Australian Government

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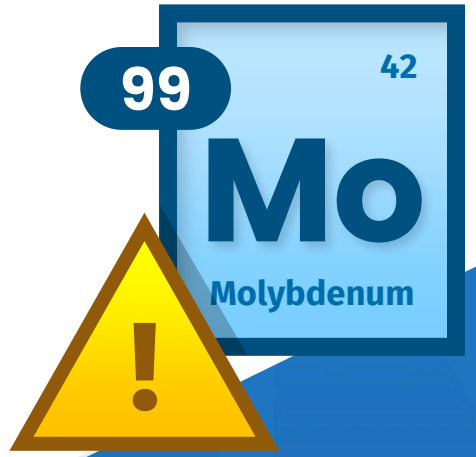
Communicating Potential Skin Dose from Radioactive Contamination at ANM



John Bus

Nuclear Safety Review Officer

Science. Ingenuity. Sustainability.

Mo-99 Manufacturing Facility

The most widely used radioisotope in nuclear medicine globally, Mo-99 is the precursor to Tc-99m

Tc-99m is used in ~80% of all nuclear medicine procedures

Most Australians are likely to have a Tc-99m scan in their lifetime

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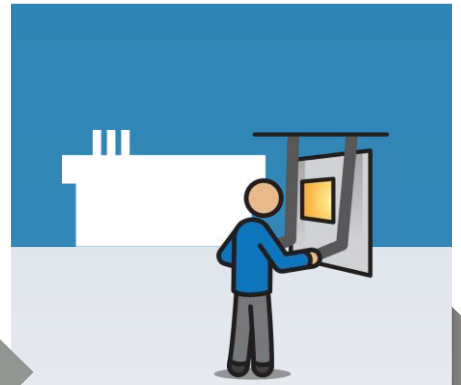
The Tc-99m Gentech® Generator Process

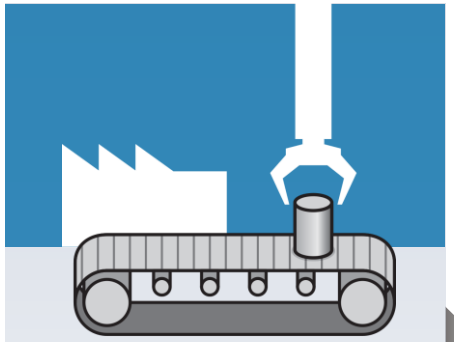
OPAL

Multi-purpose reactor



Mo-99 facility

Mo-99 manufacturing facility



Building 23

Nuclear medicine processing and distribution facility

Tc-99m Gentech® Generator

Distribution to hospitals, clinics

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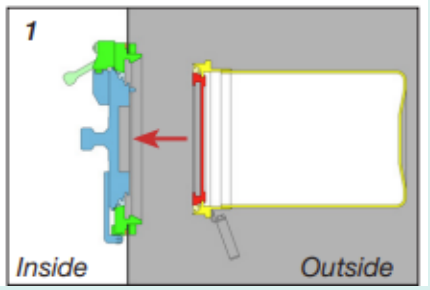
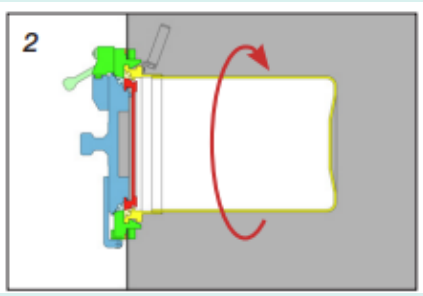
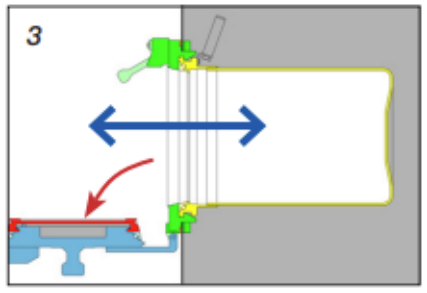
DPTE® Transfer System



Container approaching the fixed Alpha unit mounting on the back of a hot cell



Both parts are locked together with a 60° rotation of the DPTE ®



Opening of connected double doors allows the transfer of materials into & out of the hot cells

Diagram Reference: Getinge DTPE® Transfer System product brochure located at:
https://biotechnologia.pl/uploads/biotechnologia/product/leaflet/690322/DPTE-EN-121105-SUP.pdf (Accessed: 10/10/2023)

Key

Alpha unit

Beta unit

The remote handling tool used to open DPTE® containers used for the transfer of materials into and out of the hot cells

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DPTE® Container O-ring Contamination

Contamination of DPTE® (Beta unit) O-ring in lid

- Independent of number of uses
- Appears dependent on in-cell conditions at time of use
- Not uniformly deposited across O-ring
- Spreads when DPTE® is rotated during engagement and disengagement

Mixed fission product radioactive contamination

Previous optimisation studies showed it is predominately Mo-99 & I-131

The DPTE® container lid with black rubber O-ring

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Mo-99 & I-131 Contamination Hazards

High specific activity beta emitters

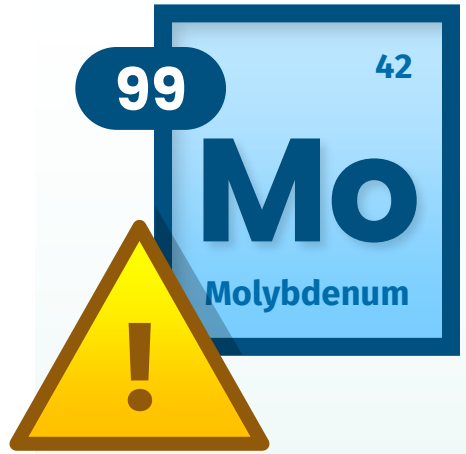
- Mo-99: 1.82 & I-131: 1.62 (mGy/h)/(kBq/cm^2)

Short exposures can lead to very high local skin doses

Skin dose not identified by routine dosimetry

Is not immediately obvious:

- Particles not easily visible
- Requires constant monitoring



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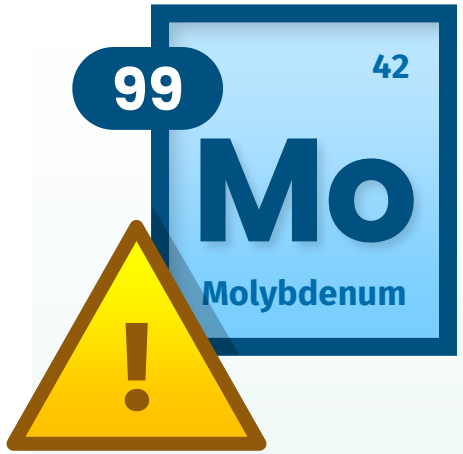
Guidance Assumptions / Parameters

Mo-99: 1.82 (mGy/h)/(kBq/cm²)

- Skin dose co-efficient previously calculated using VARSKIN v6.2.1 for a contamination incident in ANM in 2019

5-minute exposure time

- Represents good self-monitoring practice
- allows for consistency for comparison



RadEye™ B20-ER probe area of 15.2 cm² & detector efficiency of 21.5% for Mo-99 (at 3 mm)

Contamination is considered a uniform deposit of 1 cm²

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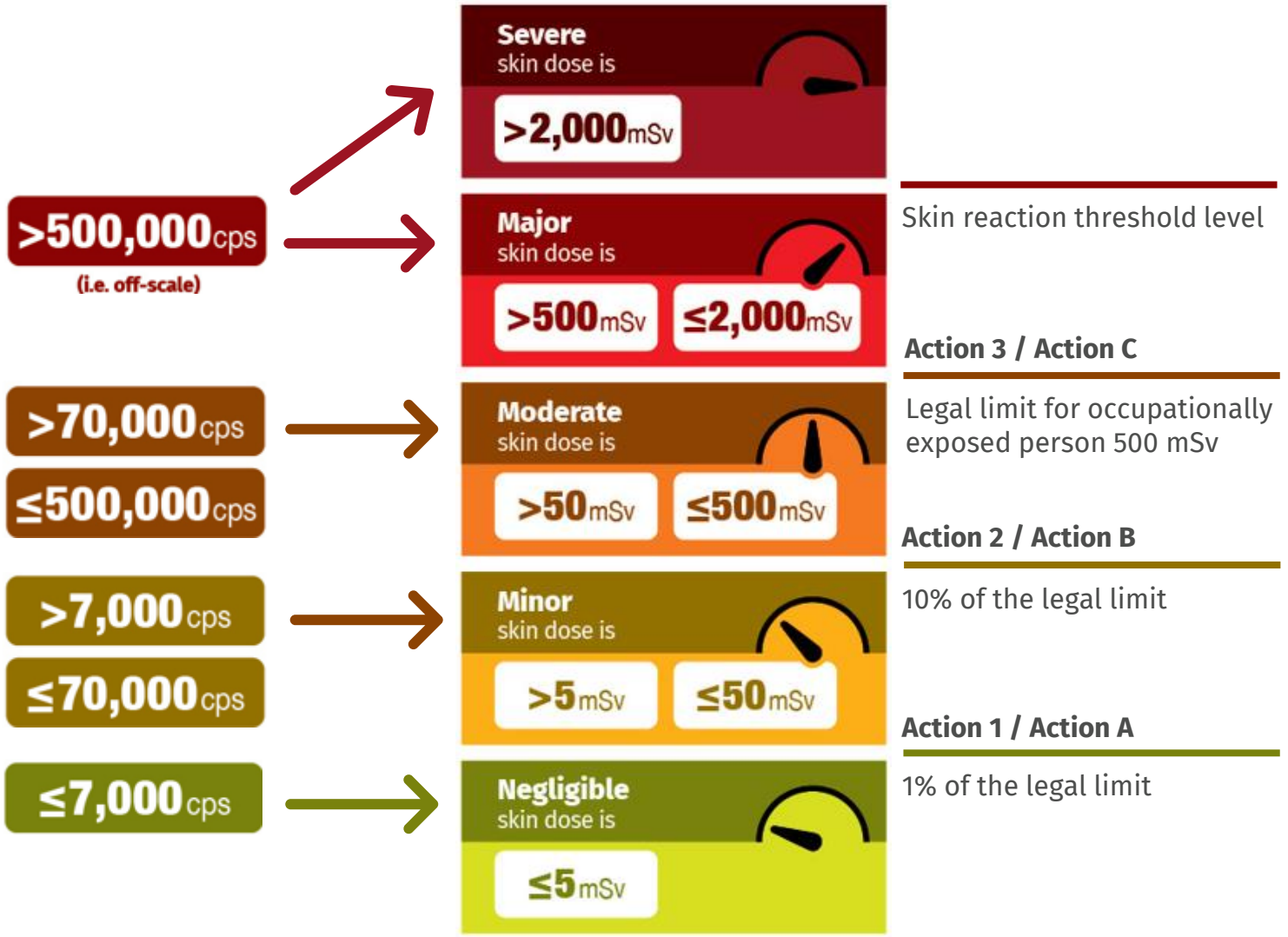
Guidance Basis



Skin reaction threshold level

Action 3 / Action C

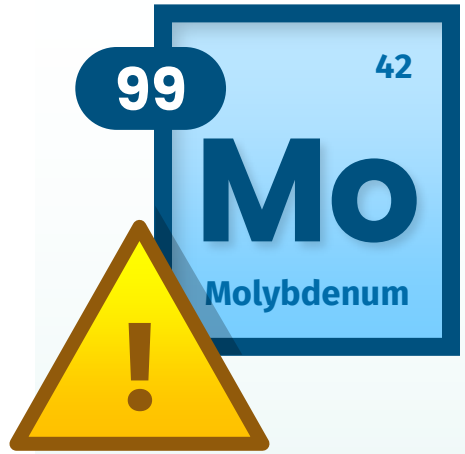
Legal limit for occupationally exposed person 500 mSv

Action 2 / Action B

10% of the legal limit

Action 1 / Action A

1% of the legal limit



Determining CPS Action Levels Based On Equivalent Skin Dose

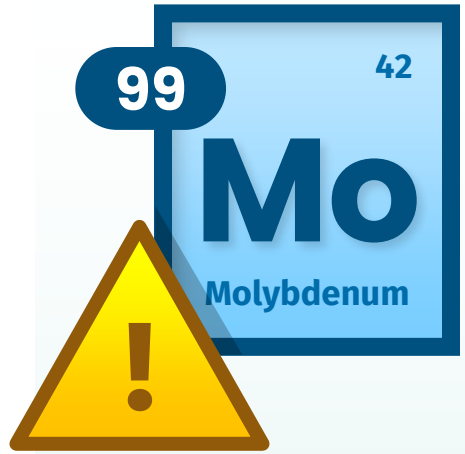
Bare Skin Scenario:

Criteria	Skin Dose (mSv)	Mo-99 (kBq)	Monitor Reading[a] (counts/second)	Tc-99m[b] (kBq)
Action 1	**5**	**33.0**	**7088**	29.2
Action 2	**50**	**330**	**70879**	292

Notes:

a. Background counts/second has been excluded in the modelling due to the negligible impact it has on the result.

b. For the Varskin modelling confirmation the presence of Tc-99m has also been accounted for and is assumed to be in secular equilibrium with the Mo-99 parent at a branching ratio of 88.6%.



