



Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO)

Preliminar results of the FORO project " Application of risk matrix method in industrial radiography"

Walter Adrian TRUPPA
NUCLEAR REGULATORY AUTHORITY

*16th European ALARA Network Workshop,
Berne, Switzerland, 14 – 16 March 2016*

About FORO

Who are we?

*an association of **Nuclear and Radiological regulators** created in 1997 with the aim of promoting **Radiation Protection, Nuclear Safety and Security** at the highest level in the region.*

Our Vision

*being a fruitful environment for strengthening **safety** through the **exchange** of information and practices, as well as through **technical and scientific projects** in matters of mutual interest.*

Our Language

Spanish

Our Mission

- *Promote **Safety**,*
- ***Exchange** of information and knowledge,*
- *Development of **projects of common interest**,*
- ***Harmonization** of the regulatory practices, and*
- ***Cooperation** with national, regional and international organizations and associations with **similar objectives**.*

FORO Members

ARGENTINA



Autoridad Regulatoria Nuclear

BRAZIL



Comissão Nacional de Energia Nuclear

CHILE



Comisión Chilena de Energía Nuclear

COLOMBIA



Ministerio de Minas y Energía

CUBA



Centro Nacional de Seguridad Nuclear

SPAIN



Consejo de Seguridad Nuclear

MEXICO



Comisión Nacional de Seguridad Nuclear y Salvaguardias

PERU



Instituto Peruano de Energía Nuclear

URUGUAY



Autoridad Reguladora Nacional en Radioprotección

FORO Program

- *Radiation protection of workers*
- *Radiation protection of patients*
- *Radiation protection of the public and the environment*
- *Emergency preparedness and response*
- *Accident and Incident Management*
- *Control of radiation sources*
- *Decommissioning and closure of Installations*
- *Radioactive waste management*
- *Nuclear safety*
- *Transport of radioactive material*
- *Knowledge management*
- *Human and organizational factors*
- *Physical security*
- *Legal issues*

FORO Activities (1)

Nine projects completed:

1. Prevention of *accidental exposures* in radiation therapy through the application of probabilistic risk assessment (*SEVRRRA* tool);
2. Collaborative approaches between regulatory and health authorities for regulatory control of *medical exposures*;
3. Regulatory assessment and inspection of *NPPs' ageing management and long-term operation*;
4. Control of *inadvertent radioactive material from scrap metal in recycling industries*;

FORO Activities (2)

