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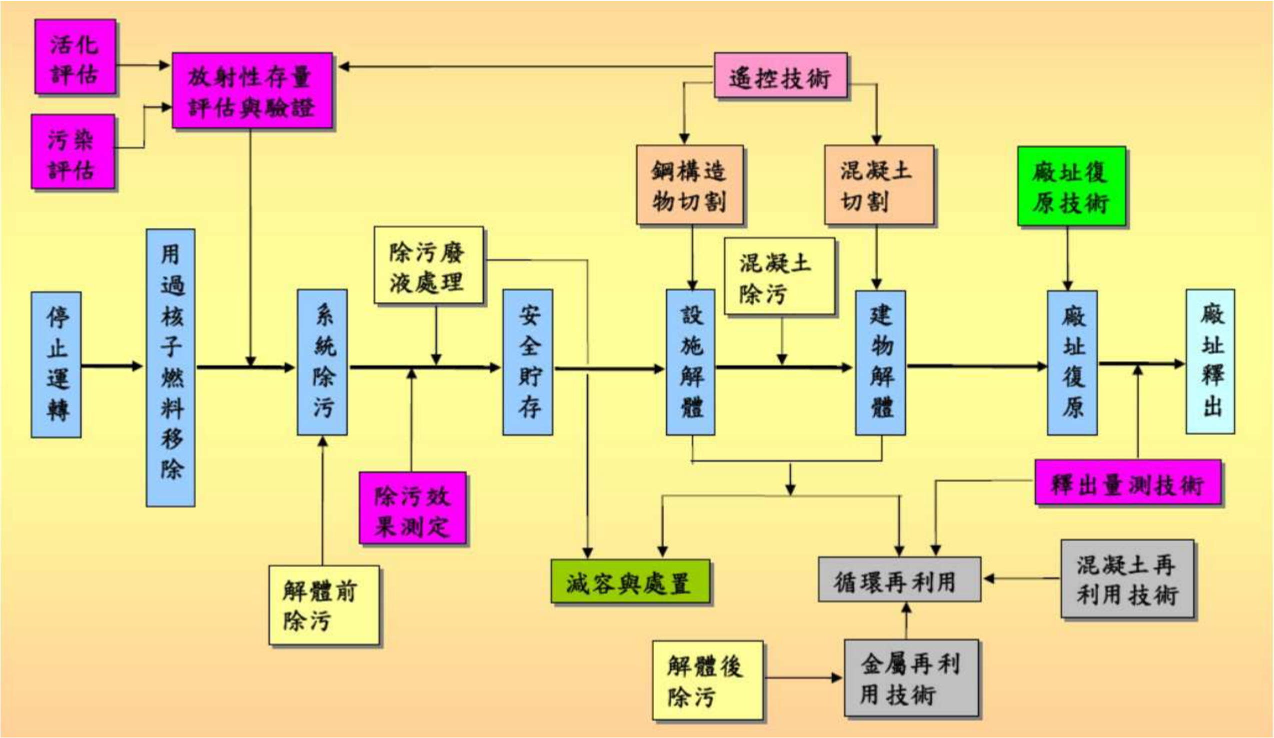
活化評估
污染評估
放射性存量評估與驗證
遙控技術
鋼構造物切割
混凝土切割
廠址復原技術
停止運轉
用過核子燃料移除
系統除污
除污廢液處理
安全貯存
設施解體
混凝土除污
建物解體
廠址復原
廠址釋出
除污效果測定
解體前除污
減容與處置
釋出量測技術
循環再利用
混凝土再利用技術
解體後除污
金屬再利用技術