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Varskin Modelling Confirmation (1)

Source Geometry Information:

Source Geometry Type:	Cylinder
Source Diameter:	1.13 cm
Source Thickness:	1.00 µm
Source Density:	1.00 g/cm^3

Exposure Information:

Dose Depth:	7.00 mg/cm^2
Exposure Time:	5.00 min
Dose Averaging Area:	1.00 cm^2

Nuclide Information:

Nuclide	Database	Source Z	Activity	Units
Mo-99	ICRP107	7.42	33.0	kBq
Tc-99m	ICRP107	7.42	29.2	kBq

Shallow Dose Equivalent Results (mSv):

Nuclide	Electrons	Photons	Total
Mo-99	4.434e+00	7.581e-03	4.442e+00
Tc-99m	5.110e-01	1.165e-02	5.226e-01
Total:			**4.964e+00**

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Varskin Modelling Confirmation (2)

Source Geometry Information:

Source Geometry Type:	Cylinder
Source Diameter:	1.13 cm
Source Thickness:	1.00 µm
Source Density:	1.00 g/cm^3

Exposure Information:

Dose Depth:	7.00 mg/cm^2
Exposure Time:	5.00 min
Dose Averaging Area:	1.00 cm^2

Nuclide Information:

Nuclide	Database	Source Z	Activity	Units
Mo-99	ICRP107	7.42	330	kBq
Tc-99m	ICRP107	7.42	292	kBq

Shallow Dose Equivalent Results (mSv):

Nuclide	Electrons	Photons	Total
Mo-99	4.435e+01	7.581e-02	4.442e+01
Tc-99m	5.111e+00	1.165e-01	5.227e+00
Total:			**4.965e+01**

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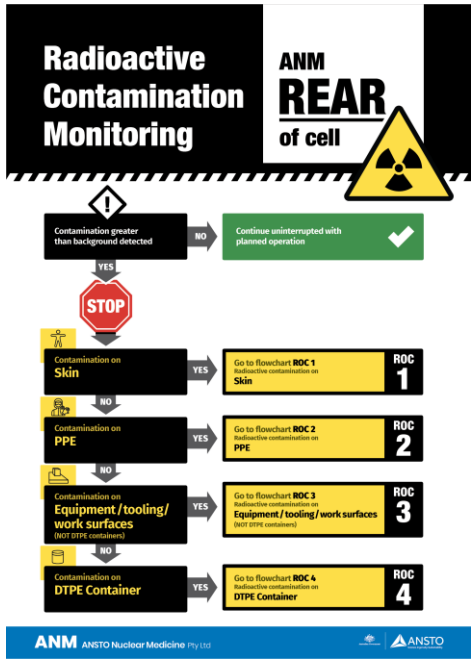
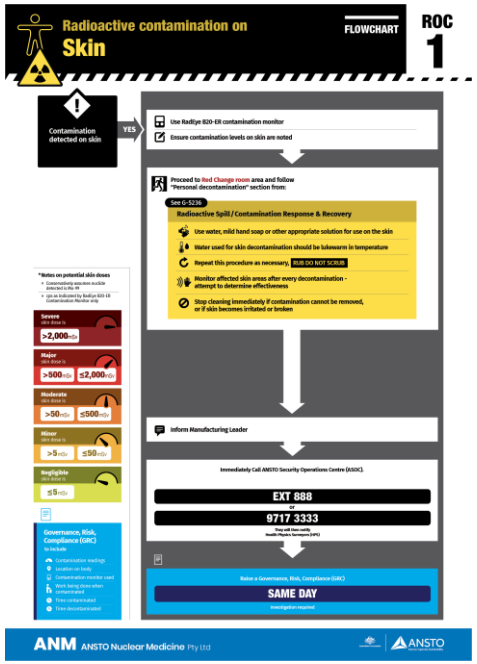
Flow Charts(Rear of Cells)

