SOURCE TERM REDUCTION IN COFRENTES N.P.P

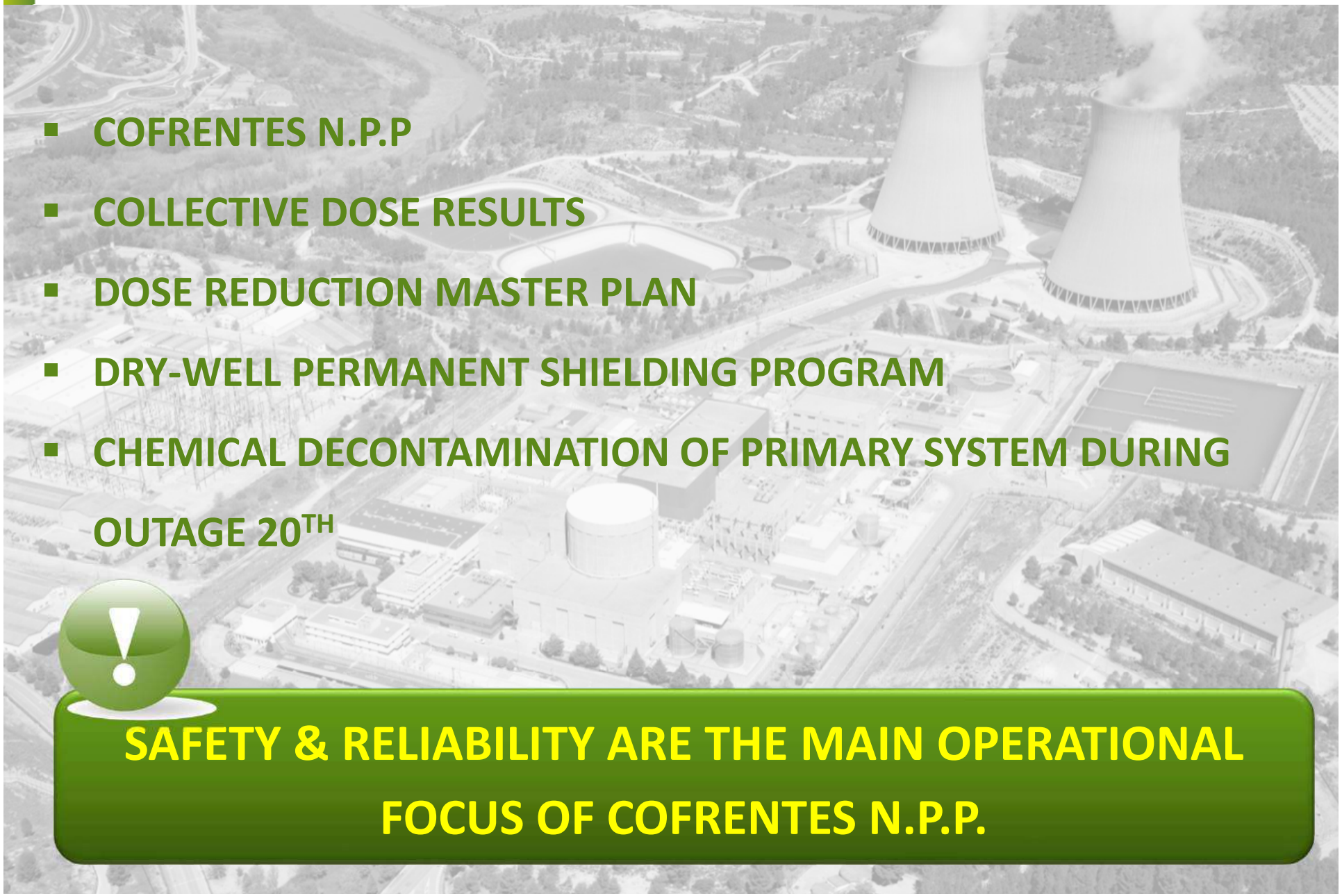
DRY-WELL PERMANENT SHIELDING PROGRAM & CHEMICAL DECONTAMINATION OF PRIMARY SYSTEMS

2nd IRPA workshop on reasonableness in the implementation of the ALARA principle

23-24 October, 2018

Paris - FRANCE

Eduardo Sollet – Former Cofrentes R.P.M.



- COFRENTES N.P.P
- COLLECTIVE DOSE RESULTS
- DOSE REDUCTION MASTER PLAN
- DRY-WELL PERMANENT SHIELDING PROGRAM
- CHEMICAL DECONTAMINATION OF PRIMARY SYSTEM DURING OUTAGE 20TH

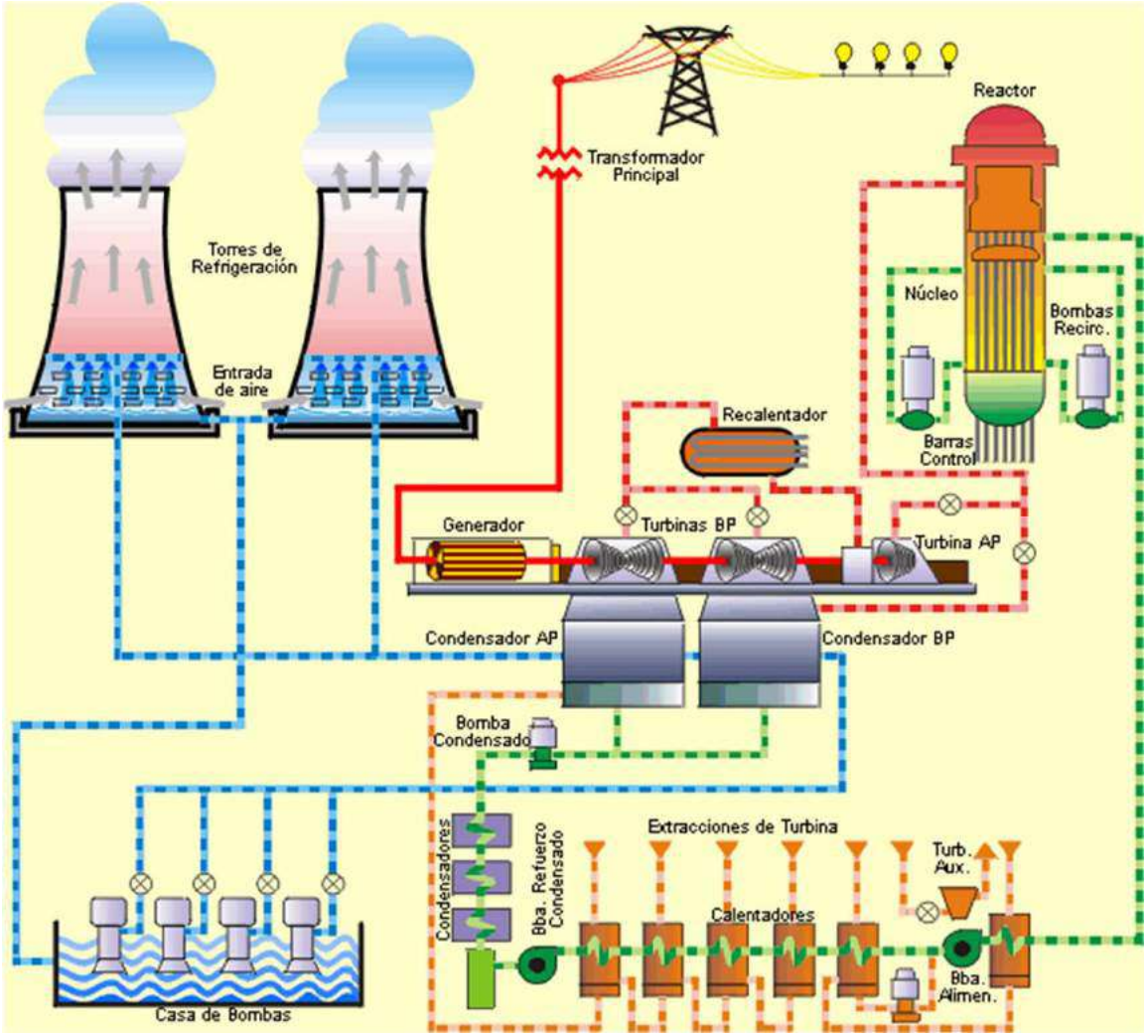
SAFETY & RELIABILITY ARE THE MAIN OPERATIONAL FOCUS OF COFRENTES N.P.P.