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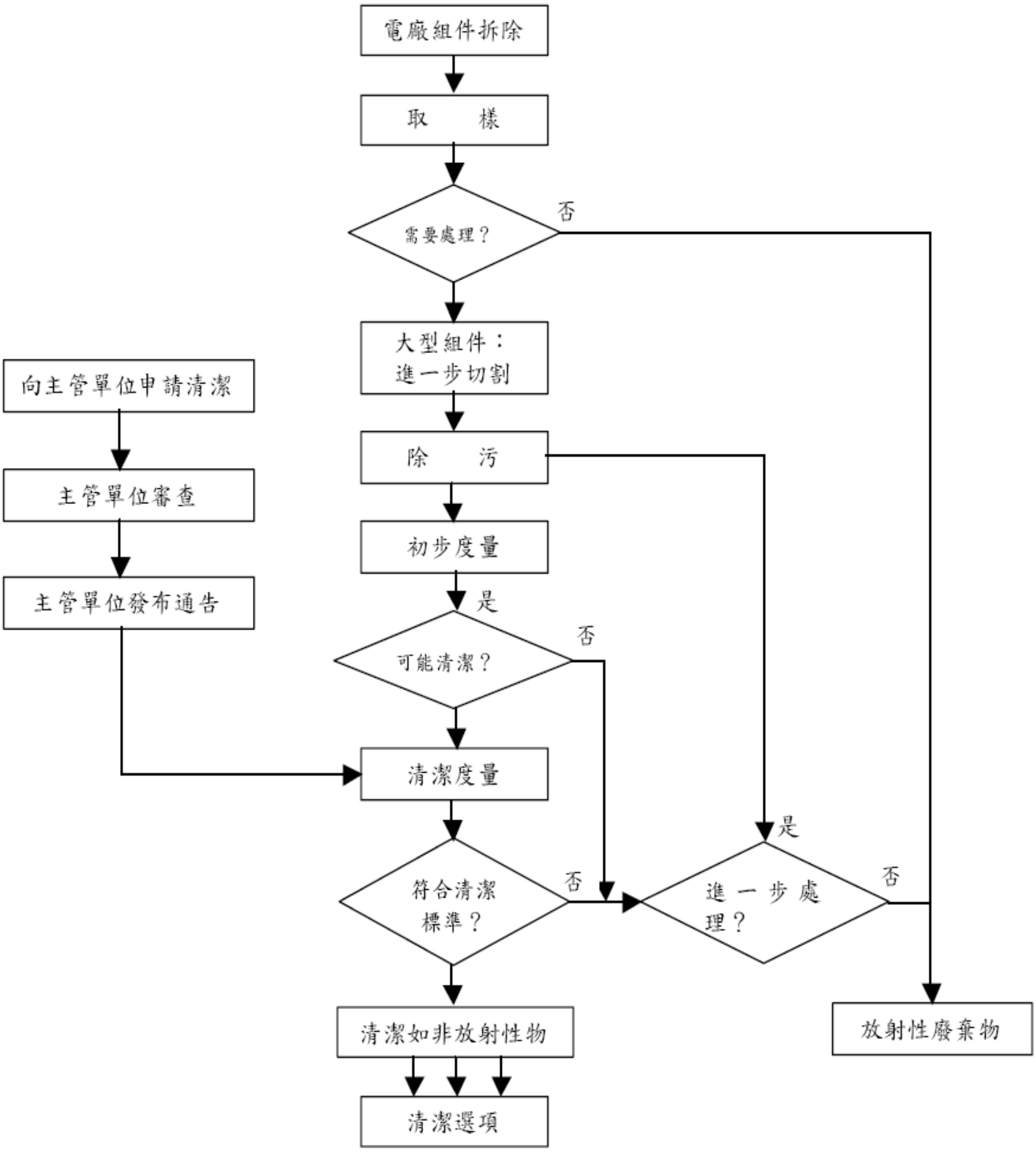

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[1] 341 , 26 , 100 5

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[2] IAEA, Decontamination of water cooled reactors, IAEA Technical Reports No.365, Vienna, 1994; PNL EPRI SA – 14675, 1987.

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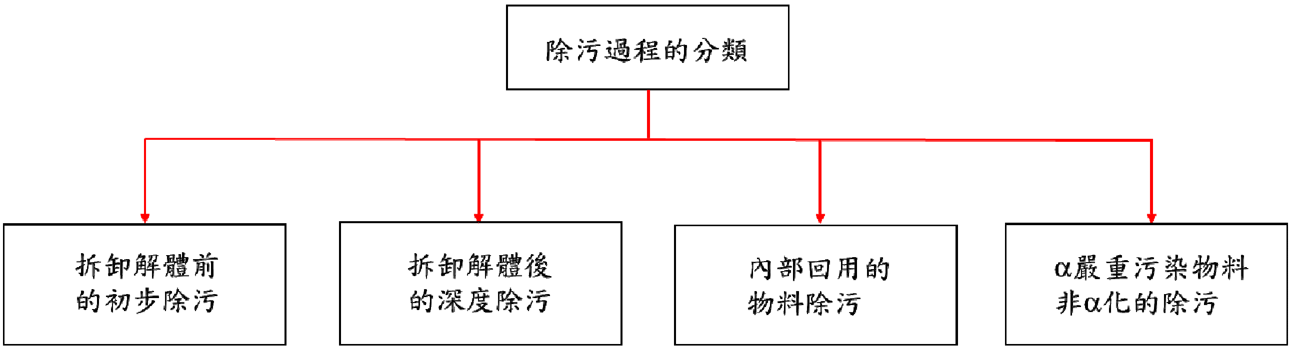

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[4] American Society of Mechanical Engineer(ASME). The Decommissioning Handbook. Chapter 23, ASME, New York, 2004.

