

**Technical Basis for Transport
of Radioactive Materials
Emergency Planning**

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Introduction

The IAEA Regulations establish that

“In the event of accident or incidents during the transport of radioactive material, emergency provisions, as established by relevant national and/or international organizations, shall be observed to protect persons, property and environment....” [par. 304 TS-R-1 2009 Edition]

Concept of defence in depth in nuclear activities

➤ Prevention

Design and administrative elements with the scope to prevent accidents or incidents that can damage the barriers

➤ Mitigation

Multiple barriers to restrict the release of radioactive material to the environment

➤ Limitation of radiological consequences

System and structures to prevent or to limit the damage of the barriers against hypothetical accident or incident scenarios

Concept of defence in depth in the transport of radioactive material

Action	Tool
Prevention	<ul style="list-style-type: none">❖ Management system❖ Radiation protection programme❖ Shipment authorization❖ Itinerary limitation (tunnels, bridges, etc.)

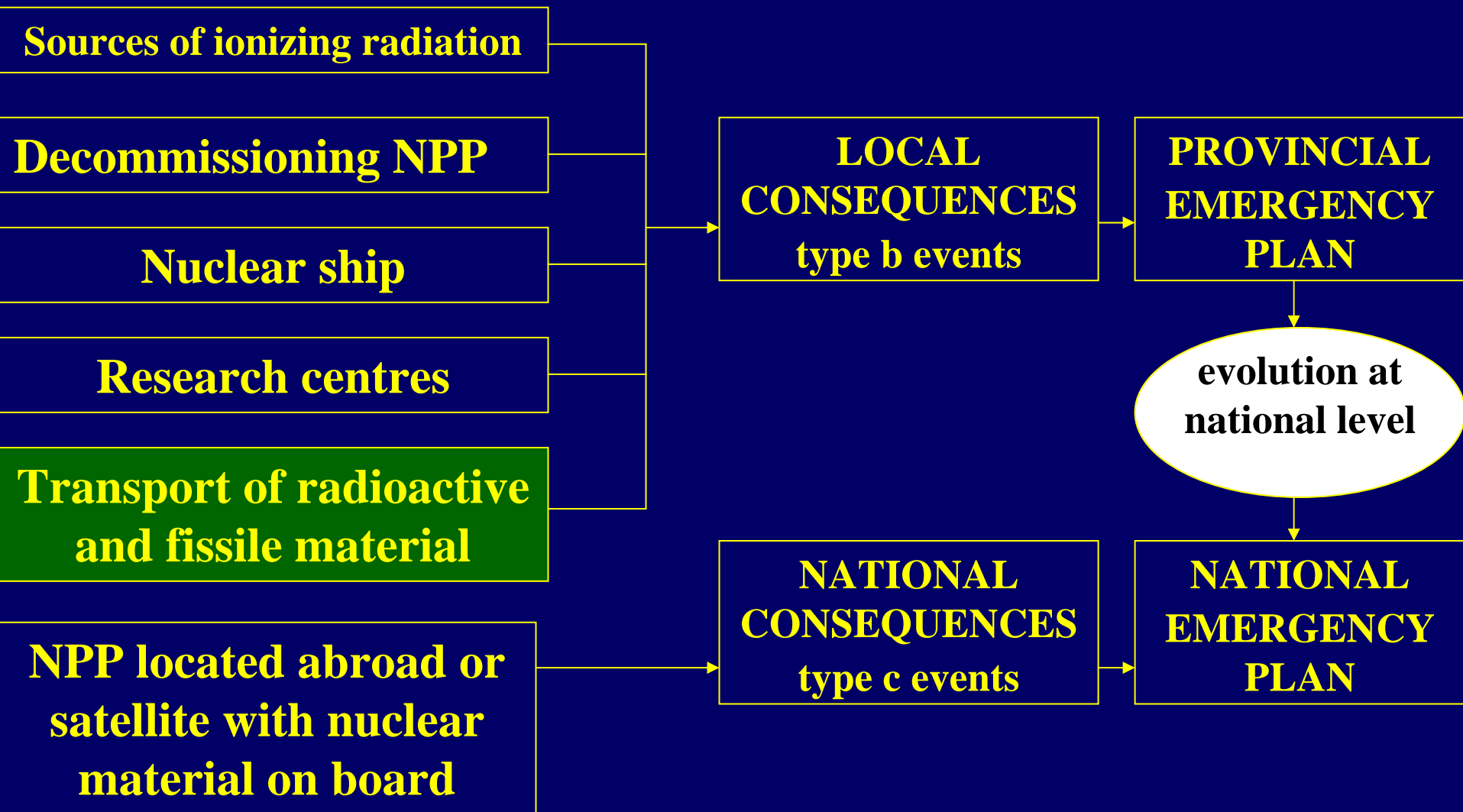
cont...Concept of defence in depth in the transport of radioactive material