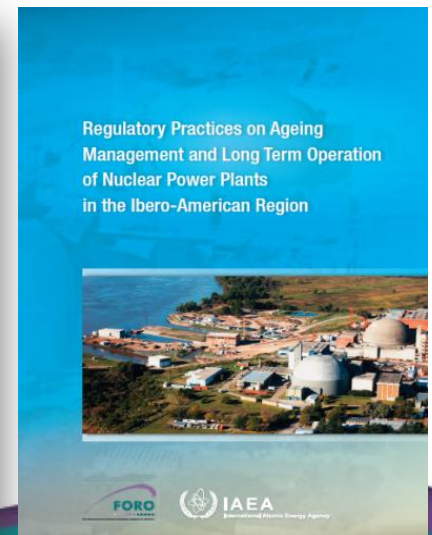
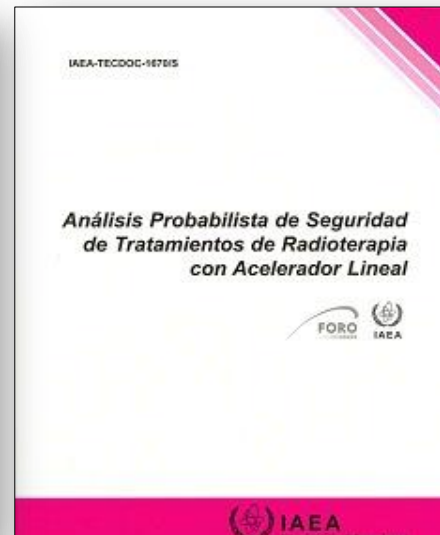
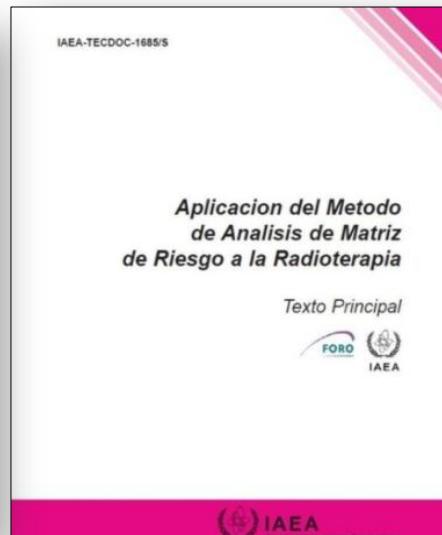
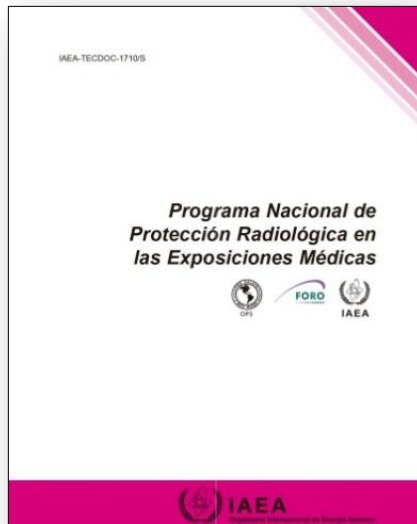
5. Assessment of *stress tests* performed to NPPs in the FORO countries;
6. *Harmonisation* of regulatory criteria in *emergency preparedness and response*;
7. *Licensing of cyclotrons* for the production of radionuclides by positron emission tomography in medical applications.
8. *Capacity building for regulatory staff related to the safety of nuclear reactors* (Recently Finished).
9. *Guidelines to promote and develop safety culture* on practices involving the use of *ionizing radiation* (Recently Finished).

FORO Activities (3)

Two projects under development:

1. *Clearance criteria in radioactive installations.*
2. *Risk assessment methodology for industrial practices*

- *Risk Matrix Methodology applied to Radiotherapy) - TECDOC 1685/S.*
- *Probabilistic Safety Assessment applied to Radiotherapy) - TECDOC 1670/S.*
- *Programme of Radiological Protection in Medicine -self assessment guidelines to regulators-) - TECDOC 1710/S.*
- *Regulatory Practices on Ageing Management and Long Term Operation of Nuclear Power Plants in the Ibero-American Region.*



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The Information Channel on Nuclear and Radiological Events

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Events

Sort by: [Date Posted](#) | [Event Date](#)

Items per page:

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Radiographer Overexposure Argentina, 27 Aug 2015, INES: 3

On September 08, 2015, Nuclear Regulatory Authority (ARN) was informed about a radiological incident during industrial radiography of a boiler's manifold in the Thermoelectric Power Station, located in Río Turbio, Santa Cruz. Two workers were exposed to a radiation field of 1.62 TBq (44 Ci) of...

Reported by Autoridad Regulatoria Nuclear (ARN) of Argentina on 11 Feb 2016. Last update on 11 Feb 2016

Worker Overexposure United States of America, 27 Jan 2016, INES: 2

During an inspection in January 2016, the State of Florida noted that one of the licensee's employees working with a particle accelerator had exceeded the 50 mSv (5 rem) worker exposure limit for 2015 (overexposure nominally was 52 mSv (5.2 rem)). This employee also had nine high exposure...

Reported by Nuclear Regulatory Commission (NRC) of United States of America on 03 Feb 2016. Last update on 03 Feb 2016

Overexposure to Radiographer United States of America, 11 Nov 2015, INES: 2

After performing a radiograph, the radiographer believed he had cranked the source back inside the camera. However, when he went to retrieve the film, he noticed that his survey meter was reading off-scale, and then he noticed that his pocket dosimeter also read off-scale. The radiographer's...