[5] INER-OM-1114R 96

[6] European Commission. European Nuclear Decommissioning Training Facility. A Training Material, Belgium (2005).

[7] US Department Of Energy. The Decommissioning Handbook CD Supplement 2004 (2004).

[8] INER-5263 97

[9] INER-3966 95

[10] IAEA. New methods and techniques for decontamination in maintenance or decommissioning operations--Results of a co-ordinated research programme 1994-1998. IAEA-TECDOC-1022, Vienna (1998).

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[11] Enserch Inc., Department of Energy Office of Environment Restoration. Decommissioning Handbook. DOE/EM-0142P (1994).

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[12] K. Archibald, R. Demmer, M. Argyle, L. Lauerhass, and J. Tripp, “Cleaning and decontamination using strippable and protective coatings at the Idaho National Engineering and Environmental Laboratory,” WM’99 Conference, Feb 28 ~ March 4 (1999).

[13] M. Varady, B. Mantooth, T. Pearl, and M. Willis, “Reactive decontamination of absorbing thin film polymer coatings: model development and parameter determination,” American Physics Society March Meeting 2014, Volume 59, Number 1, March 3–7, 2014; Denver, Colorado (2014).

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3.3.2

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1980

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http://www.knightarmour.com)

3.3.3

(Oak Ridge National Laboratory, ORNL)

[14]

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[14] T.L. White, R.G. Grubb, L.P. Pugh, D. Foster Jr., and W.D. Box, “Removal of contaminated concrete surfaces by microwave heating—phase I results,” presented at the 18th American Nuclear Society Symposium on Waste Management Waste Management 92, Tucson, Arizona (1992).

3.3.4

PIG (pipeline pigging technology)[15]

PIG 20 60

3-4 PIG[16]

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[15] https://www.rigzone.com/training/insight.asp?insight_id=310&c_id=19

[16] http://www.tdwilliamson.com/EN/PRODUCTS/PIGGINGPRODUCTS/Pages/Home.aspx

PIG PIG PIG
(3-4)
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PIG 5%-50% 65% 90
180 PIG

( ) PIG
PIG PIG
PIG
PIG
PIG PIG
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- PIG
- PIG

- PIG PIG

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PIG

-
- 50 mm
- 1.5
- 20%
-
-
- 70°C

PIG PIG

PIG PIG

PIG

3.3.5

(1)

10%

[17]

(2)

(3)

[18]

1980

(4)

Ph. Delaporte XeCl

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[17] B. Fournel, S. Faure, J. Pouvreau, C. Dame and S. Poulain, “Decontamination Using Foams: A Brief Review of 10 Years French Experience,” Paper No. ICEM2003-4526, pp. 1483-1489; 7 pages doi:10.1115/ICEM2003-4526, ASME 2003 9th International Conference on Radioactive Waste Management and Environmental Remediation: Volumes 1, 2, and 3, Oxford, England, September 21–25 (2003).

[18] Y. Yaita; M. Enda, H. Aoi; H. Sakai; N. Saito; N. Chujo and I. Inami, “Chemical decontamination using ozone oxidation process,” 9th international conference on nuclear engineering; Nice Acropolis, France, Apr 8-12 (2001).