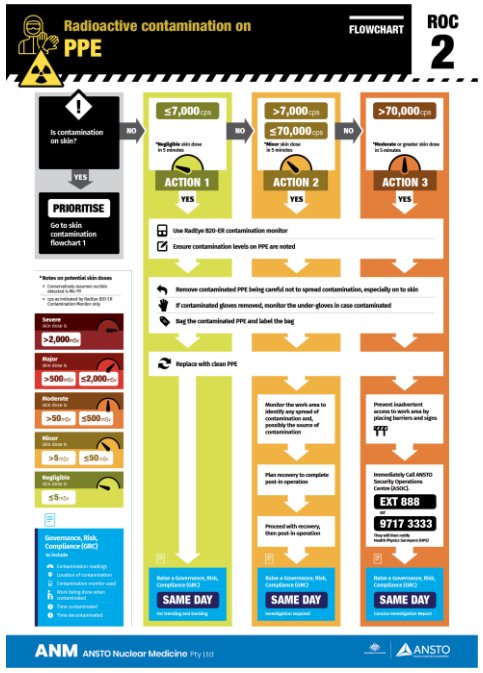
ROC Workflow



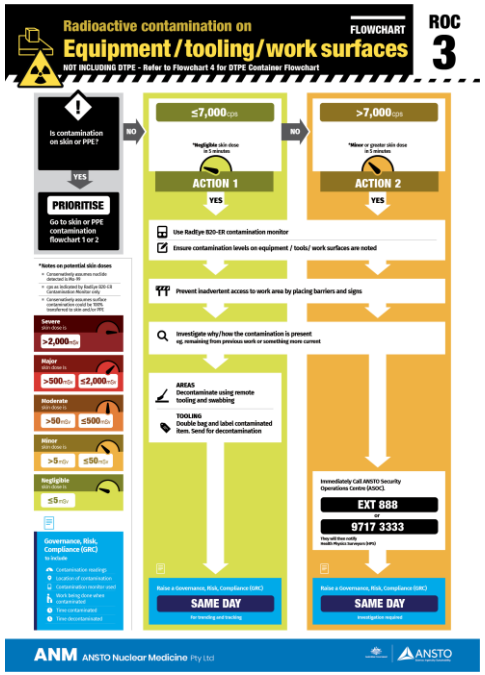
Flowchart ROC 1



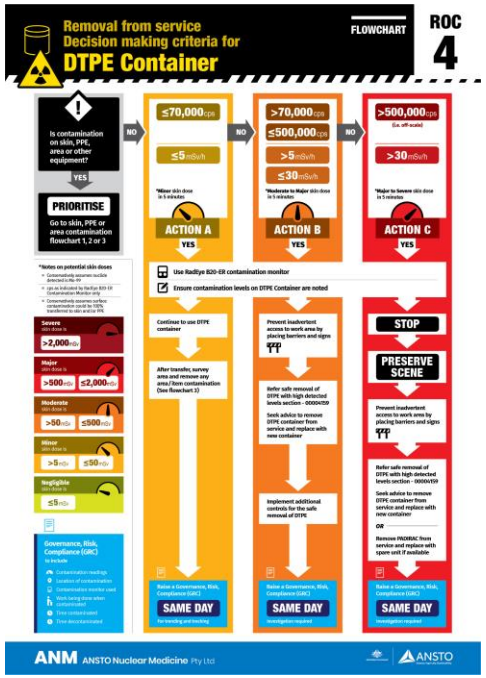
Flowchart ROC 2