SOURCE TERM REDUCTION IN COFRENTES N.P.P.

DRY-WELL PERMANENT SHIELDING & CHEMICAL DECONTAMINATION OF THE PRIMARY SYSTEM

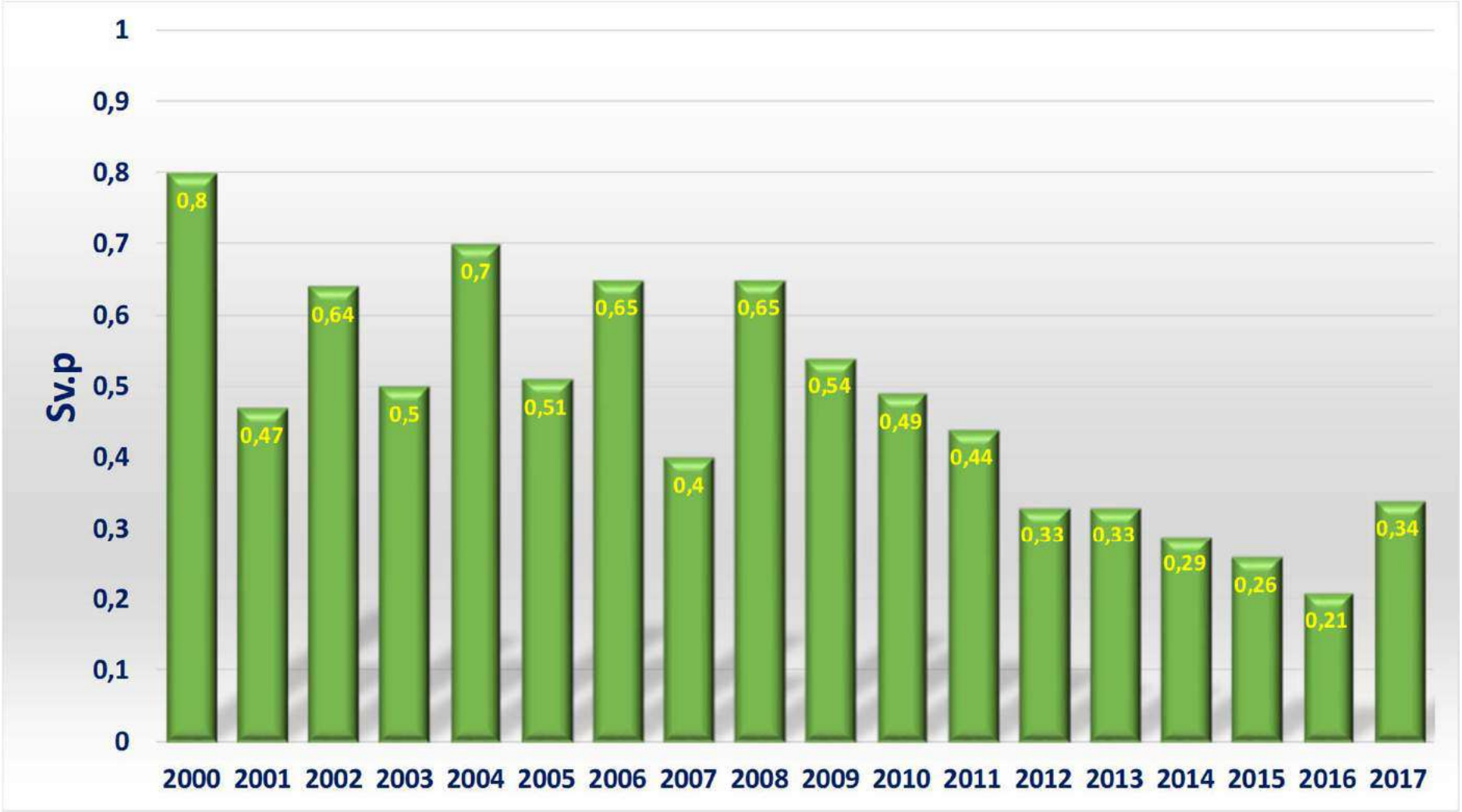
SEPR
SOCIEDAD ESPAÑOLA DE PROTECCIÓN RADIOLÓGICA

OPERATING SCHEME OF COFRENTES NPP

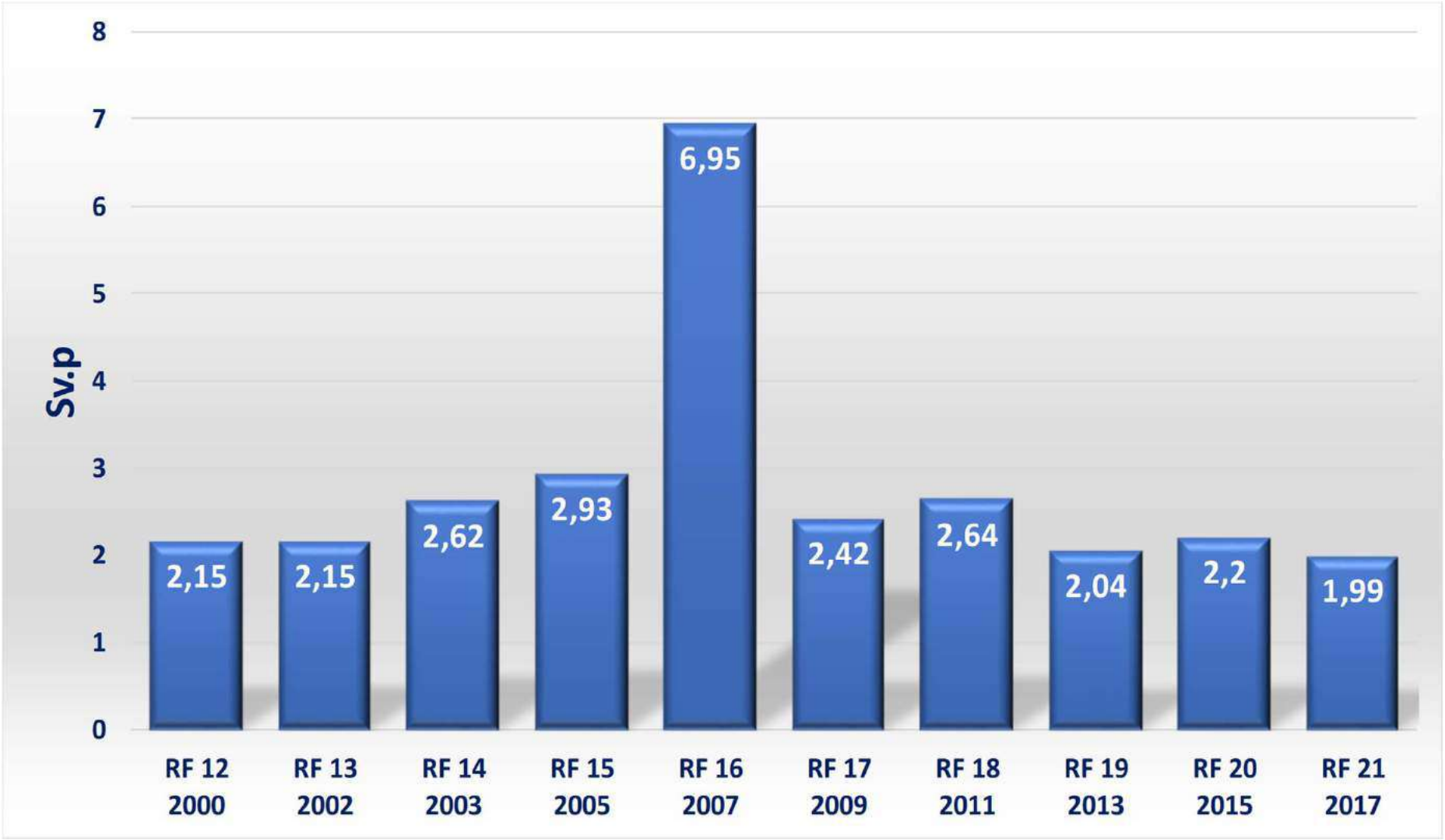


COLLECTIVE DOSE RESULTS

COLLECTIVE DOSE IN NORMAL OPERATION

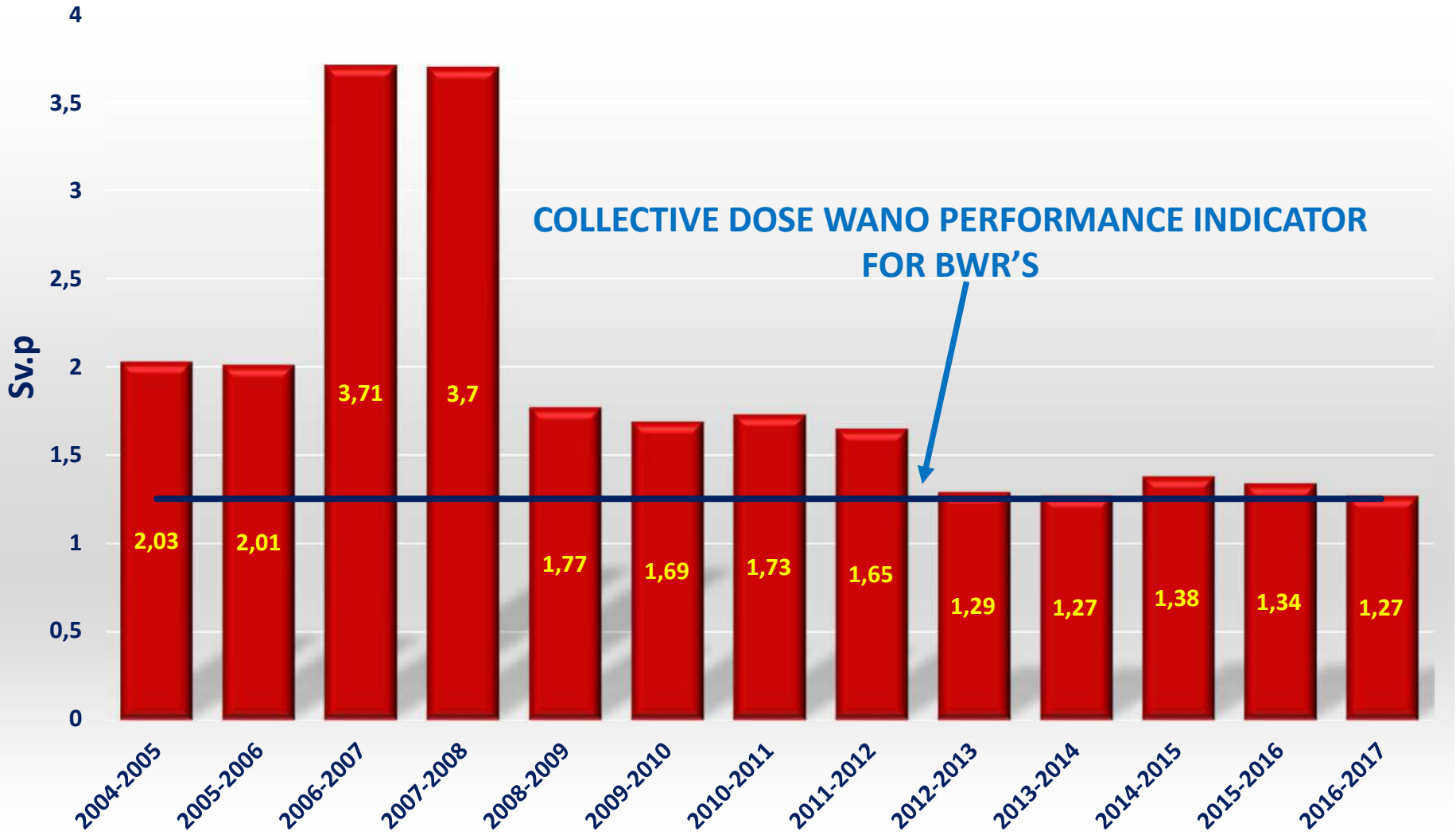


COLLECTIVE DOSE IN OUTAGES



COLLECTIVE DOSE (2 years rolling avg.)

COLLECTIVE DOSE (2 years rolling avg.)



DOSE REDUCTION MASTER PLAN

CORNERSTONES OF THE DOSE REDUCTION MASTER PLAN

1 **OC** — ORGANIZATION COMMITMENT
Actions whose primary Goal is to commit all the Organization with the Dose Reduction

2 **WM** — WORK MANAGEMENT
Actions directed to do the works successfully avoiding rework and applying ALARA considerations extensively

3 **ST** — SOURCE TERM
Actions directed to reduce the source term as the key element to reduce the exposure of workers

4 **PT** — PLANT TOOLS
Actions directed to reduce the exposure time of workers and to improve the training in radiological protection including ALARA techniques

5 **PI** — PLANT IMPROVEMENTS
Actions associated to plant design changes to include ALARA considerations since the first phases of the plant modifications

CORNERSTONES OF THE DOSE REDUCTION MASTER PLAN

OC ORGANIZATION COMMITMENT	WM WORK MANAGEMENT	SC SOURCE TERM	PT PLANT TOOLS	PI PLANT IMPROVEMENTS
CO-CA ALARA Culture	GT-PT Work Planning	ST-ECI Equipment & Component Improvements	H-RM Remote Monitoring	MP-CD Design Modifications
CO-R Resources	GT-ETLA Work Completion and Lessond Learned	ST-CM Control & Monitoring	H-F Training	MP-C Plant Housekeeping
		ST-AR Activity Reduction		
		ST-SH Shielding		