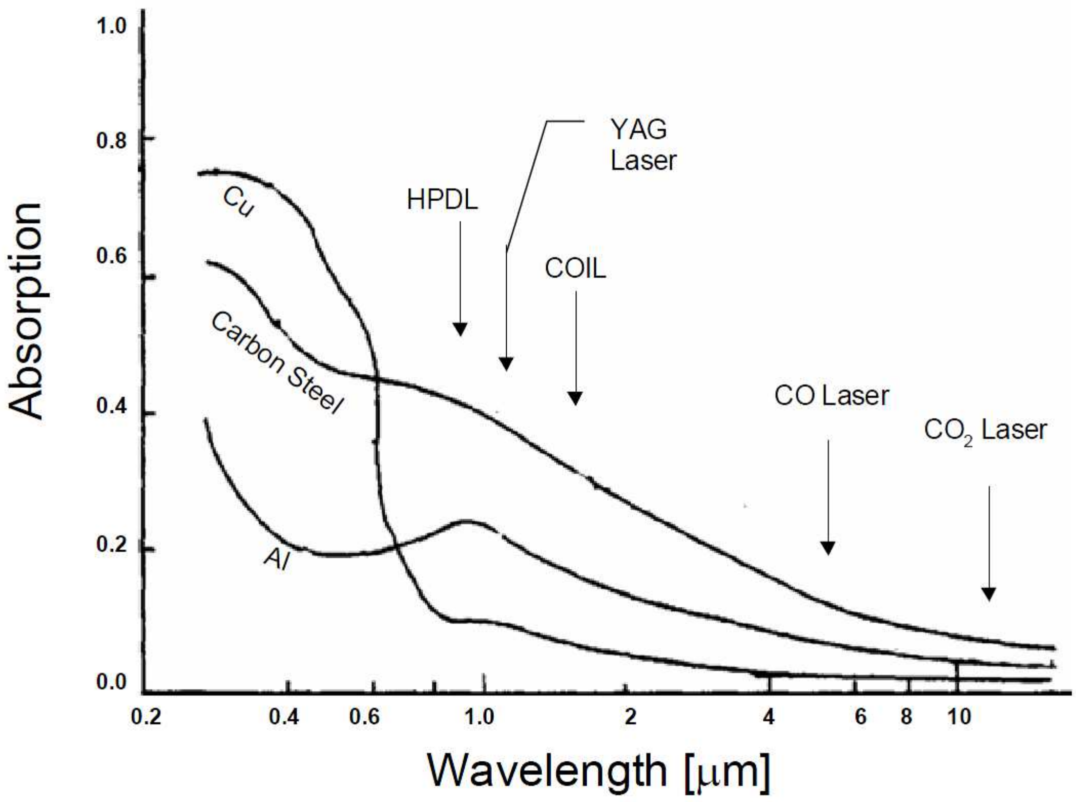
[19] ( )

(Cs Co Eu) (Decontamination factor,

DF) 15 100

3-5

(Cu) (Carbon Steel) (Al)



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[19] Ph. Delaporte, M Gastaud, W. Marine, M. sentis, O. Uteza, P. Thouvenot, J.L. Alcaraz, J.M.Le Samedy and D. Blin, “Radioactive oxide removal by XeCI laser,” *Applied Surface Science* **197-198** 826-830 (2002).

K. Fujiwara

[20]

(80%)

(6)

Yong-Hwan Kim [21]

(1%) (CH_4) (O_2)

$Co_2(CO)_8$

95%

(7)

380 MPa

14 m/s

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[20] K. Fujiwara, S. Furukawa, K. Adachi, T. Amakawa, and H. Kanbe, “A new method for decontamination of radioactive waste using low-pressure arc discharge,” *Corrosion Science* **48** 1544-1559 (2006).

[21] Y.H. Kim, Y.H. Choi, J.H. Kim, J. Park, W.T. Ju, K.H. Paek, Y.S. Hwang, “Decontamination of radioactive metal surface by atmospheric pressure ejected plasma source,” *Surface and Coatings Technology* **171**, 317-320 (2003).

(8)

3-2

3-2

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4

100

104 12

4.1

Cs-137 Sr-90

Co-60 Fe-59 Mn-54

Co-58

10

Fe-55 Co-60 Ni 63

5 Co-60 40

Co-60

8

4.1.1

95%

50%

40 (100

kWe) 10^{17}

(Bq)

99.9%

0.1%

4-1

4-2

4-1

		*1		
	L1	30	1,530	1,600
	L2	4,210	8,870	13,100
	L3	—	13,080	13,100
		4,300	23,500	27,800
		—	40,160	40,200
		4,300	63,700	67,900

128,700

*1

L1

L2 L3 3

(L1) 50 100

300

(L2) 300

(L3) 30 50

4-2

	(Bq/ton)		
	(L1)	(L2)	(L3)
Co-60	-	10^{15}	10^{10}
Cs-137	-	10^{14}	10^{8}
Sr-90	-	10^{13}	10^{7}
Ni-63	-	10^{13}	-
C-14	10^{16}	10^{11}	-
Tc-99	10^{14}	10^{9}	-
CI-36	10^{13}	-	-
I-129	10^{12}	-	-
	10^{11}	10^{10}	-

(1)

1.

2.

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4.1.2

(4.2.4)