Reported by Nuclear Regulatory Commission (NRC) of United States of America on 19 Nov 2015. Last update on 19 Nov 2015

Overexposure of two industrial radiographers Iran, Islamic Republic of, 23 Sep 2015, INES: 3

Two industrial radiographers who were involved in an oil refinery projects, overexposed by Gamma radiation of Ir-92, 35 Ci. On 23/09/2015, one of the radiographers dismantled the guide tube without noticing that the source/holder was detached and stocked in the guide tube due to not having survey...

Reported by Iran Nuclear Regulatory Authority (INRA) of Iran, Islamic Republic of on 18 Nov 2015. Last update on 18 Nov 2015

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Nuclear Events Web-based System (2014-2015)

Radiographer Overexposure

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Overexposure of two industrial radiographers

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Overexposure to Radiographer

While on location at a temporary jobsite, the licensee radiographer attempted to disconnect the guide tube from the radiography camera, without ensuring the source was in the shielded position. The licensee has confirmed a whole body dose of 64 mSv (6.4 rem) which exceeds the statutory dose limit...

Overexposure to Radiographer

The Lead Radiographer and three assistant radiographers were completing two exposures lasting 35 seconds each. The set-up time for the exposures was approximately 15 to 18 minutes. After completing two exposures, one individual noticed that his pocket dosimeter read off scale, a second individual...

Overexposure to workers to radiografic source

Three workers were exposed to doses while working in a bunker. One worker was shielded, two were not. The source is Se-75 1,5 TBq Two workers were exposed to approx. 30 mSv, well above the annual limit of 20 mSv The shielded workers dose was approx. 0.6 mSv. None of the workers had...

Dangerous Source at Cárdenas

On April 14th 2015, the National Commission on Nuclear Safety and Safeguards received a report about the theft of a vehicle transporting a radioactive source. This had occurred in the municipality of Cardenas, in the State of Tabasco, Mexico. The stolen source was Ir-92 with an activity of 32 Ci....

Missing Dangerous Source at Salamanca

In February 3rd. 2015, the National Commission on Nuclear Safety and Safeguards (this is Mexico's nuclear regulatory authority) was informed by a licensee that three vehicles of its property had been stolen, each one was transporting an Ir-92 source. Therefore, three sources were missing. On the...

Theft of a device containig radioactive source

On the 22nd of July 2015 the device containing radioactive source previously reported stolen has been recovered. On the 15th of July 2015 workers conducting industrial gammagraphy lost a device containing a category 2 radioactive source (GammaMat TI-F device with 1.76TBq Ir-192 source) at a...

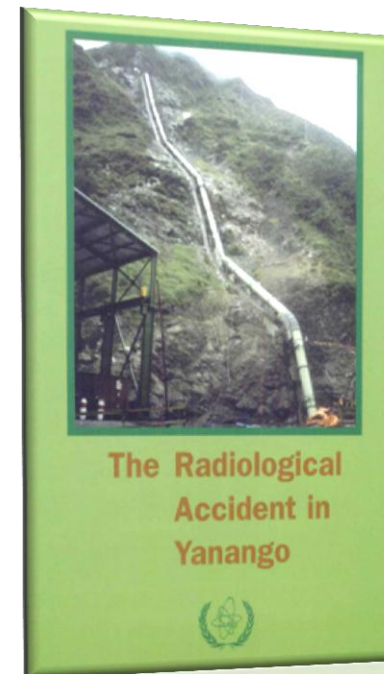
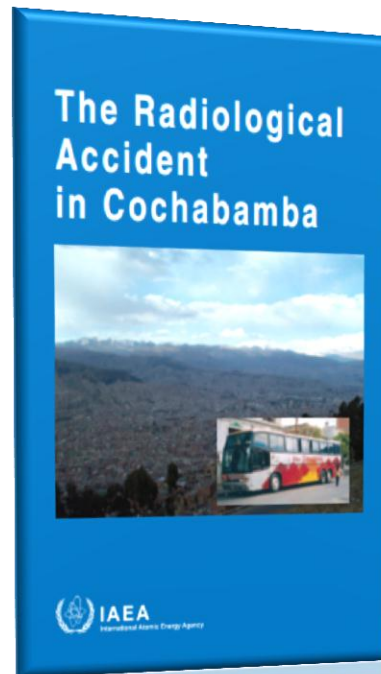
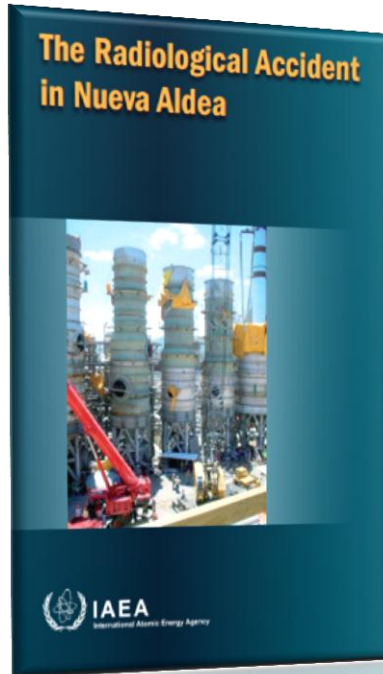
Transport incident of a gamma ray projector