5
CORNERSTONES

12
LINES OF ACTIONS

DOSE REDUCTION MASTER PLAN
ACTION PLAN ON A YEARLY BASIS

PLAN DE ACCIÓN 2014 - PLAN DIRECTOR DE REDUCCIÓN DE DOSIS REVISIÓN 9

COMPROMISO DE LA ORGANIZACIÓN		GESTIÓN DE TRABAJOS		TÉRMINO FUENTE				HERRAMIENTAS		MEJORAS DE PLANTA	
CULTURA ALARA	RECURSOS	PLANIFICACIÓN DE TRABAJOS	EJECUCIÓN DE TRABAJOS Y LECCIONES APRENDIDAS	MEJORAS EN EQUIPOS Y COMPONENTES	CONTROL Y SEGUIMIENTO	REDUCCIÓN DE ACTIVIDAD	BLINDAJES	MONITORIZACIÓN REMOTA	FORMACIÓN	CAMBIOS DE DISEÑO	CONSERVACIÓN
CO-CA-01 CAMPAÑAS ARMONIZACIÓN PUNTOS DE TRÁNSITO	CO-R-01 INCORPORACIÓN PERSONAL ALARA EN TRABAJOS PREDEFINIDOS	GT-PT-01 PROCEDIMIENTO CONTROL DOSIS INDIVIDUALES	GT-ETLA-01 SECUENCIA DESCONTAMINACIÓN CAVIDAD	TF-MEC-01 DESMINERALI-ZADORES SUMERGIBLES EN CAVIDAD	TF-CS-01 PARÁMETROS INFLUYENTES EN EL TÉRMINO FUENTE	TF-RA-01 VIABILIDAD DESCONTAMINA-CIÓN QUÍMICA	TF-B-01 INSTALACIÓN BLINDAJES PERMANENTES RECARGA	H-MR-01 TELEDOSIMETRIA	H-F-01 REFUERZO FORMACIÓN CURSO ALARA Y CONTROL CONTAMINACIÓN	MP-CD-01 VALORACIÓN RELAJACIÓN ISI	MP-C-01 SUSTITUCIÓN DE ANDAMIOS TEMPORALES
CO-CA-02 CAMPAÑAS "CADA MICROSIEVERT CUENTA" Y CONTROL CONTAMINACIÓN		GT-PT-02 BAJADA TARADO DLD PARA COLECTIVOS CONCRETOS	GT-ETLA-02 LECCIONES APRENDIDAS POZO SECO RECARGA 19	TF-MEC-02 GESTIÓN DE REPUESTOS SIN COBALTO	TF-CS-02 PROGRAMA DE INYECCIÓN DE METALES NOBLES	TF-RA-02 SISTEMA FILTRADO DEMOS	TF-B-02 INSTALACIÓN BLINDAJES PERMANENTES OPERACIÓN NORMAL	H-MR-02 USO DE MAQUINARIA REMOTA	H-F-02 ENTRENAMIENTO EN MAQUETAS	MP-CD-02 CERTIFICACIÓN DE TAPONES DE RECIRCULACIÓN	MP-C-02 PROYECTO ADECUACIÓN DE CUBÍCULOS
CO-CA-03 HOMOGENEIZACIÓN FUNCIONES MPR Y PDRD		GT-PT-03 PLANES ALARA PARA CONTRATISTAS	GT-ETLA-03 REUNIONES ALARA Y CONTROL DE LA CONTAMINACIÓN POST-TRABAJO	TF-MEC-03 PROGRAMA DE DESCOBALTIZACIÓN	TF-CS-03 VIGILANCIAS RADIOLÓGICAS EN POZO SECO Y PLANTA RECARGA	TF-RA-03 DISPONIBILIDAD SISTEMA PURIFICACIÓN RWCU	TF-B-03 INSTLALACIÓN BLINDAJES TEMPORALES	H-MR-03 MODELIZACIÓN 3D DE LA PLANTA	H-F-03 FORMACIÓN ALARA PARA SUPERVISORES	MP-CD-03 PROCESO DE TENSIONADO DE PERNOS DE TAPA DE VASIJA	MP-C-03 IDENTIFICACIÓN DE TUBERÍAS CON FLUIDOS RADIACTIVOS
CO-CA-04 HACER PDRD COMO PROCEDIMIENTO GENERAL		GT-PT-04 MEJORA PROCEDIMIENTO PUNTOS DE TRÁNSITO		TF-MEC-04 PARTICIPACIÓN EN GRUPOS DE EPRI	TF-CS-04 FIABILIDAD DEL COMBUSTIBLE	TF-RA-04 ELIMINACIÓN DE PUNTOS CALIENTES	TF-B-04 PROCEDIMIENTO GENÉRICO BLINDAJES TEMPORALES	H-MR-04 CÁMARAS DE VISIÓN REMOTA		MP-CD-04 EQUIPOS MEDIDA CONTAMINACIÓN PERSONAL EN PLANTA	
		GT-PT-06 INCLUSIÓN NUEVOS SISTEMAS EN REGLA DE MANTENIMIENTO				TF-RA-05 VIGILANCIAS RADIOLÓGICAS TRAS TRASVASES DE AGUA G41				MP-CD-05 MEJORAS EN EL PROCESO DE RESIDUOS	
										MP-CD-06 MEJORAS INSTRU-MENTACIÓN TUBO TRANSFERENCIA	
										MP-CD-07 MEJORA DEL SISTEMA DE TRATAMIENTO DE CONDENSADO	