4-1~4-3

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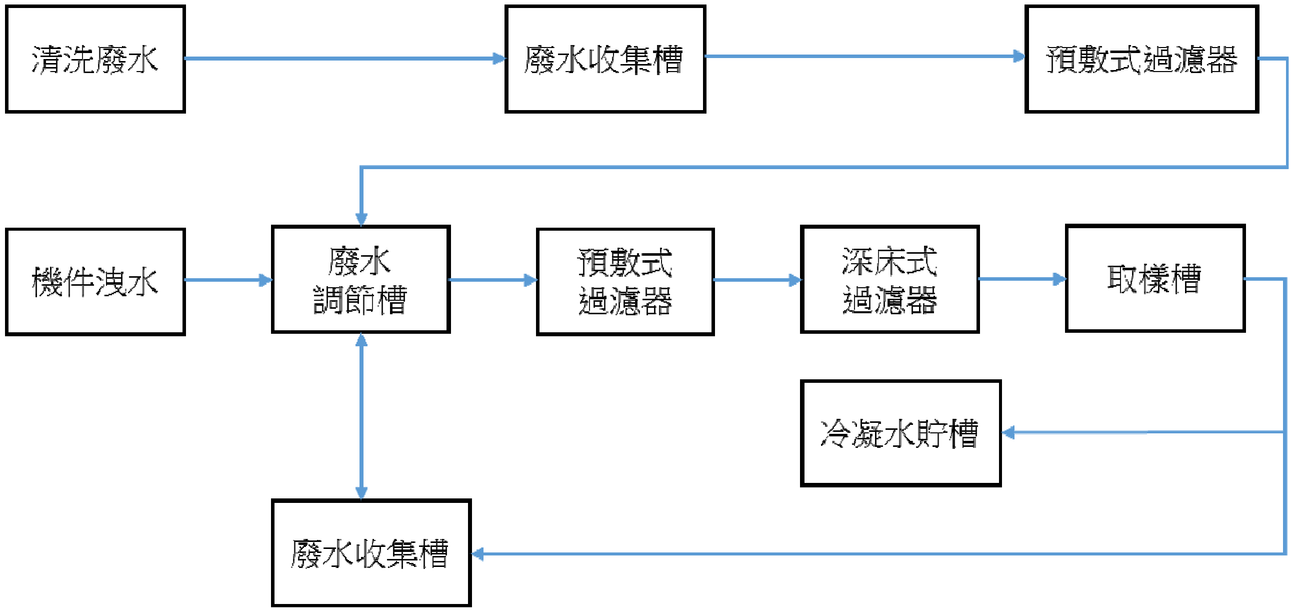
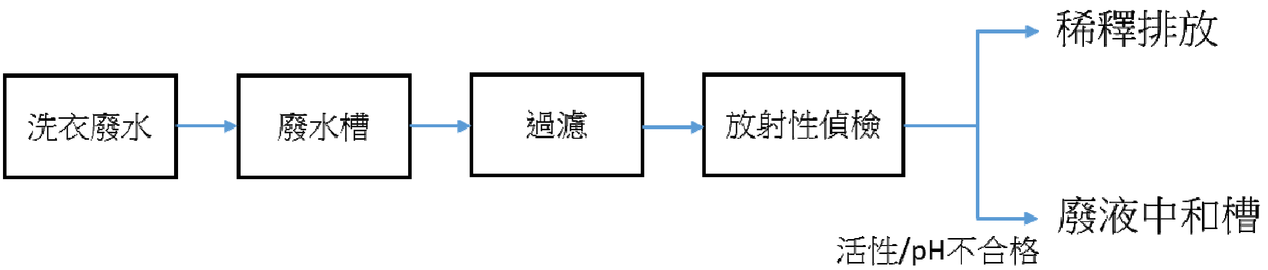
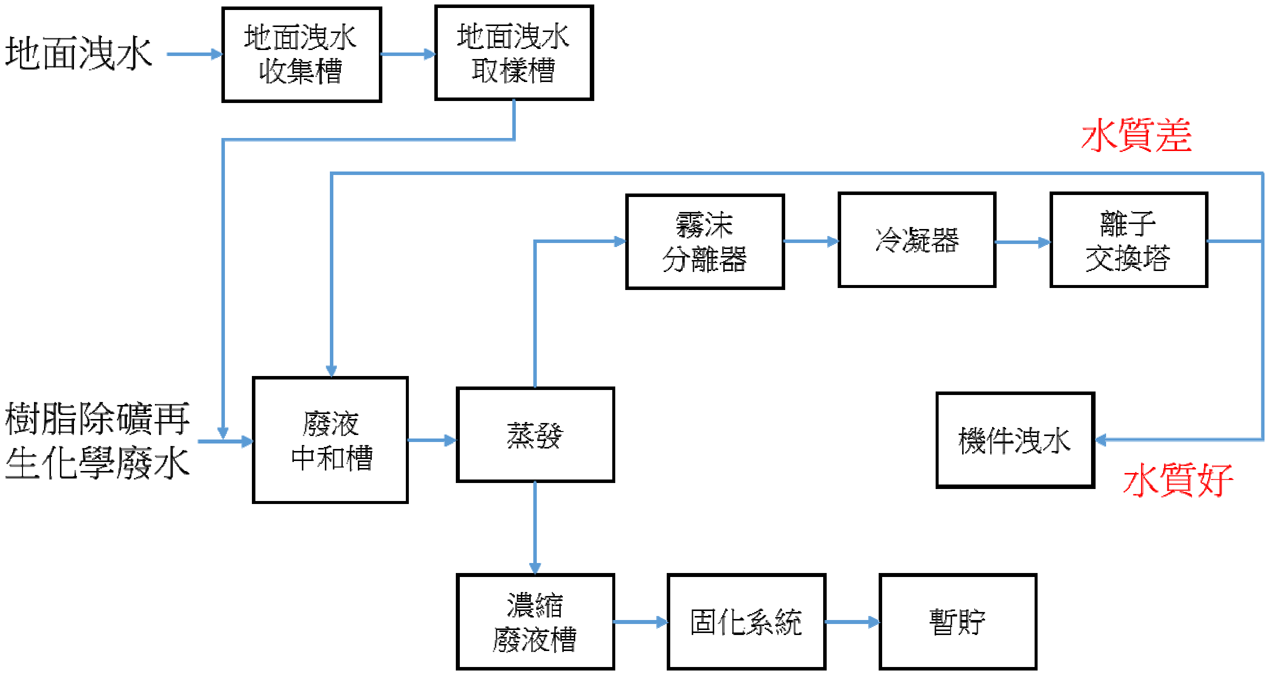