Action	Tool
Mitigation	<ul style="list-style-type: none">❖ Design of package❖ Physical form of radioactive material (special form)❖ Package requirements (qualification tests)

cont...Concept of defence in depth in the transport of radioactive material

Action	Tool
Limitation of radiological consequences	<ul style="list-style-type: none">❖ Emergency preparedness❖ Emergency plan

Emergency preparedness at local and national level



National regulatory framework

The Governmental Decree of the 10th of February 2006 establishes the provisions for emergency preparedness for transport of radioactive and fissile material

- **A local emergency plan shall be prepared by the Prefect of each Italian province for transport of radioactive material on the basis of ISPRA Technical Report**
- **A specific emergency plan for transport of spent fuel shall be prepared by the Prefect of the provinces crossed by the shipment on the basis of a technical report prepared by the carrier and approved by a Technical Commission with the advice of ISPRA**

The reasons for the technical report

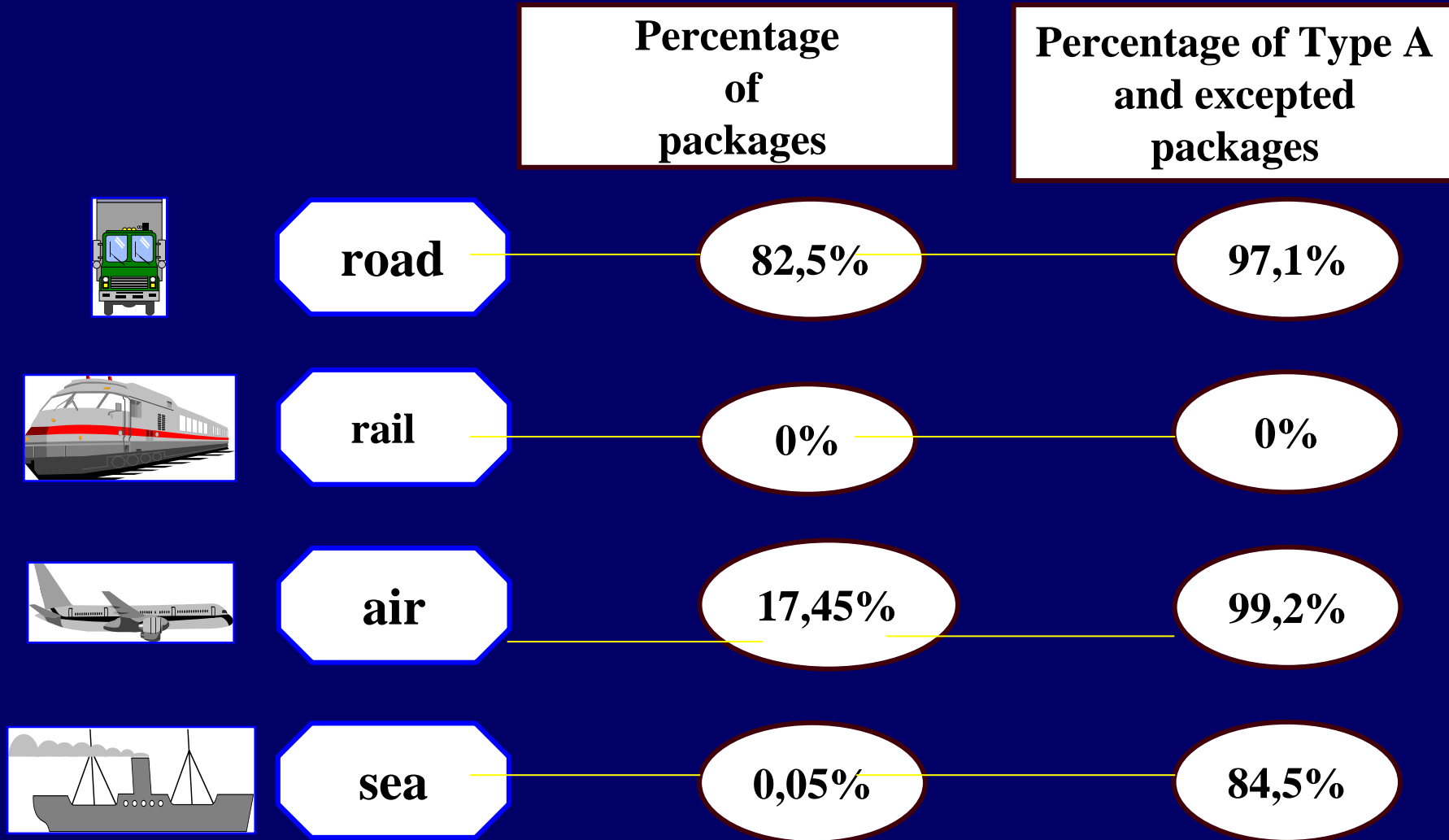
- **To provide the technical basis to prepare homogeneous emergency plans by the Prefects of each province of the Italian territory (107 provinces)**
- **To provide data on the transport of radioactive materials of each Italian province to better adapt the emergency plans to the real shipments**

Parameters to define the accident scenarios

The following parameters are considered to define the accident scenarios:

- **Mode of transport**
- **Radioactive material involved in the accident**
- **Activity involved in the accident**
- **Accident severity**

Mode of transport



Road transport

	years		
	2005	2006	2007
No. packages	238000	310000	292000
No. shipments	95000	87000	85000

cont...Road transport

Type of package	No. packages	%
Excepted package	164688	56,4
Type A	118844	40,7
IP	292	0.1
Type B	8176	2,8
Total	292000	

Radioactive material involved in the accident

- ❖ On the basis of the data on prevalent radionuclides and packages transported only **non special form radioactive material** is considered for the accident scenarios
- ❖ For non special form radioactive material the prevalent contribution to the total dose is provided by the **inhalation dose** and the dose by the **cloud submersion**

Activity involved in the accident

National Regulations establishes two activity thresholds for the notification of the shipments to the public authorities

- ❖ Shipments of Type A packages with activity grater than $3A_1$ or $3A_2$
- ❖ Shipments of Type B packages with activity grater than $30A_1$ or $30A_2$