On 16th March 2015, ASN was informed by the ECW company (Courcelles-les-Lens) that one of their gamma ray projects had been carried on the public highway on 2nd March 2015 in conditions failing to comply with a number of requirements stipulated by the transport approval issued by ASN. Indeed, the..

Stolen pick-up truck with Ir-192 cat II source

In July 3rd. 2014, at the Municipality of Atizapán de Zaragoza, Mexico State, Mexico, a pick-up truck was stolen, this vehicle was transporting an Industrial Radiography Ir-192 radioactive source, with activity of 1.23 TBq, category II. On July the 4th, 2014, the vehicle was found at the... .

LESSONS LEARNED OF ACCIDENTS REPORTED IN OUR REGION

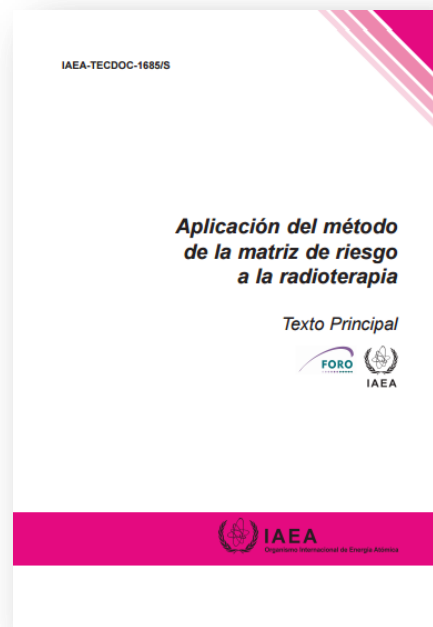
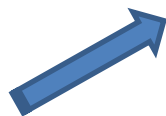


What about other possible types of events in industrial radiography??
How many other events do we need to react??

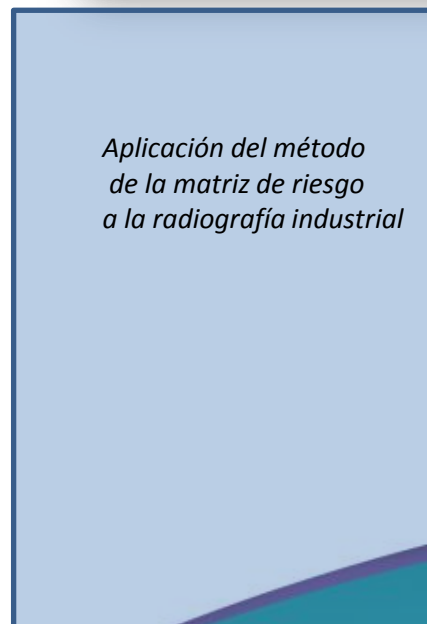
FIRST STEPS TO BUILD THE PROJECT



Synergy
FORO - FORO



Experience and collaboration of previous FORO project about Risk matrix in radiotherapy