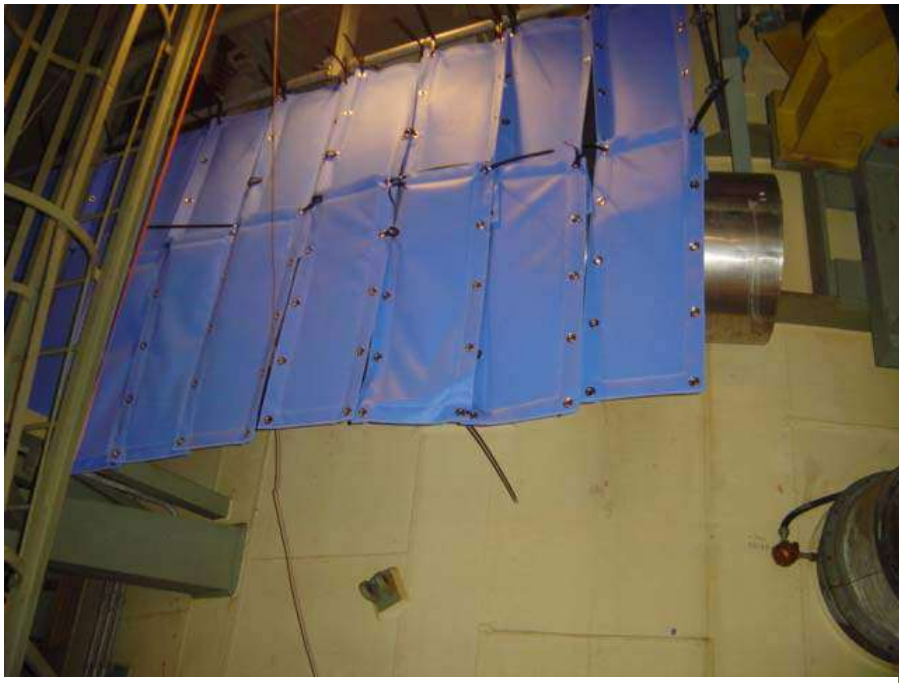

DRY-WELL PERMANENT SHIELDING PROGRAM

BACKGROUND INFORMATION

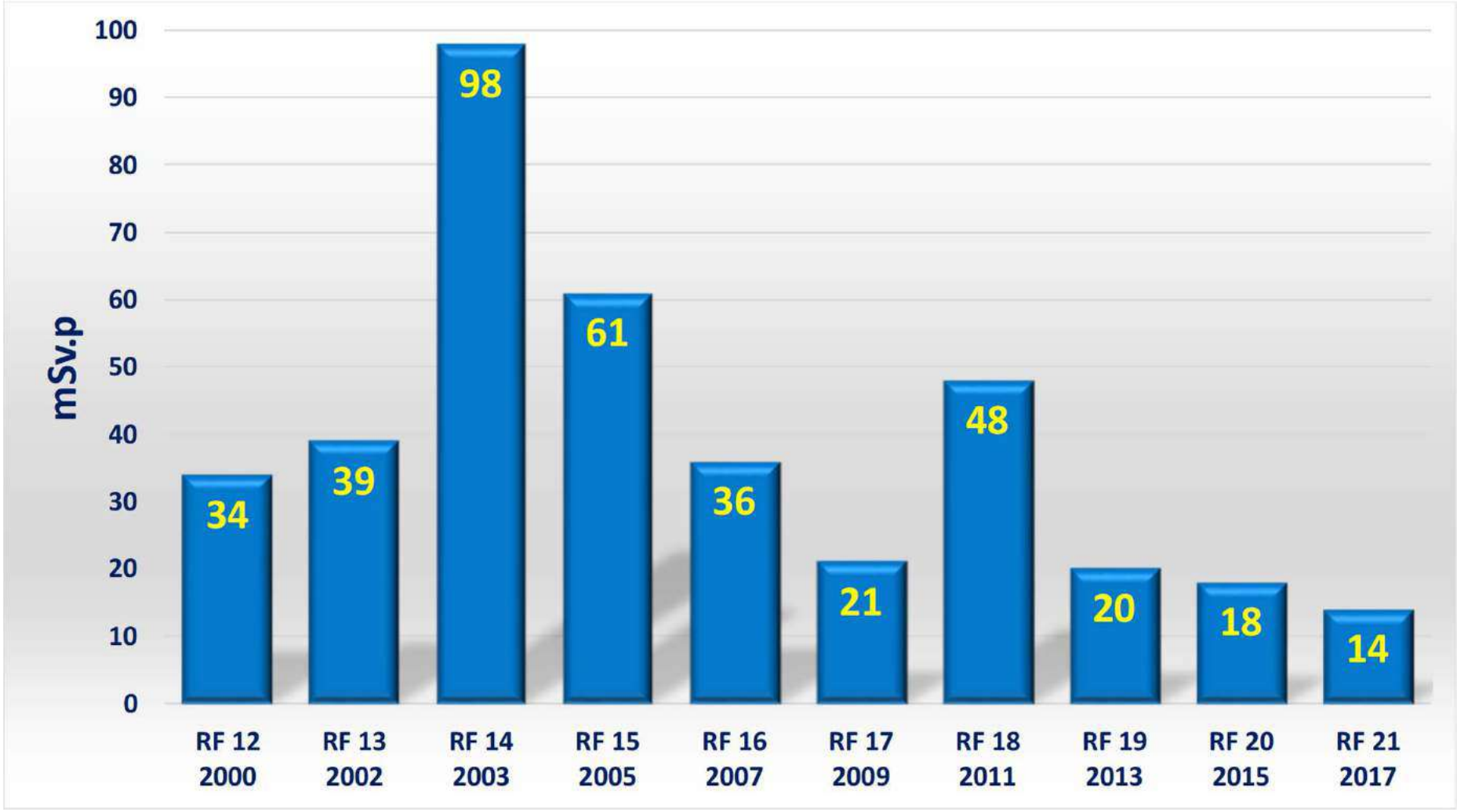
During refuel outages temporary shielding is installed to reduce dose and to enhance worker Radiological Safety inside the Dry-Well. Shielding is then removed at the end of the outage. The current temporary shielding tasks results in dose exposures to installing personnel which also significantly contribute to the total outage dose. To reduce exposure to personnel performing work inside the Dry-Well and those installing and removing temporary shielding, permanent shielding, in the form of suspended lead blankets, was first installed during RF16 (2007).

WHY PERMANENT SHIELDING

- To reduce doses arising from installing and removing temporary shielding (20 to 30 tons)
- To reduce occupational risks from handling heavy pieces (20 o more kg)
- To reduce risks of damaging plant components
- To reduce outage length (1 to 3 days saved)



COLLECTIVE DOSE USED IN TEMPORARY SHIELDING

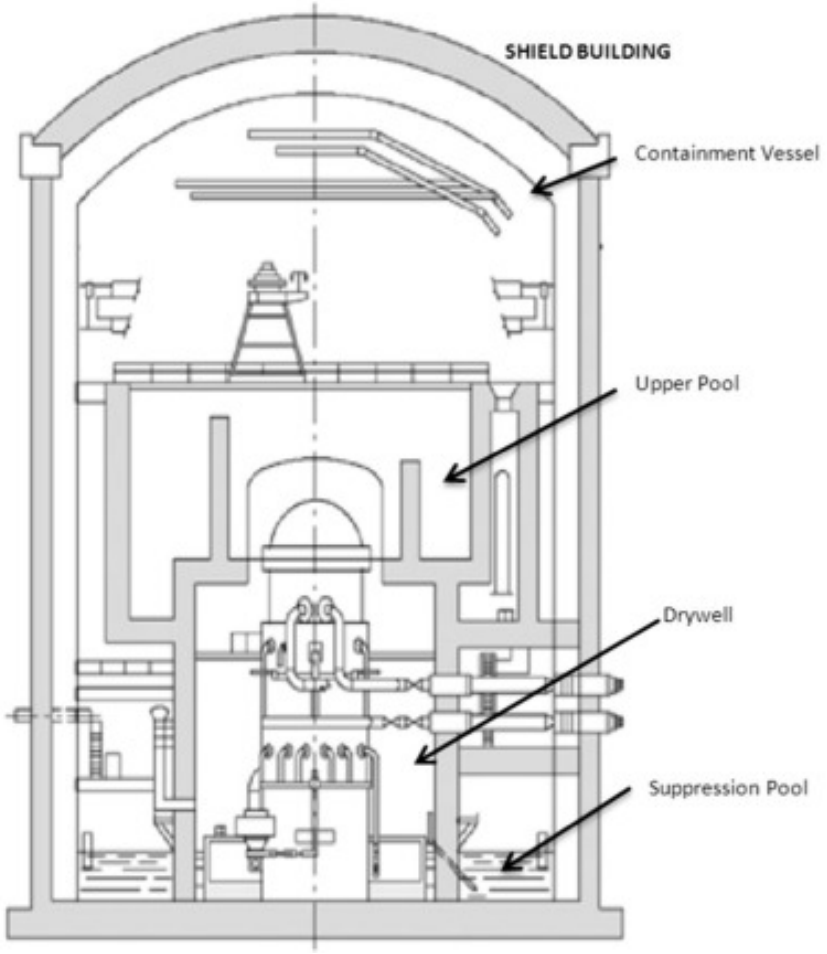


TEMPORARY SHIELDING

TEMPORARY SHIELDING

BACKGROUND INFORMATION

- Permanent shielding, in the form of suspended lead blankets was first installed during RF16 (2007)
- Installation continued in RF17 (2009), RF18 (2011) and RF20 (2015)
- Now more than 40 Tn of lead (more than 2000 blankets) are permanently installed in the Dry-Well