4-1


洗衣廢水
廢水槽
過濾
放射性偵檢
稀釋排放
廢液中和槽
活性/pH不合格

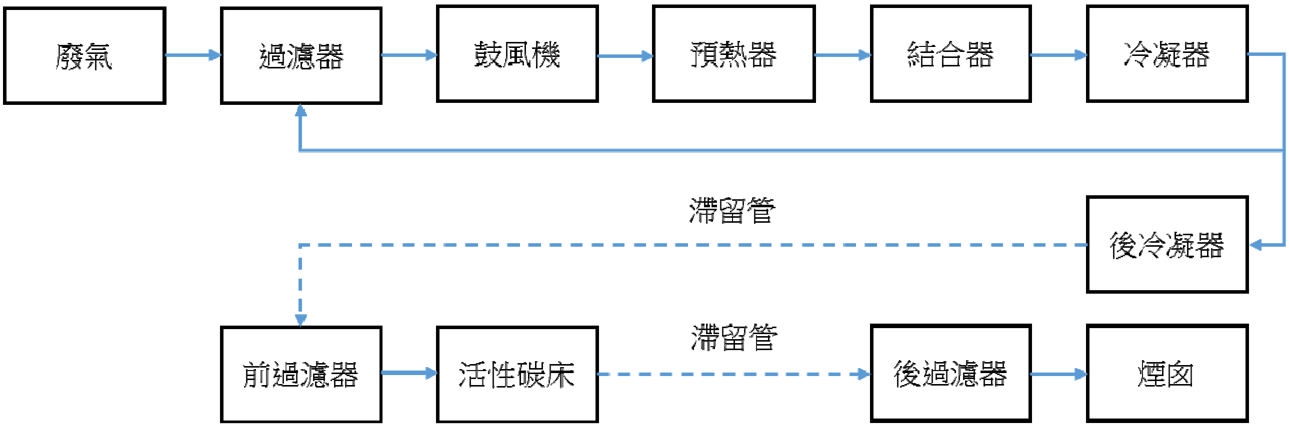
4-2


地面洩水
地面洩水收集槽
地面洩水取樣槽
水質差
霧沫分離器
冷凝器
離子交換塔
樹脂除礦再生化學廢水
廢液中和槽
蒸發
機件洩水
水質好
濃縮廢液槽
固化系統
暫貯