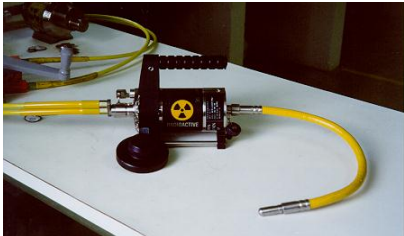


New FORO document about Risk matrix in industrial radiography

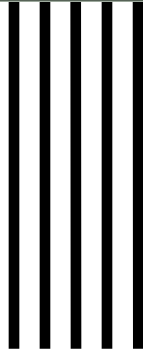
FIRST APPROUCH:
Regional IRPA Congress 2013,
Río de Janeiro, Brazil

ABOUT RISK MATRIX

human error or
equipment
frequency (f)



Probability of
failure of
barriers to
avoid
accidents (p)



Accidental
exposure



Consequences

(C)



$$\text{Risk} = R = f \times p \times C$$

- **f** is the frequency (or annual frequency of occurrence) of the hazard (initiating event)
- **p** is the probability of failure of the barriers provided
- **C** is the severity of the potential harm (consequences)

RISK MATRIX METHOD

- The "Risk Matrix" method has been extensively used for safety assessments in different practices and industries.
- The method is characterized by being systematic and simple.
- The basic criteria is to divide each independent variable of the equation of risk. (e.g.: low, medium, high and very high)
- The project includes a strong interaction between the risk matrix and the software named SEVRRRA₍₁₎, to evaluate and compare different risks in industrial radiography.

(1) Developed by Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO)

RISK MATRIX EXAMPLE

f _H	P _H	C _{VH}	R _{VH}	f _H	P _H	C _H	R _{VH}	f _H	P _H	C _M	R _H	f _H	P _H	C _L	R _M
f _M	P _H	C _{VH}	R _{VH}	f _M	P _H	C _H	R _H	f _M	P _H	C _M	R _H	f _M	P _H	C _L	R _M
f _L	P _H	C _{VH}	R _H	f _L	P _H	C _H	R _H	f _L	P _H	C _M	R _M	f _L	P _H	C _L	R _M
f _{VL}	P _H	C _{VH}	R _H	f _{VL}	P _H	C _H	R _H	f _{VL}	P _H	C _M	R _M	f _{VL}	P _H	C _L	R _M
f _H	P _M	C _{VH}	R _{VH}	f _H	P _M	C _H	R _H	f _H	P _M	C _M	R _H	f _H	P _M	C _L	R _M
f _M	P _M	C _{VH}	R _H	f _M	P _M	C _H	R _H	f _M	P _M	C _M	R _M	f _M	P _M	C _L	R _M
f _L	P _M	C _{VH}	R _H	f _L	P _M	C _H	R _H	f _L	P _M	C _M	R _M	f _L	P _M	C _L	R _L
f _{VL}	P _M	C _{VH}	R _H	f _{VL}	P _M	C _H	R _M	f _{VL}	P _M	C _M	R _M	f _{VL}	P _M	C _L	R _L
f _H	P _L	C _{VH}	R _H	f _H	P _L	C _H	R _H	f _H	P _L	C _M	R _M	f _H	P _L	C _L	R _L
f _M	P _L	C _{VH}	R _H	f _M	P _L	C _H	R _H	f _M	P _L	C _M	R _M	f _M	P _L	C _L	R _L
f _L	P _L	C _{VH}	R _M	f _L	P _L	C _H	R _M	f _L	P _L	C _M	R _M	f _L	P _L	C _L	R _L
f _{VL}	P _L	C _{VH}	R _M	f _{VL}	P _L	C _H	R _M	f _{VL}	P _L	C _M	R _M	f _{VL}	P _L	C _L	R _L
f _H	P _{VL}	C _{VH}	R _H	f _H	P _{VL}	C _H	R _M	f _H	P _{VL}	C _M	R _M	f _H	P _{VL}	C _L	R _L
f _M	P _{VL}	C _{VH}	R _M	f _M	P _{VL}	C _H	R _M	f _M	P _{VL}	C _M	R _M	f _M	P _{VL}	C _L	R _L
f _L	P _{VL}	C _{VH}	R _M	f _L	P _{VL}	C _H	R _L	f _L	P _{VL}	C _M	R _L	f _L	P _{VL}	C _L	R _L
f _{VL}	P _{VL}	C _{VH}	R _M	f _{VL}	P _{VL}	C _H	R _L	f _{VL}	P _{VL}	C _M	R _L	f _{VL}	P _{VL}	C _L	R _L

$$\text{Risk} = R = f \times p \times C$$

SEVRRRA SOFTWARE

- SEVRRRA is a software (tool) developed by the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies to facilitate the assessment of the risk level of different applications, uses and standardize regulatory activities, by promoting best practices.
- SEVRRRA gives the opportunity to identify strengths and weaknesses of the services of industrial radiography, regarding on the implementation of safety measures and barriers with the aim of reducing the probabilities of a radiological incident/accident and its consequences.