Flowchart ROC 3



Flowchart ROC 4



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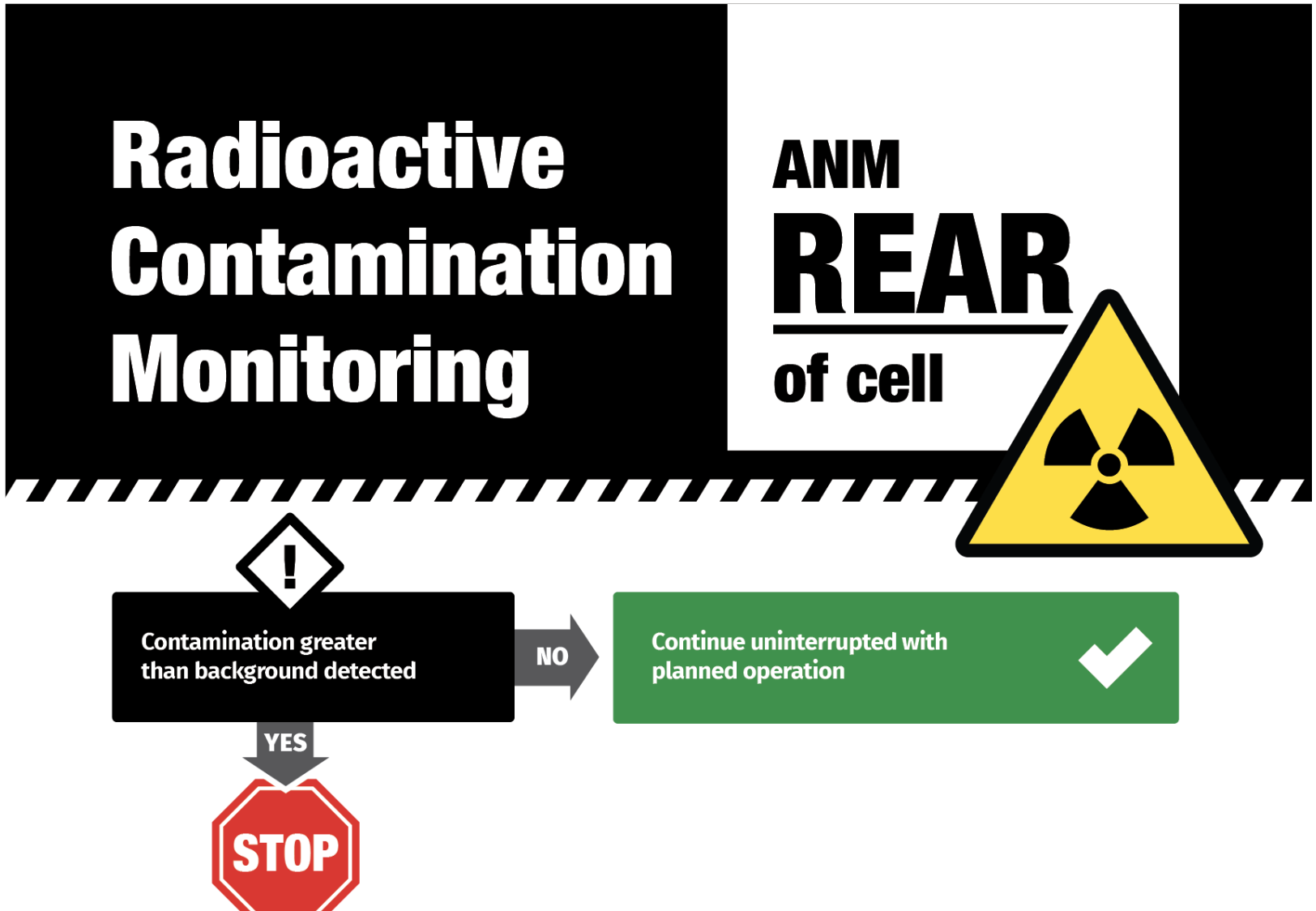
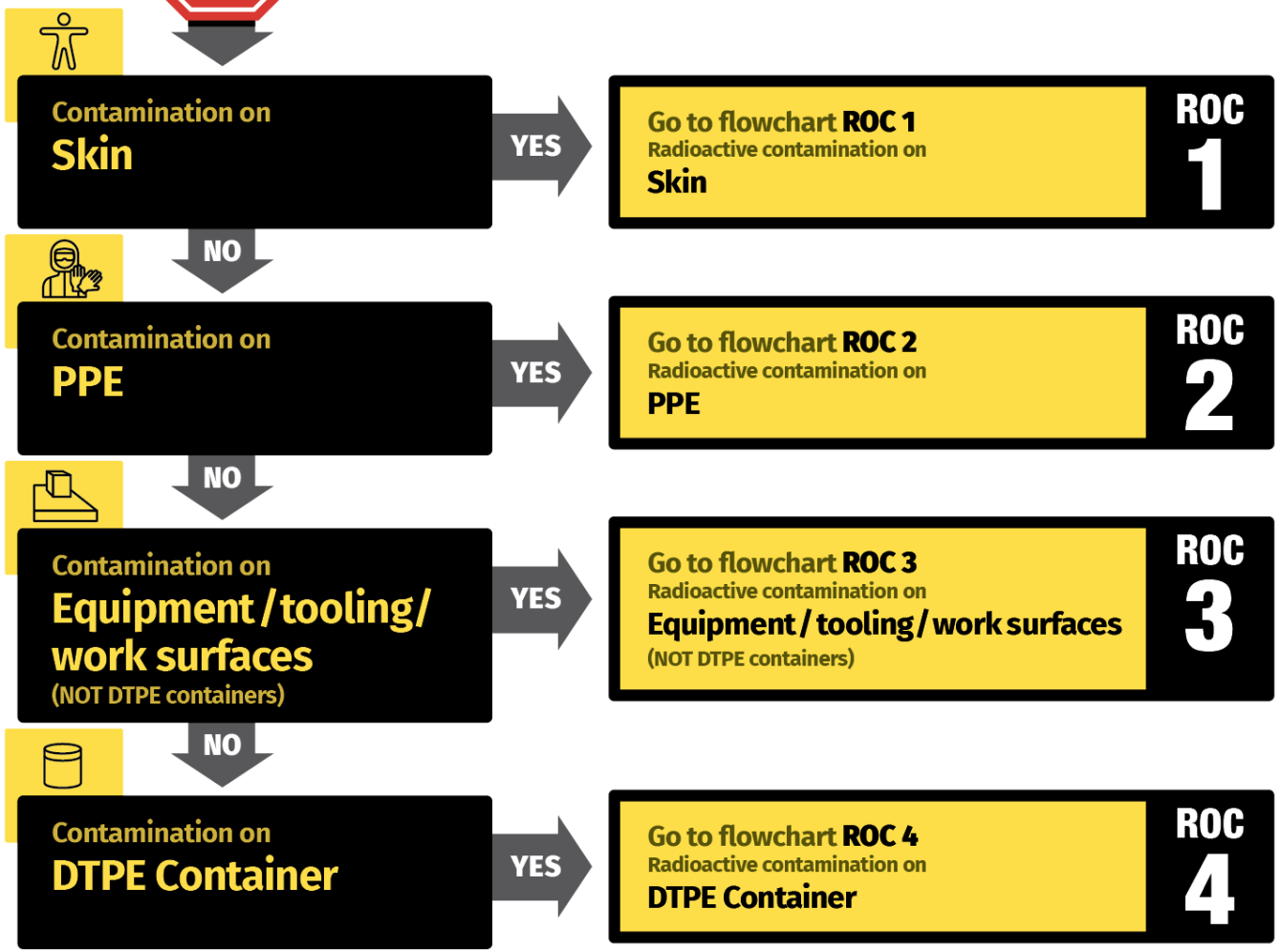
ROC Workflow



