.
σ_f	Fission cross-sections.
SF	Separation factor.
Shielding	Material used to absorb radiation before it can cause damage or injury.
Si	Silicon.
SKB	Swedish Nuclear Fuel and Waste Management Co. (Sweden).
Sm	Samarium.
Sn	Tin.
Solvent extraction	A separatory process in which one or more components of a mixture are transferred from one solvent to another essentially immiscible with it (usually from aqueous solution to an organic oil or the reverse).
SPIN	Separation-Incineration; French research programme on partitioning and transmutation.
SPX	Super-Phénix; a fast reactor in France.
Stripping	Back-extraction of material after solvent extraction.
Super-criticality	An accelerating fission chain reaction in which more than one neutron from each fission goes on to cause another.
SUPERFACT	Actinide incineration experiment in fast reactor, Phénix (France).
Sv	Sievert; the S.I. unit of absorbed radiation dose.
SWU	Separation work unit.
SYNROC	Synthesised material based on inorganic compounds.
t	Metric ton (1 t =10^3 kg).
T	Tritium; the hydrogen isotope of mass number 3 (two neutrons in the nucleus). β-emitting with a half-life of 12·3 years.
Tailings	The residue after separation of valuable ore components in mining or milling.
TALSPEAK	Trivalent Actinide-Lanthanide Separation by Phosphorus reagent Extraction from Aqueous Complexes.
TBP	Tributylphosphate; an organic extractant used for PUREX process.
TBq	Tera-becquerel (= 10^{12} Bq)
Tc	Technetium.
Thermal neutron	A neutron at or near energetic equilibrium with the surroundings.
Third phase	In solvent extraction, sometimes formed when the concentration of extracted species exceeds solubility in the diluent; may render the process ineffective or inoperable.
tHM	Metric ton of heavy metal.
THORP	The British THermal Oxide Reprocessing Plant at Sellafield, Cumbria (UK).
Ti	Titanium.

TIGRE	One of the heterogeneous recycling concepts studied within the French SPIN-programme by placing minor actinides targets in the guiding tube of a PWR-assembly.
TiN	Titanium nitride.
TOPO	Trioctylphosphine oxide.
TPTZ	Tripyridyltriazine ligand.
TRPO	Trialkylphosphine oxed; an organic solvent extracion compound used for MA separation.
TRU	Transuranic element; Np, Pu, Am, Cm, Bk, Cf.
TRUEX	TRansUranium EXtraction; a typical process flowsheet based on CMPO for MA separation.
TWhe	Tera-watt hour electric (1 TWhe $=10^{12}$ Whe).
U	Uranium; the heaviest element occurring naturally in significant amounts; atomic number 92.
UN	Uranium nitride.
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation.
UO_2	Uranium dioxide.
UP2	A reprocessing plant in La Hague (France).
UP3	A reprocessing plant in La Hague (France).
Vitrification	The conversion of wastes to a glassy form for permanent disposal.
vol.%	Per cent in volume.
wt%	Per cent in weight.
Xe	Xenon.
Y	Yttrium.
Zircaloy	An zirconium based alloy, used as fuel cladding on account of its resistance to corrosion and low neutron absorption.
Zn	Zinc.
Zr	Zirconium.
ZrN	Zirconium nitride.