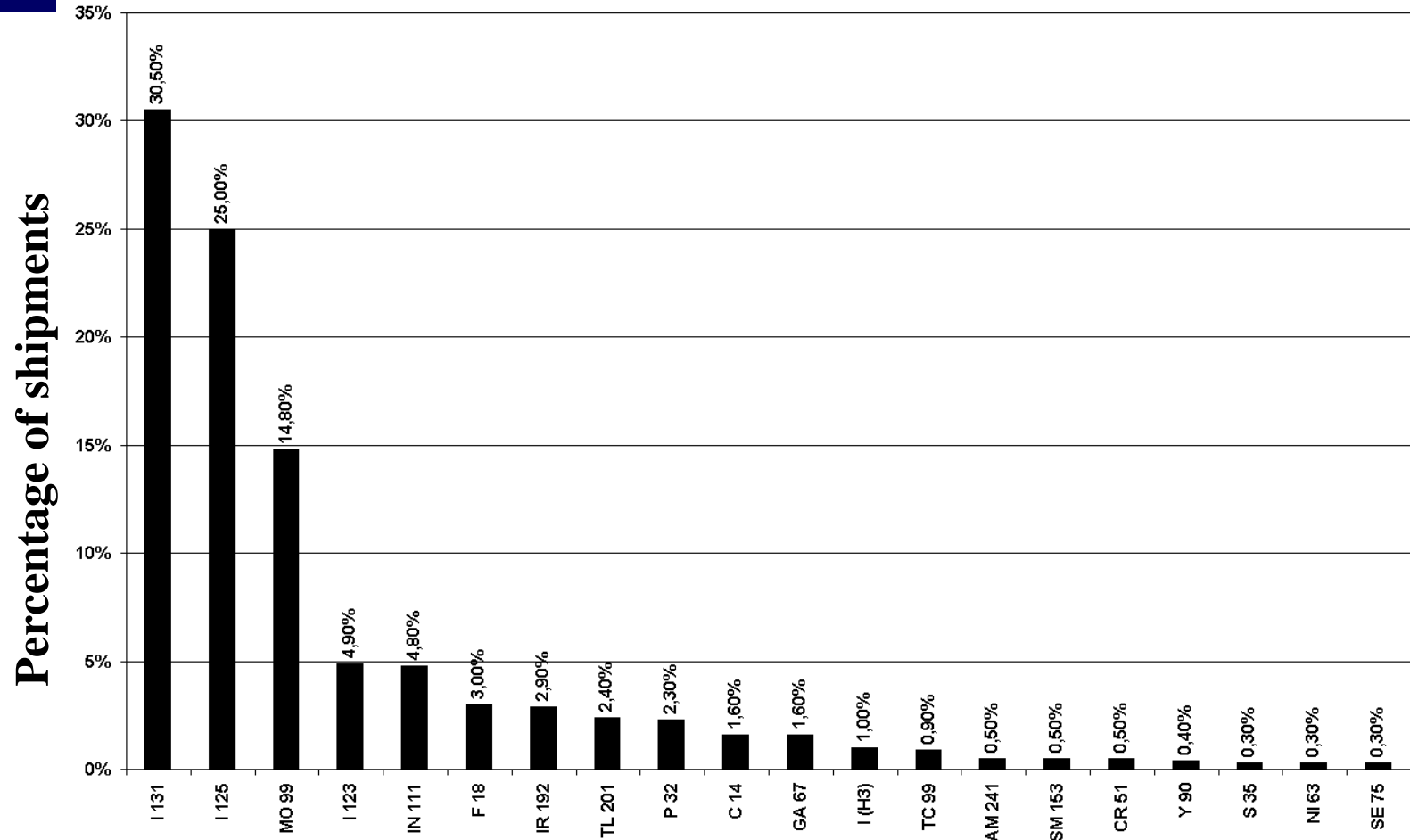
The values $3A_2$ and $30A_2$ are set for the accident scenarios

cont... Activity involved in the accident

- **Radioactive material with activity $3A_2$ and $30A_2$ are considered as a mixture of radionuclides**
- **The mixture of radionuclide are formed by the radionuclides (20) much more transported**
- **Three radionuclides of the mixture I-125, I-131 and Mo-99 represent about 70% of the total Type A and excepted packages transported**