ROC Workflow



Radioactive contamination on Skin

FLOWCHART

ROC 1

Contamination detected on skin

YES

- Use RadEye B20-ER contamination monitor
- Ensure contamination levels on skin are noted

Proceed to **Red Change room** area and follow "Personal decontamination" section from:

See G-5236

Radioactive Spill / Contamination Response & Recovery

- Use water, mild hand soap or other appropriate solution for use on the skin
- Water used for skin decontamination should be lukewarm in temperature
- Repeat this procedure as necessary, RUB DO NOT SCRUB
- Monitor affected skin areas after every decontamination - attempt to determine effectiveness
- Stop cleaning immediately if contamination cannot be removed, or if skin becomes irritated or broken

***Notes on potential skin doses**

- Conservatively assumes nuclide detected is Mo-99
- cps as indicated by RadEye B20-ER Contamination Monitor only

Severe skin dose is >2,000mSv

Major skin dose is >500mSv ≤2,000mSv

Moderate skin dose is

Flowchart ROC 1

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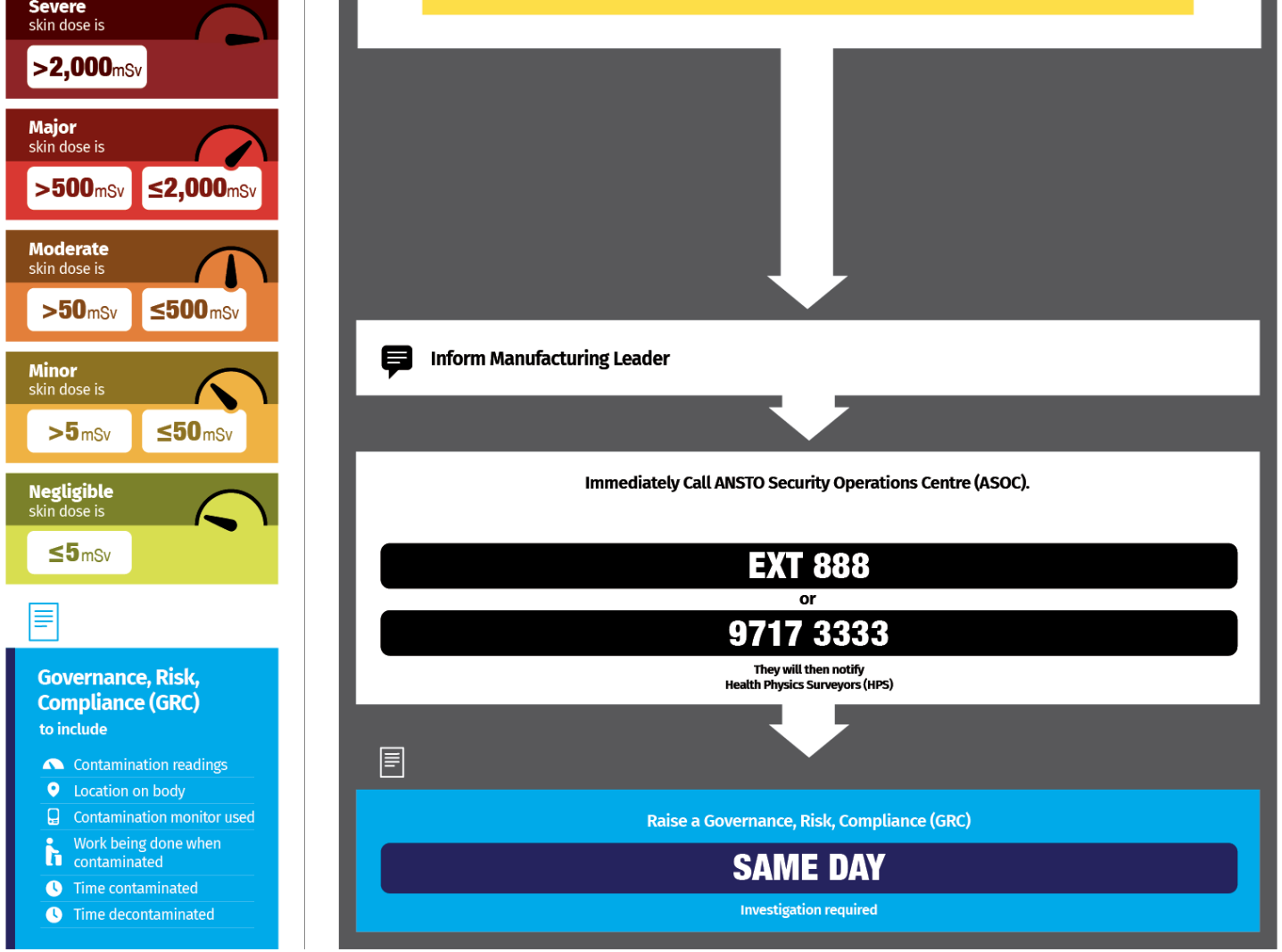

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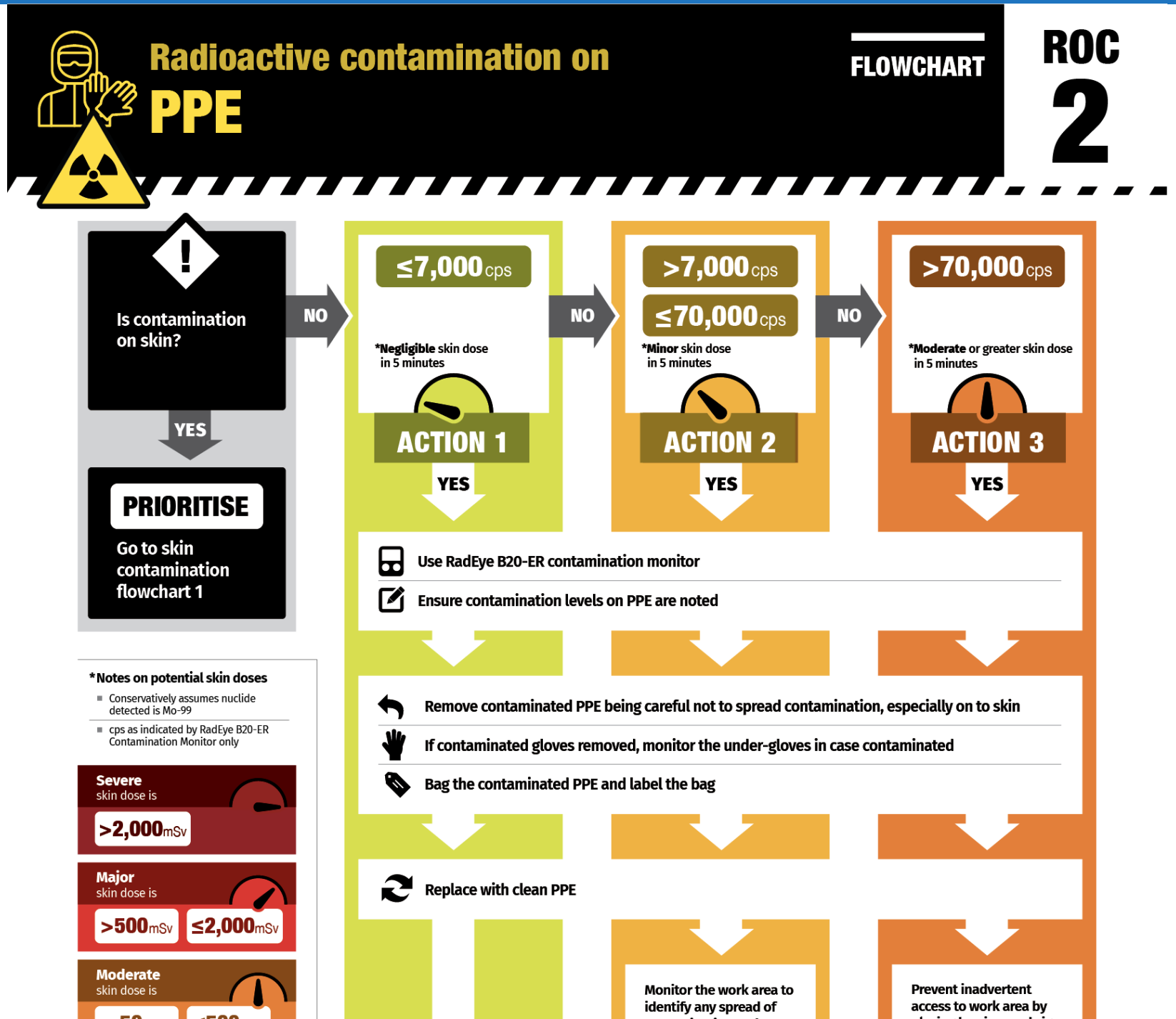