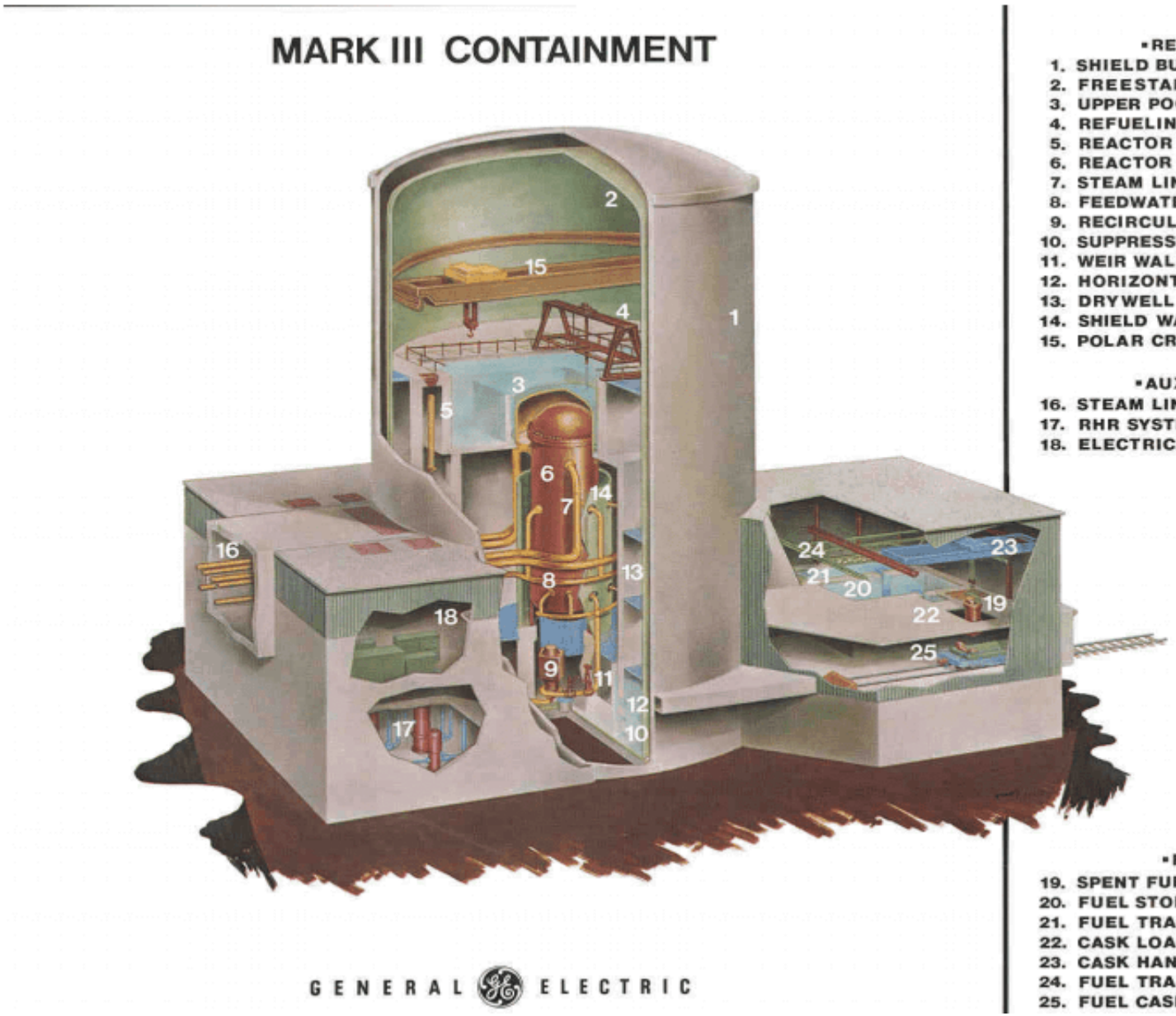


BACKGROUND INFORMATION

Approximately 65-75% of the outage dose is received in the Dry-Well, being the recirculation system (B33 loops) and the Clean-Up lines (G33) the highest dose contributors. At the beginning of the outage, a large quantity of temporary shielding is installed and removed at the end. For both the installation and removal, 3 to 5 days are dedicated. Note that about 20 or 30 tons of lead blankets of temporary shielding are installed with a important radiological cost, risks in occupational accidents by movement and placement of the lead and also risk of damage to structures, components and equipment of the plant.

SOURCE TERM REDUCTION IN COFRENTES N.P.P.