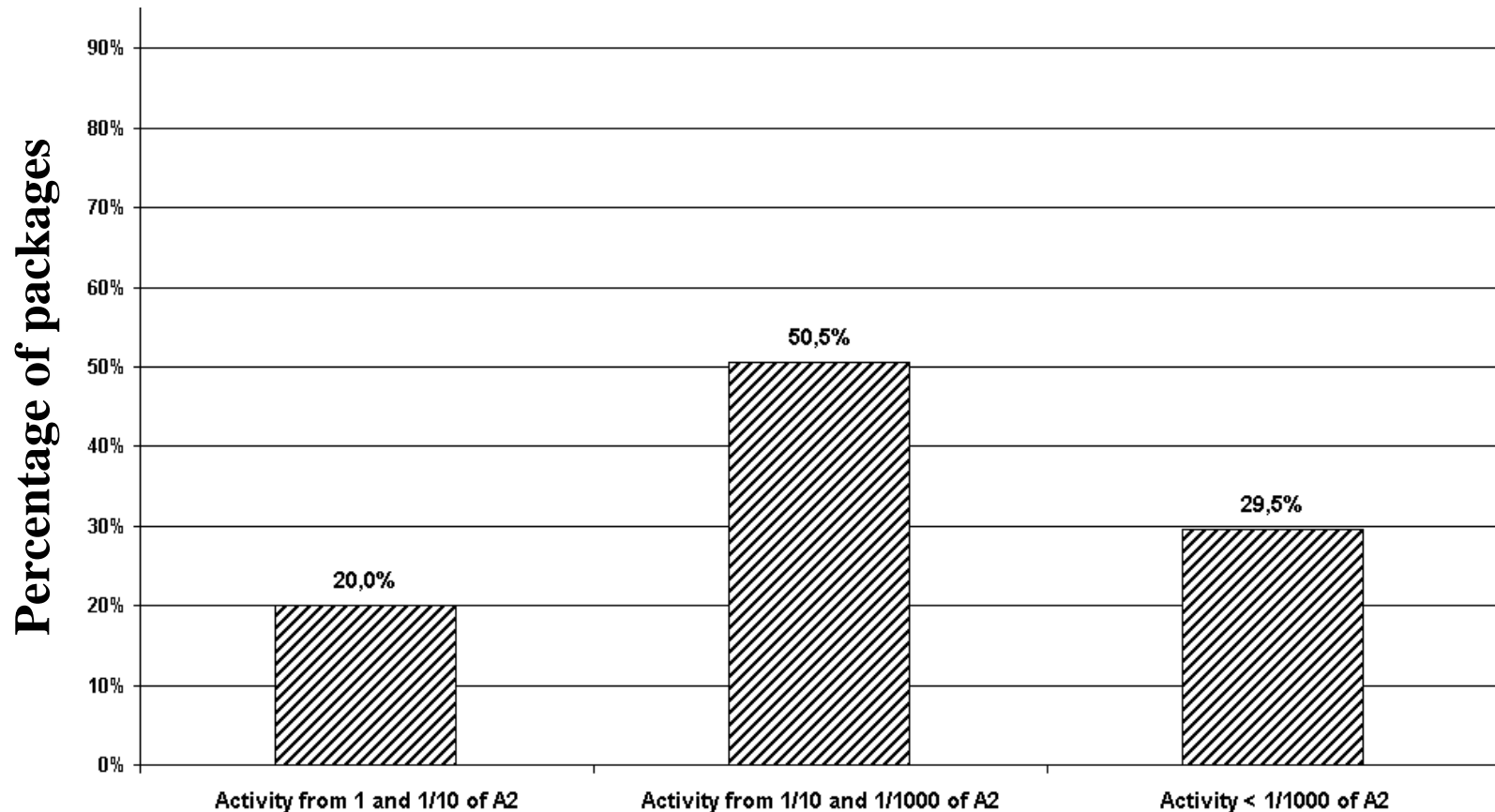
Mixture of radionuclides

Twenty much more transported radionuclides in the years 2005-2007

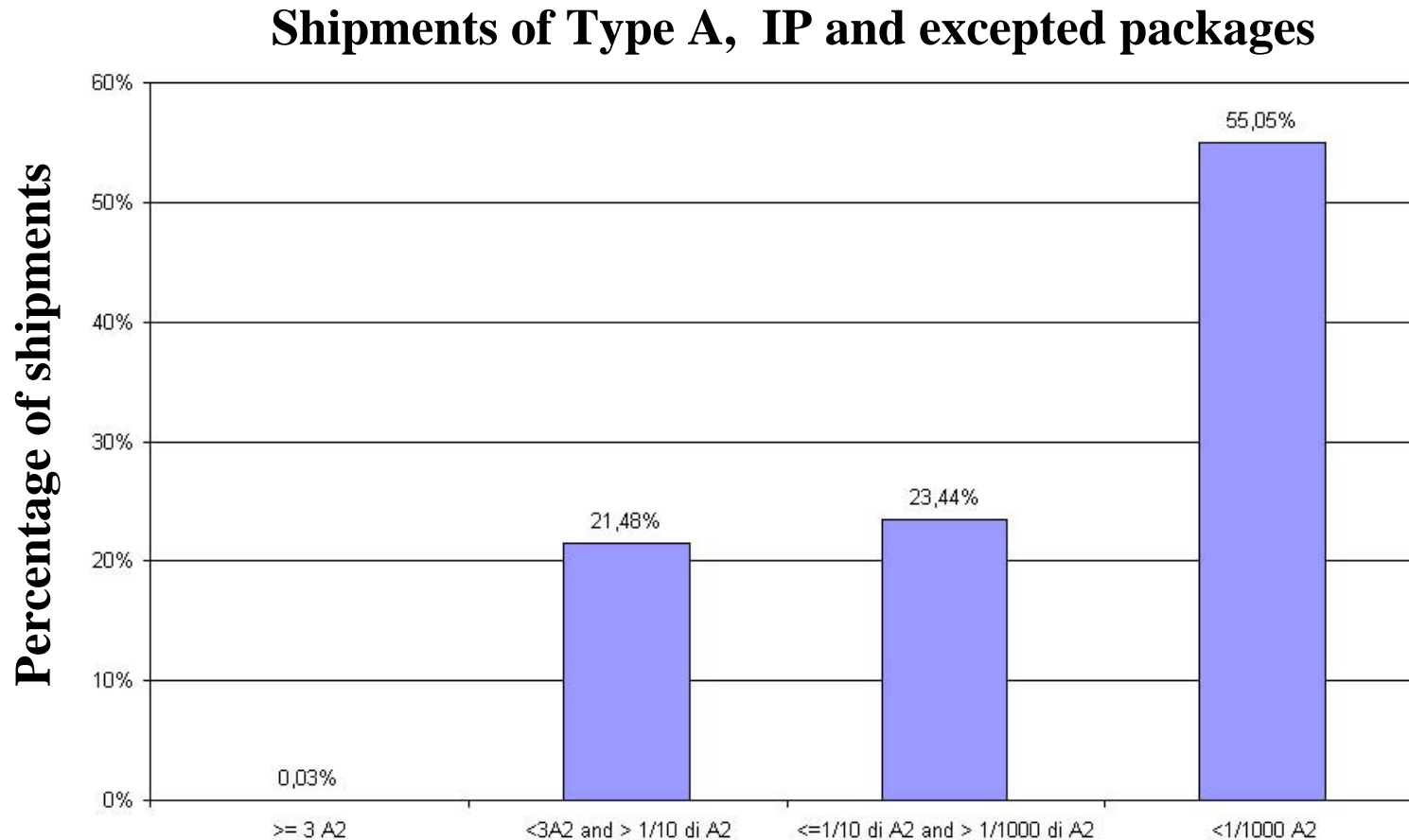


Activity in Type A packages

Range of activity in Type A packages in the year 2007



Activity per shipment of Type A, IP and excepted packages



Accident severity

- **Very heavy accident:** crash, with fire, between the vehicle with radioactive material on board and another vehicle
- **Heavy accident:** crash between the vehicle with radioactive material on board and another vehicle
- **Light accident:** a small crash between the vehicle with radioactive material on board and another vehicle