THE PROJECT: STEP BY STEP

STEP 1: MEETING IN CUBA. Establishment of criteria and methodology to apply in the risk matrix of industrial radiography.

STEP 2 AND 3: MEETINGS IN MÉXICO evaluation of different incident, accidents, barriers, frequencies and consequences.

Evaluation of SEVRRA software for industrial radiography. The tool is a specific program which takes into account the initiator (failures), barriers and consequences.



Nine authorized companies for industrial radiography in México were invited to participate in the technical meetings and an important group of operators attend the two meetings sharing experiences.

STEP 4: LAST MEETING IN MADRID (NEXT APRIL) to discuss and prepare the final document.

EVALUATION OF EVENTS (INICIATOR)

Catálogo de sucesos iniciadores - 1 a 10 de 20

1 ▼ añadir nuevo

<< < > >>

Mostrar todo registros Limpiar filtro

No.	Código	Nombre	Frecuencia	Consecuencia	Práctica	Etapa	Subetapa	Orden ▲	Estatus	
			Ninguna ▼	Ninguna ▼	Radiografía Industrial móvil con fuentes de radiación X ▼	Ninguno ▼	Ninguno ▼		Ninguno ▼	Filtrar
1	AD-EH-CEFB	Se adquiere un equipo con...	FB	CM	Radiografía Industri...	ADQUISICION	Ninguna	1	Activo	editar borrar ByR
2	AL-EH-SERXA	Sustracción del equipo de...	FB	CMA	Radiografía Industri...	ALMACEN EN SEDE CENT..	Ninguna	1	Activo	editar borrar ByR
3	TR-FMF	Falla de los medios de fi...	FMB	CMA	Radiografía Industri...	TRANSPORTE	Ninguna	1	Activo	editar borrar ByR
4	PT-NETAC	No se realiza evaluación ...	FM	CM	Radiografía Industri...	PRETRABAJO	Ninguna	1	Activo	editar borrar ByR
5	OP-EH-ECCC	Error al conectar la cons...	FB	CM	Radiografía Industri...	OPERACIÓN - IRRADIAC...	Ninguna	1	Activo	editar borrar ByR
6	AL-EH-CC	Caída del equipo dañandos...	FMB	CM	Radiografía Industri...	ALMACEN EN SEDE CENT..	Ninguna	2	Activo	editar borrar ByR
7	TR-EH-EF	Error de fijación del equ...	FB	CMA	Radiografía Industri...	TRANSPORTE	Ninguna	2	Activo	editar borrar ByR
8	PT-EDAC	Error al definir el área ...	FM	CM	Radiografía Industri...	PRETRABAJO	Ninguna	2	Activo	editar borrar ByR
9	OP-FTPC	Fallo del temporizador de...	FMB	CA	Radiografía Industri...	OPERACIÓN - IRRADIAC...	Ninguna	2	Activo	editar borrar ByR
10	TR-EH-SET	Robo del equipo durante e...	FB	CMA	Radiografía Industri...	TRANSPORTE	Ninguna	3	Activo	editar borrar ByR

SCREEN OF SEVRRRA SOFTWARE



Práctica=> Radiografía industrial móvil con fuentes de radiación gamma

- Etapa 1: ADQUISICIÓN
- Etapa 2: ALMACENAMIENTO
- Etapa 3: ALMACENTEMPORAL
- Etapa 4: TRANSPORTE
- Etapa 5: PRETRABAJO
- Etapa 6: OPERACIÓN
- Etapa 7: MANTENIMIENTO

Resumen de la Práctica (Sucesos Iniciadores)