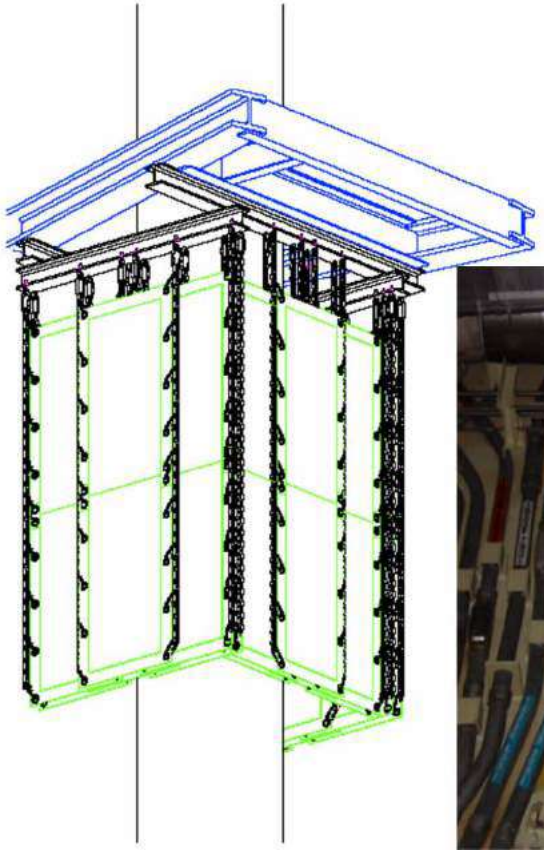
DRY-WELL PERMANENT SHIELDING & CHEMICAL DECONTAMINATION OF THE PRIMARY SYSTEM

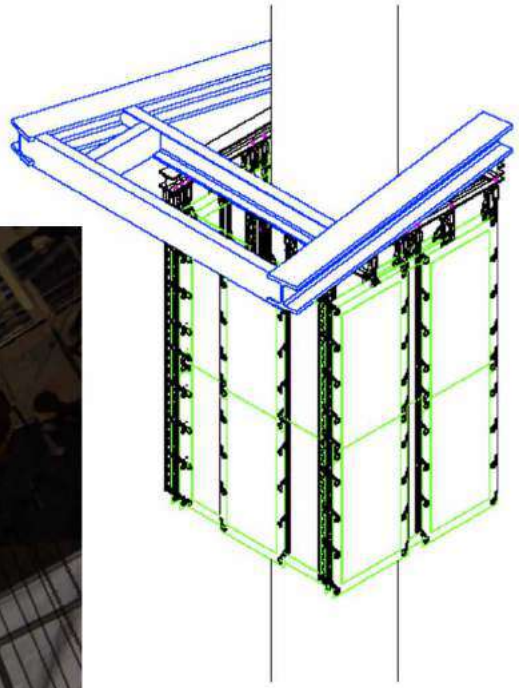


AREAS TO SHIELD

PERMANENT SHIELDING DESIGN

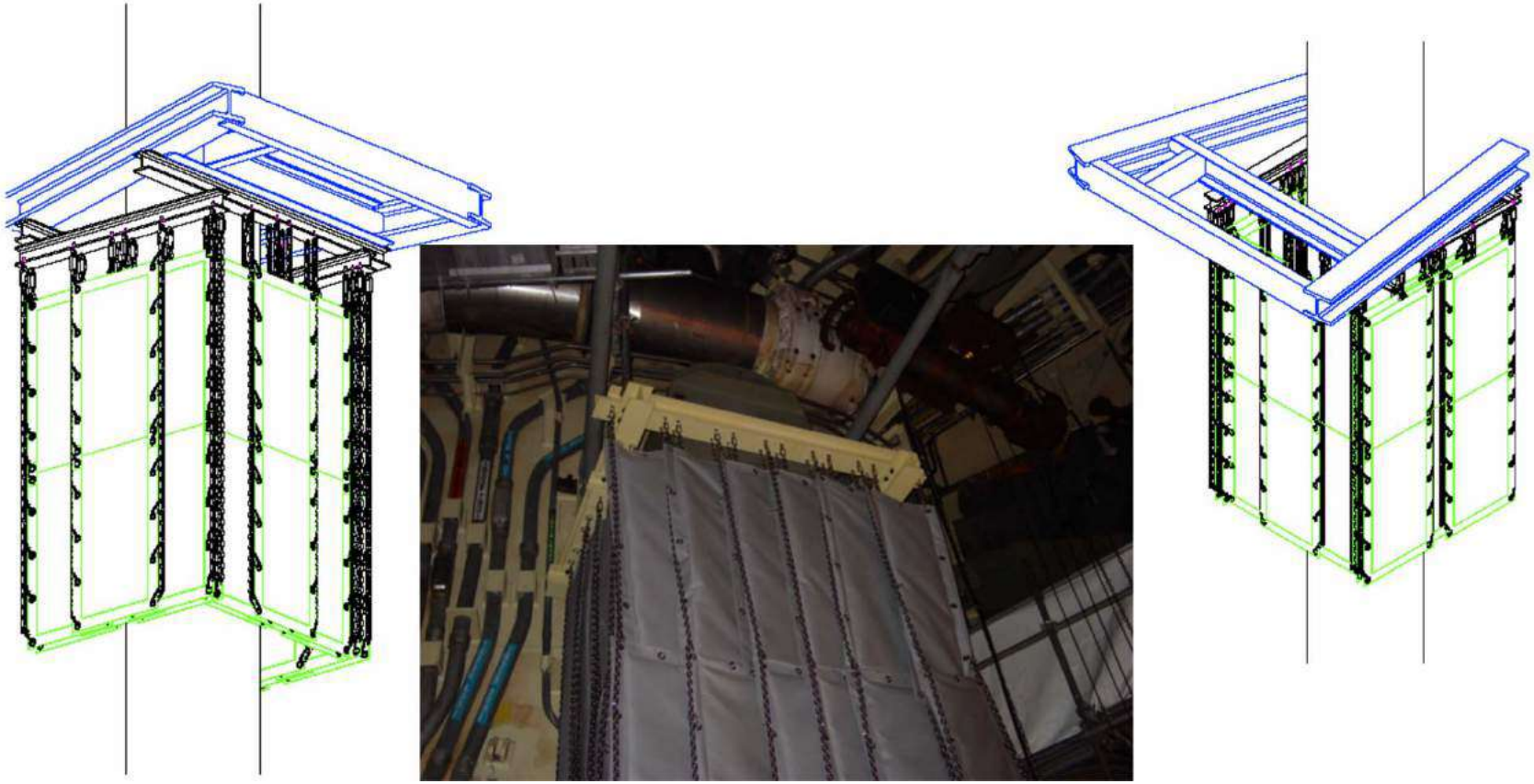
The lay-out of permanent shielding will be carried out through screens (shadow shield) formed by lead blankets attached to chains that hang from auxiliary structures tied in turn to existing structures in the Dry-Well. This provision aims to reduce inertial loads transmitted to the anchors and to facilitate the work of assembly and disassembly.





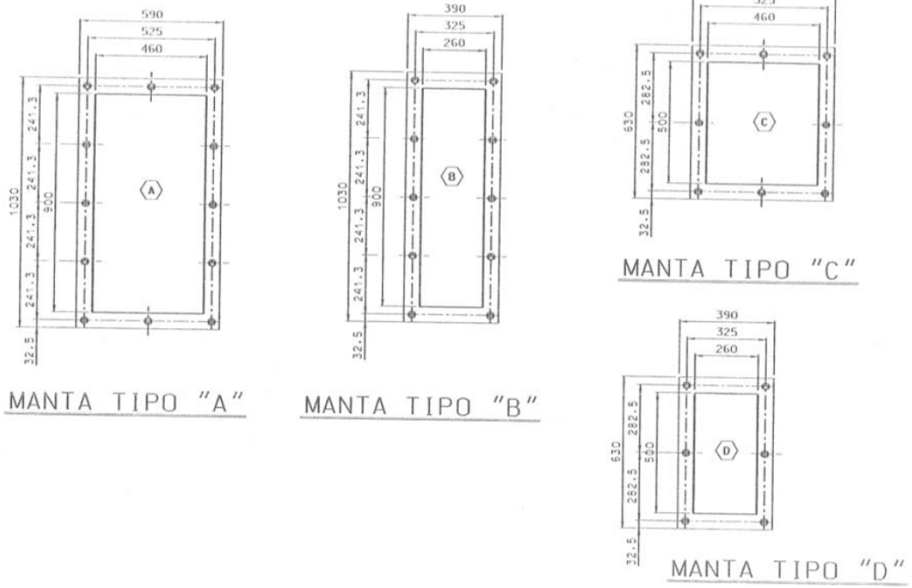
PERMANENT SHIELDING DESIGN

- **Lead blankets as shadow shield screens attached to chains that hang from auxiliary structures tied in turn to existing structures in the Dry-Well**



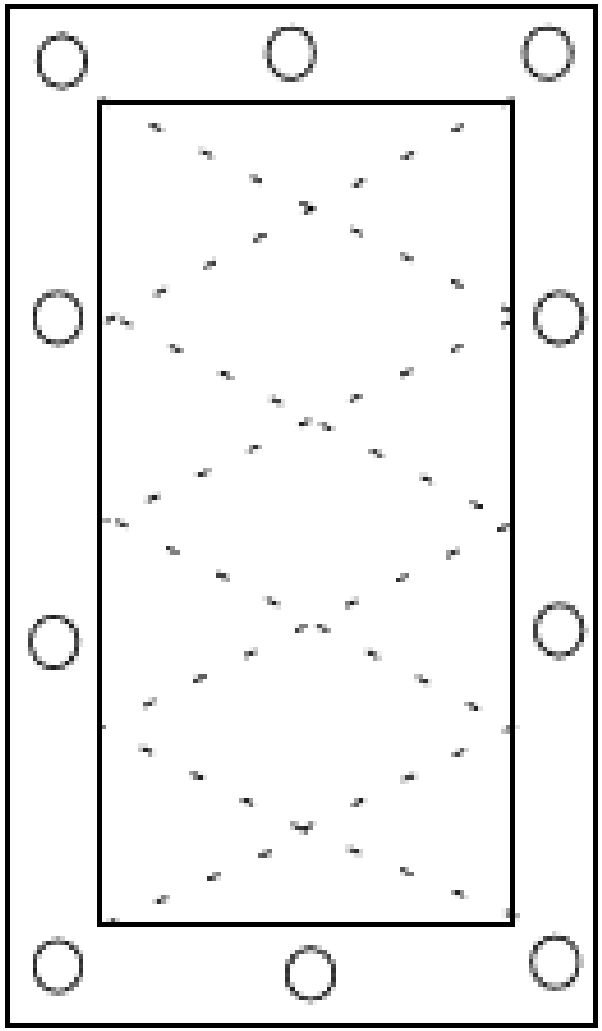
LEAD BLANKETS

Fabricated with lead wool, encased in a double layer of Alpha Meritex fiberglass fabric with no hydrogenated components, impregnated with a fire retardant silicone rubber material designed for use in high temperature (260 °C) nuclear applications. Four types of lead blankets of different sizes are used:



LEAD BLANKETS

To avoid the lead from flowing to the lower part of the blanket due to heat (high temperature), the lead wool is sewn with Kevlar thread forming a rhomboidal structure. All the sewings are also made with Kevlar threads