4-3

4.1.3

4-4



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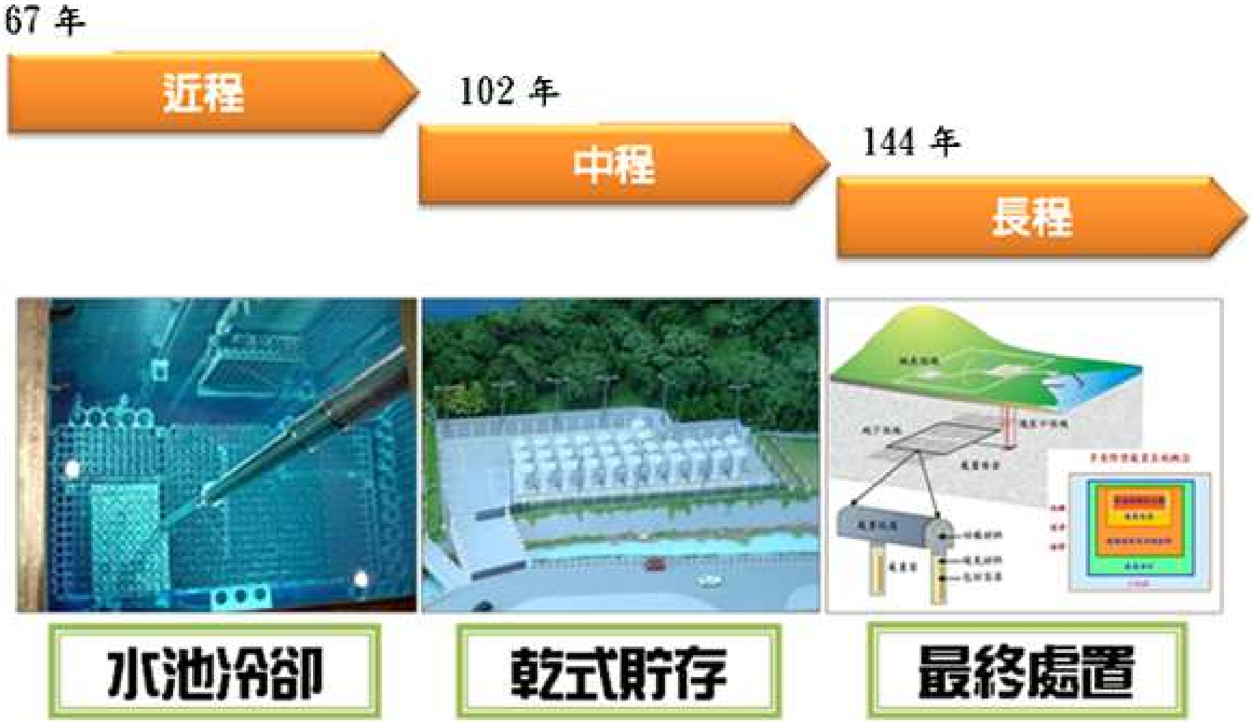
4.1.4

2001 6 18 (1)

(2)

(3)



4-5 ( )

7

4.1.5

(Neutron Flux) (2D 3D)

(activated foils)

DORT MCNP-5

ORIGEN-S/SCALE 5

6.25 μSv/h

Co Nb Eu Co Cs

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4.2.1

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4.2.2

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[22] IAEA. Methods for the minimization of radioactive waste from the decontamination and decommissioning of nuclear facilities R . Vienna : IAEA Technical Reports , 2001.

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50 100

Humboldt Bay Zion (SAFSTOR)

4-3 Humboldt Bay Zion (DECON) SAFSTOR

DECON 25 [23, 24]

4-6

4-7 Humboldt Bay Zion 2010

4-3 Humboldt Bay Zion

		SAFSTOR	DECON	
Humboldt Bay	7/2/1976	7/16/1985	Dec 2008	12/31/2015
Zion	2/13/1998	3/9/1998	11/14/2013	12/31/2020

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[23] http://www.nrc.gov/info-finder/decommissioning/power-reactor/humboldt-bay-nuclear-power-plant-unit-3.html

[24] http://www.nrc.gov/info-finder/decommissioning/power-reactor/zion-nuclear-power-station-units-1-2.html