Núm.	Etapa	Riesgo Muy Alto (RMA)	Riesgo Alto (RA)	Riesgo Medio (RM)	Riesgo Bajo (RB)	No Aplica (NA)	Registrados	Total por Etapa	Completo
1	ADQUISICIÓN	0	0	0	0	0	0	8	✗
2	ALMACENAMIENTO	0	0	0	0	0	0	12	✗
3	ALMACENTEMPORAL	0	0	0	0	0	0	6	✗
4	TRANSPORTE	0	0	0	0	0	0	12	✗
5	PRETRABAJO	0	0	0	0	0	0	8	✗
6	OPERACIÓN	0	0	0	0	0	0	25	✗
7	MANTENIMIENTO	0	0	0	0	0	0	4	✗
Total		0	0	0	0	0	0	75	0

nismos nucleares



1	ADQUISICIÓN	0	2	5	1	0	8	8	✓
2	ALMACENAMIENTO	0	6	6	0	0	12	12	✓
3	ALMACENTEMPORAL	0	0	0	0	0	0	6	✗
4	TRANSPORTE	0	0	0	0	0	0	12	✗
5	PRETRABAJO	0	0	0	0	0	0	8	✗
6	OPERACIÓN	0	0	0	0	0	0	25	✗
7	MANTENIMIENTO	0	0	0	0	0	0	4	✗
Total		0	8	11	1	0	20	75	2