Flowchart ROC 2

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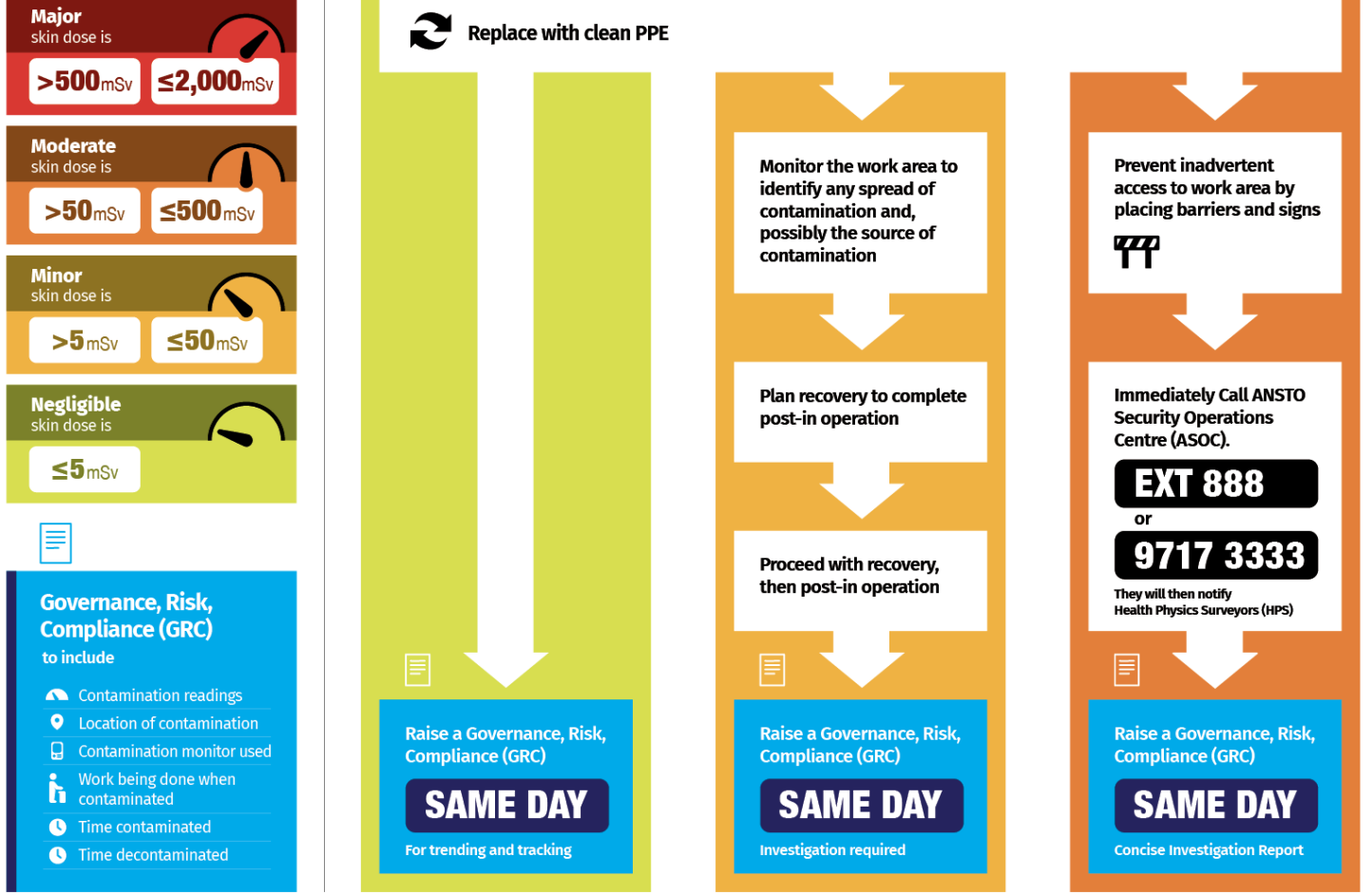

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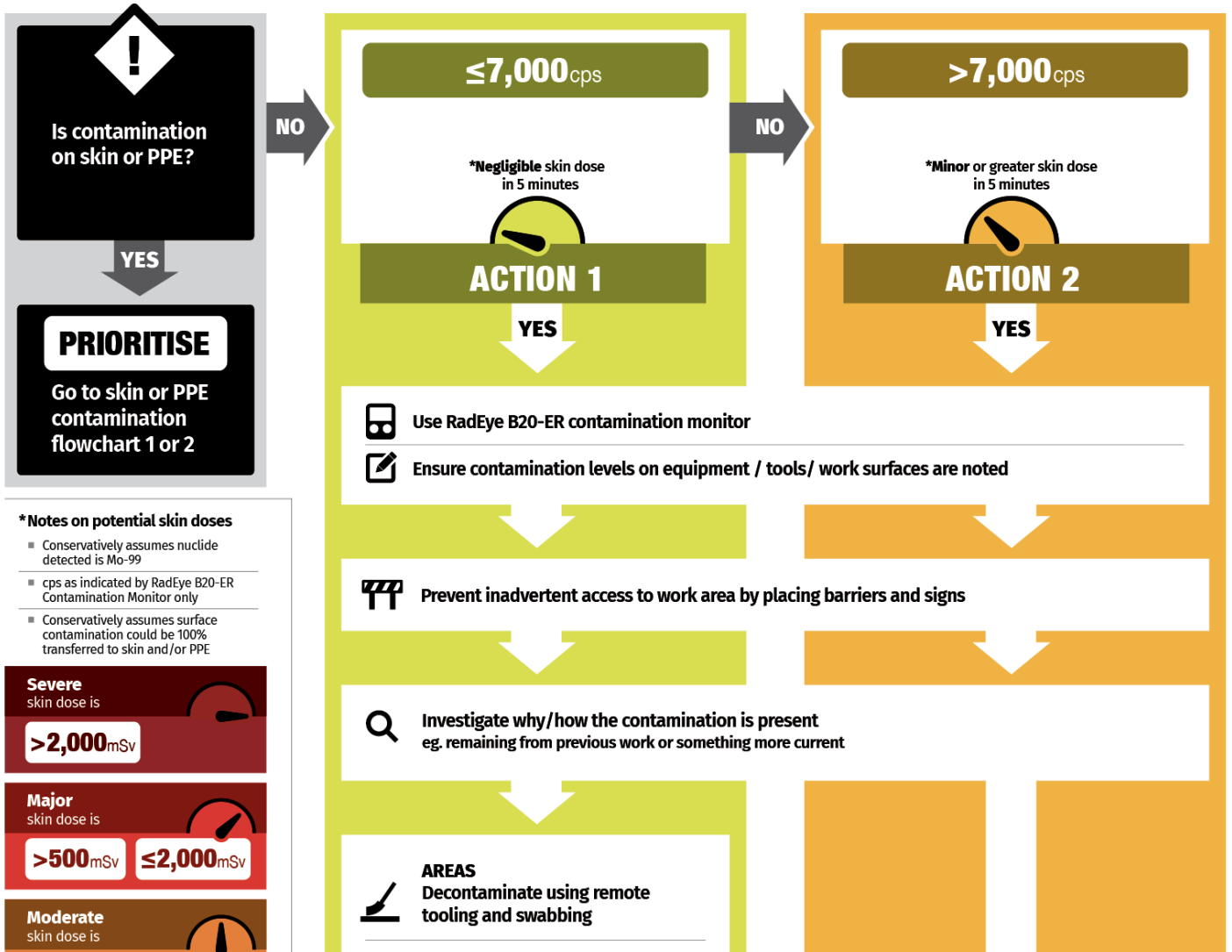
Radioactive contamination on Equipment / tooling / work surfaces