Accident scenarios

➤ Scenario No.1

very heavy accident of vehicle with Type A packages on board with total activity of $3A_2$

➤ Scenario No.2

very heavy accident of vehicle with Type A packages on board with total activity of $30A_2$

Radiological consequences for Scenario No.1

Shipment characteristics:

total activity = $3A_2$ (6.95 TBq)

packages = Type A

physical state = non special form;

type of radionuclide = mixture of radionuclides

Percentage of radionuclides in the mixture

$^{131}\text{I}=31\%$; $^{125}\text{I}=25,4\%$; $^{111}\text{In}=4,9\%$; $^{99}\text{Mo}=14,8\%$; $^{123}\text{I}=5\%$;
 $^{18}\text{F}=3\%$; $^{192}\text{Ir}=2,9\%$; $^{201}\text{Tl}=2,4\%$; $^{32}\text{P}=2,3\%$; $^{14}\text{C}=1,6\%$;
 $^{67}\text{Ga}=1,6\%$; $^3\text{H}=1\%$; $^{99\text{m}}\text{Tc}=0,9\%$; $^{241}\text{Am}=0,5\%$; $^{153}\text{Sm}=0,5\%$;
 $^{51}\text{Cr}=0,5\%$; $^{90}\text{Y}=0,4\%$; $^{35}\text{S}=0,3\%$; $^{63}\text{Ni}=0,3\%$; $^{75}\text{Se}=0,3\%$

cont...Radiological consequences for Scenario No.1

	distances in metres – doses in mSv						
Groups of population	50	100	150	200	300	400	500
infants	6.32	1.62	0.725	0.409	0.196	0.117	0.077
children	11.5	2.95	1.31	0.736	0.352	0.209	0.139
adults	9.81	2.52	1.13	0.642	0.309	0.134	0.123

Radiological consequences for Scenario No.2

Shipment characteristics:

total activity = $30A_2$ (69.5 TBq)

packages = Type A

physical state = non special form;

type of radionuclide = mixture of radionuclides

Percentage of radionuclides in the mixture

$^{131}\text{I}=31\%$; $^{125}\text{I}=25,4\%$; $^{111}\text{In}=4,9\%$; $^{99}\text{Mo}=14,8\%$; $^{123}\text{I}=5\%$;
 $^{18}\text{F}=3\%$; $^{192}\text{Ir}=2,9\%$; $^{201}\text{Tl}=2,4\%$; $^{32}\text{P}=2,3\%$; $^{14}\text{C}=1,6\%$;
 $^{67}\text{Ga}=1,6\%$; $^3\text{H}=1\%$; $^{99\text{m}}\text{Tc}=0,9\%$; $^{241}\text{Am}=0,5\%$; $^{153}\text{Sm}=0,5\%$;
 $^{51}\text{Cr}=0,5\%$; $^{90}\text{Y}=0,4\%$; $^{35}\text{S}=0,3\%$; $^{63}\text{Ni}=0,3\%$; $^{75}\text{Se}=0,3\%$

cont...Radiological consequences for Scenario No.2

	distances in metres – doses in mSv						
Groups of population	50	100	150	200	300	400	500
infants	63.2	16.2	7.25	4.09	1.96	1.17	0.77
children	115	29.5	13.1	7.36	3.52	2.09	1.39
adults	98.1	25.2	11.3	6.42	3.09	1.34	1.23

Distances recommended for protective actions

Protective actions	Scenario No.1	Scenario No.2
exclusion	50 m	100 m
sheltering	100 m	300 m

Conclusions

- **The Technical Report integrated by the data on transport of radioactive material will be the basis to developed the emergency plans by the Prefect**
- **Two reference scenarios are identified for accident in road transport that are also representative for the other modes of transport**
- **Protective actions are indicated on the basis of the evaluation of the radiological consequences of the two accident scenarios**

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...Thank you for your attention