FINAL SEVRRRA REPORT



SEVRRRA

Foro Iberoamericano de Organismos
Reguladores Radiológicos y Nucleares

SEVRRRA
3.0
DRAFT

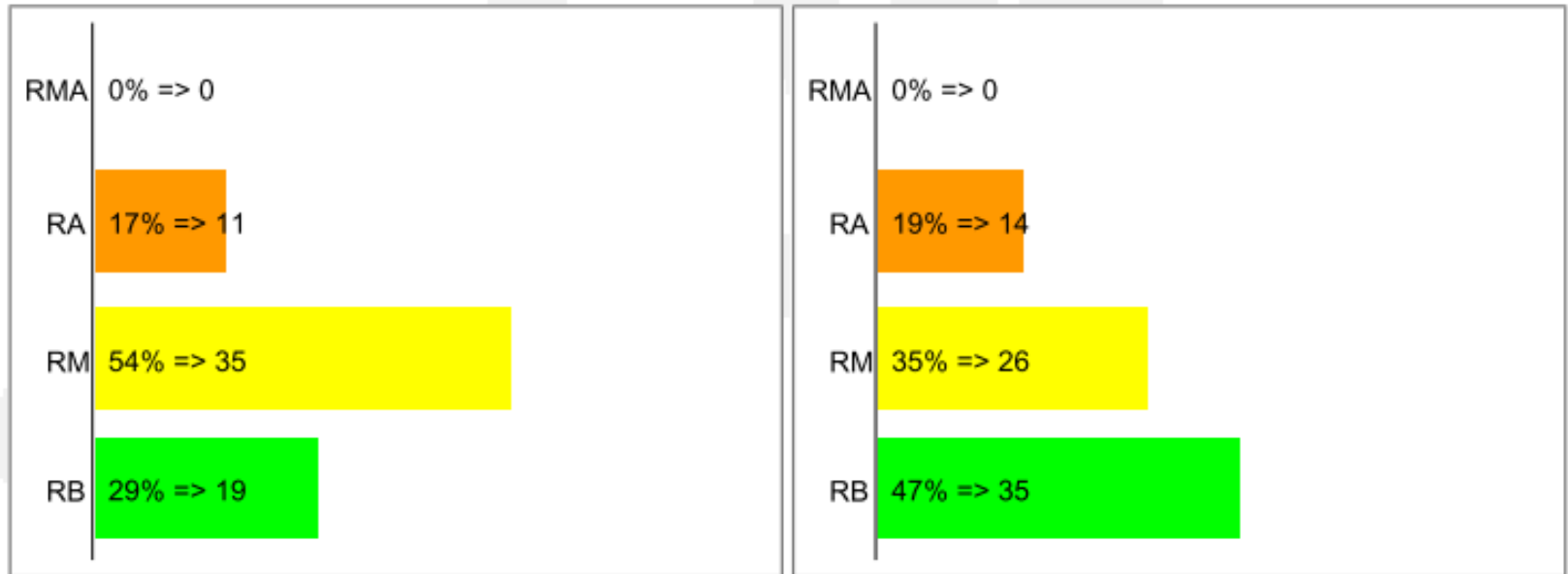


Núm.	Etapa	Riesgo Muy Alto (RMA)	Riesgo Alto (RA)	Riesgo Medio (RM)	Riesgo Bajo (RB)	No Aplica (NA)	Analizados	Total por Etapa	Completo
1	ADQUISICIÓN	0	0	5	3	0	8	8	✓
2	ALMACENAMIENTO	0	3	6	3	0	12	12	✓
3	ALMACENTEMPORAL	0	0	0	0	6	6	6	✓
4	TRANSPORTE	0	5	5	1	1	12	12	✓
5	PRETRABAJO	0	0	6	2	0	8	8	✓
6	OPERACIÓN	0	3	13	9	0	25	25	✓
7	MANTENIMIENTO	0	0	0	1	3	4	4	✓
Total		0	11	35	19	10	75	75	7

FINAL SEVRRRA REPORT

Actual

Referencia



FINAL SEVRRRA REPORT

Sucesos Iniciaores con riesgo Alto y Muy Alto

En base a la información que hemos vertido, los siguientes sucesos iniciadores los obtuvimos con Riesgo Alto y Muy Alto:

Código SI	Suceso Iniciador	Riesgo de Referencia	Riesgo Obtenido	Barreras y Reductores Faltantes
AL-DXF-AMR	Incendio en el almacén	RM	RA	B-44, RF-42,
AL-DXE-AMR	Explosión en el almacén que daña el equipo	RA	RA	RF-45,
AL-DXEXT-AMR	Eventos naturales que afecten la instalación con la consecuente pérdida de control de la fuente y equipos.	RA	RA	Ninguna
TR-HUR-VET	Hurto del vehículo que ocasiona que la fuente caiga en el dominio público	RA	RA	RF-96, RF-97, RF-104, RC-33,
TR-ROB-VET	Robo con violencia del vehículo que ocasiona que la fuente caiga en el dominio público	RA	RA	RF-96, RF-97, RF-104, RC-33, RC-63,
TR-ROB-CONT	Robo con violencias del equipo (proyector) que ocasiona que caiga en el dominio público	RA	RA	RF-96, RF-97, RF-104, RC-33,
TR-TRA-VTP	Accidente en un transporte no autorizado que ocasiona que el equipo (proyector) caiga en el dominio público	RA	RA	RC-33,
TR-HUR-VTP	Hurto del equipo (proyector) durante el traslado en transporte no autorizado que ocasiona que caiga en el dominio público	RA	RA	RC-33,
OP-HUR-CONT	Intento de hurto del equipo (proyector) durante los trabajos	RA	RA	RF-107, RF-142, RC-33,
OP-ROB-CONT	Robo con violencia del equipo (proyector) durante los trabajos	RA	RA	RC-33,
OP-HMDS-PE	Errores durante la ejecución del plan de emergencia que afecta la efectividad de las respuestas planificadas	RA	RA	RF-136,

CONCLUSIONS

- **Methodology of Risk Matrix and SEVRRRA software can detect deviations, failures and errors during the practice.**
- **This situation gives the opportunity to correct and solve situations which can lead into radiological consequences.**
- **SEVRRRA software is friendly and easy to apply.**
- **No special or specific knowledge on the risk matrix methodology is necessary for radiographers.**
- **The risk evaluation is a good tool to reduce the rate of incidents / accidents, and to avoid unjustified radiation exposure of workers and the public.**
- **The project provides a methodology and an innovative tool to reduce the radiological risk.**
- *More details and final results of the project coming soon...!!!.*

CONCLUSIONS

- ✓ It is necessary to strengthen radiation safety measures.
- ✓ We need to reduce the probability of occurrence of radiological events.
- ✓ One only commitment. One only philosophy.



Thank you