FLOWCHART

ROC 3

NOT INCLUDING DTPE - Refer to Flowchart 4 for DTPE Container Flowchart



***Notes on potential skin doses**

- Conservatively assumes nuclide detected is Mo-99
- cps as indicated by RadEye B20-ER Contamination Monitor only
- Conservatively assumes surface contamination could be 100% transferred to skin and/or PPE

Severe skin dose is >2,000mSv

Major skin dose is >500mSv ≤2,000mSv

Moderate skin dose is

Flowchart ROC 3

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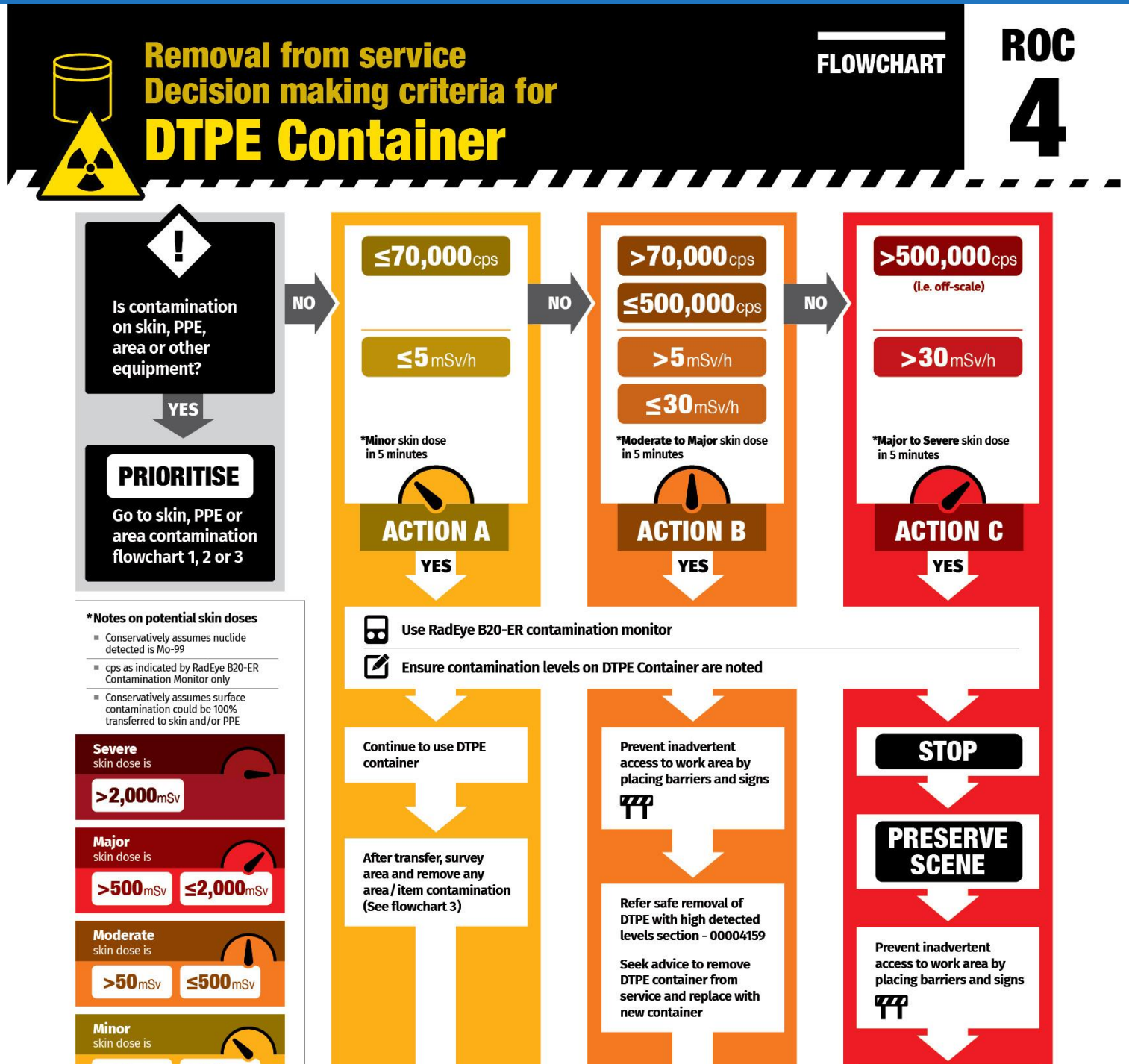

Flowchart ROC 4

Note: “contamination” levels and dose rates measured on a **used** DTPE container may be due to radiation from the contents of the DTPE container, including contamination that may be have built up within the container

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Summary

Clear concise guidance for any contamination scenario based on a consistent set of numbers
Allows the workers and management to make better informed decisions

Based on conservative assumptions/parameters
Helps mitigate the exposure risk from potentially significant skin / PPE contamination scenarios

Increased reporting culture
Better recognition of the magnitude of the DPTE® container O-ring contamination issue

Further work currently in the planning stage
- Automatic bagging of the DPTE® container on removal from PADIRAC flask
- Single use DPTE® container before storage (swipe card system) for decay, then removal of O-ring, washing inside and out and installing new O-ring for use with serial number traceability

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Questions

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