4-6 Humboldt Bay

4-7 Zion

8

4.2.5

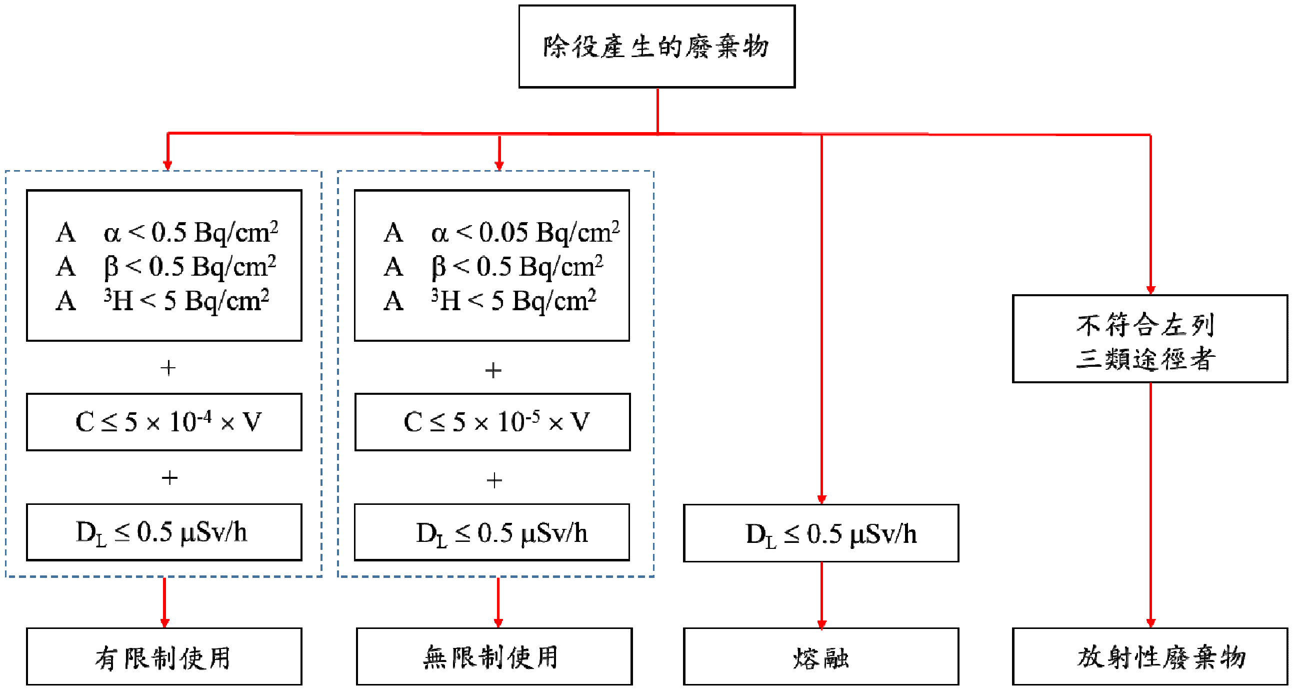
2004 8 RS-G-1.7

10 μSv/yr

2005

(102FCMA006)

4-8 (Karlsruher Institut für Technologie)



A – 表面活度；C – 質量比活度；D_L – 劑量率；V – 活度

4-8

4.2.6

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2006 6 28 (Act 2006-739)

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PIG

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- MARSAME (Multi-Agency Radiation Survey and Assessment of Materials and Equipment manual)[25]
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[25] http://www.epa.gov/radiation/marssim/marsame.html

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    a.

    b.

    c.

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    a.

    b.

3.

    a.

    b.

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8. INER-5263

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9.

INER-3966 95

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13. M. Varady, B. Mantooth, T. Pearl, and M. Willis, “Reactive decontamination of absorbing thin film polymer coatings: model development and parameter determination,” American Physics Society March Meeting 2014, Volume 59, Number 1, March 3–7, 2014; Denver, Colorado (2014).
14. T.L. White, R.G. Grubb, L.P. Pugh, D. Foster Jr., and W.D. Box, “Removal of contaminated concrete surfaces by microwave heating—phase I results,” presented at the 18th American Nuclear Society Symposium on Waste Management Waste Management 92, Tucson, Arizona (1992).
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16. http://www.tdwilliamson.com/EN/PRODUCTS/PIGGINGPRODUCTS/Pages/Home.aspx
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21. Y.H. Kim, Y.H. Choi, J.H. Kim, J. Park, W.T. Ju, K.H. Paek, Y.S. Hwang, “Decontamination of radioactive metal surface by atmospheric pressure ejected plasma source,” *Surface and Coatings Technology* **171**, 317-320 (2003).

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Waste Management, Safety Series No. 111-F, IAEA, Vienna 1995

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32. INTERNATIONAL ATOMIC ENERGY AGENCY, Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No. GS-R-1, IAEA, Vienna 1999

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34. INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Design, Safety Standards Series No. NS-R-2, IAEA, Vienna 1999

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39. INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Medical, Industrial and Research Facilities, Safety Standards Series No. WS-G-2.2, IAEA, Vienna 1999
40. INTERNATIONAL ATOMIC ENERGY AGENCY, Principles for Limiting Releases of Radioactive Effluents into the Environment, Safety Series No. 77, IAEA, Vienna 1986
41. INTERNATIONAL ATOMIC ENERGY AGENCY, Regulatory Control of Radioactive Discharges to the Environment, Safety Standards Series No. RS-G-1.5, IAEA, Vienna 1999
42. INTERNATIONAL ATOMIC ENERGY AGENCY, Decontamination of Nuclear Facilities to Permit Operation, Inspection, Maintenance, Modification or Plant Decommissioning, Technical Reports Series No. 249, IAEA, Vienna 1985
43. INTERNATIONAL ATOMIC ENERGY AGENCY, Methods for Reducing Occupational Exposures During the Decommissioning of Nuclear Facilities, Technical Reports Series No. 278, IAEA, Vienna 1987
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IAEA, Vienna 1972

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57.“ ” ,
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58.“ ”
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