RADIOLOGICAL BENEFIT OF THE PERMANENT SHIELDING

DOSE RATE REDUCTION FACTOR

ÁREA	DESCRIPCIÓN DE LA ZONA DE INSTALACIÓN	CUBÍCULO	ELEV.	DOSE RATE (mSv/h)			Reduction Factor
				CONTACT TO PIPE	PRE-SHIELDING	POST-SHIELDING	
1	Línea de aspiración del Lazo A del B33	R.1.01	0,660	1,50	0,70	0,20	3,5
2	Línea de aspiración del Lazo B del B33	R.1.01	0,660	2,05	1,30	0,50	2,6
3A	Línea del E12 y válvula E12F010 (cota inferior)	R.1.01	0,660	1,90	0,90	0,25	3,6
3B	Línea del E12 y válvula E12F009 (cota superior)	R.1.01	0,660	2,6	1,3	0,65	2,0
4	Línea vertical del G33 hacia G33F001	R.1.01	0,660	0,5 (*1)	0,42	0,2	2,1
5	Línea de impulsión del Lazo A del B33	R.1.01	0,660	1,00	0,62	0,28	2,2
6	Línea de impulsión del Lazo B del B33	R.1.01	0,660	1,05	0,50	0,16	3,1
7	Colector y 2 raiser del Lazo B del B33	R.1.01	0,660	1,50	0,70	0,20	3,5
8	Línea aspiración Lazo A y válvula B33F023A	R.0.03	-3.600	1,55	0,85	0,30	2,8
9A	Bomba B33C001A: plataforma de trabajos	R.0.03	-1.600	1,50	0,50	0,25	2,0
9B	Bomba B33C001B: plataforma de trabajos	R.0.03	-1.600	2,05	0,60	0,25	2,4
10A	Línea del G33 hacia G33F102	R.0.03	-3.600	0,45 (*1)	0,60 (*2)	0,40 a 0,50	1,2
10B	Línea del G33 hacia G33F001	R.0.03	-3.600	0,5 (*1)	0,7 (*2)	0,50 a 0,60	1,2
		AVERAGE		1,28	0,65	0,25	2,48

NOTA:
(*1) Values after Clean-up Chem Decon made in RF17 (2009)
(*2) Values influenced by Clean-up pipe with contact dose rates greater tan 20 mSv/h and Recir. pipes without shielding

RADIOLOGICAL BENEFIT OF THE PERMANENT SHIELDING

PERMANENT SHIELDING INSTALLED IN THE DRY-WELL

ÁREA	DESCRIPCIÓN TUBERÍA	CUBÍCULO	ELEV.	EJECUCIÓN	OCP	LEAD BLANKETS INSTALLED					
						TIPO A (31 kg)	TIPO B (18 kg)	TIPO C (18 kg)	TIPO D (10 kg)	TOTAL MANTAS Pb	TOTAL kg Pb
1	Línea de aspiración del Lazo A del B33	R.1.01	0,660	R16 (2007)	4228	36	36	16	12	100	2172
2	Línea de aspiración del Lazo B del B33	R.1.01	0,660			52	8	8		68	1900
3A	Línea del E12 y válvula E12F010 (cota inferior)	R.1.01	0,660			56	12	10		78	2132
3B	Línea del E12 y válvula E12F009 (cota superior)	R.1.01	0,660	R17 (2009)	4336	56	12	10		78	2132
4	Línea vertical del G33 hacia G33F001	R.1.01	0,660			44	34	12	8	98	2272
5	Línea de impulsión del Lazo A del B33	R.1.01	0,660				92	34		126	2268
6	Línea de impulsión del Lazo B del B33	R.1.01	0,660				92	34		126	2268
7	Colector y 2 raiser del Lazo B del B33	R.1.01	0,660				54	24		78	1404
8	Línea aspiración Lazo A y válvula B33F023A	R.0.03	-3.600			16	86	4	10	116	2216
9A	Bomba B33C001A: plataforma de trabajos	R.0.03	-1.600				20	20	8	48	800
9B	Bomba B33C001B: plataforma de trabajos	R.0.03	-1.600				20	20	8	48	800
10A	Línea vertical del G33 desde G33FF110	R.0.03	-3.600				58			58	1044
10B	Línea vertical del G33 hacia G33F001	R.0.03	-3.600				32	8		40	720
			TOTAL			260	556	200	46	1062	22128

INSTALLATION OF 2 OVERLAPPING SHEETS OF LEAD BLANKETS, EACH ONE WITH A LEAD THICKNESS OF 6 mm, WITH A LEAD EQUIVALENT THICKNESS OF 12 mm

RADIOLOGICAL BENEFIT OF THE PERMANENT SHIELDING

COLLECTIVE DOSE SAVED IN RF17 FROM THE INSTALLATION OF PERMANENT SHIELDING

AREA	Collective Dose received in Dry-Well	Collective Dose received in 1/3 RFO	% (30%) of Collective Dose from Area Dose Rates	Increase Factor in Area Dose Rates if no Shielding were installed	Estimated Collective Dose from Area Dose Rate if no Shielding were installed	ESTIMATED COLLECTIVE DOSE SAVED
	(1)	(2) = (1)/3	(3) = 0,3*(2)	(4)	(5) = (4)*(3)	(6) = (5) – (3)
R101	645	215	64,5	2,8	180,6	116,1
R102	256	85	25,6	2,8	71,7	46,1
R003	253	84	25,3	1,9	48,1	22,8
R004	154	51	15,4	1,9	29,3	13,8
R302	102	34	N/A	5% of Collective Dose	35,7	1,7
R406	6	2	N/A	5% of Collective Dose	2,1	0,1
TOTAL	1416	472			367,4	201

PERMANENT SHIELDINGS

TEMPORARY

PERMANENT

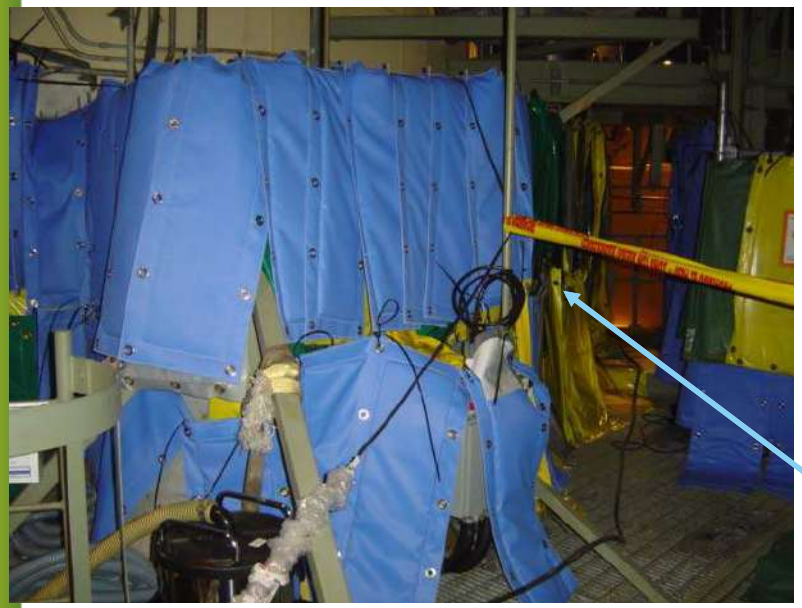
Measurement Point

AREA DOSE RATES			
CONTACT ON PIPE	PRE-SHIELDING	POST-SHIELDING	REDUCTION FACTOR
1,5	0,7	0,2	3,5

TEMPORARY

PERMANENT SHIELDINGS

PERMANENT



Measurement Point

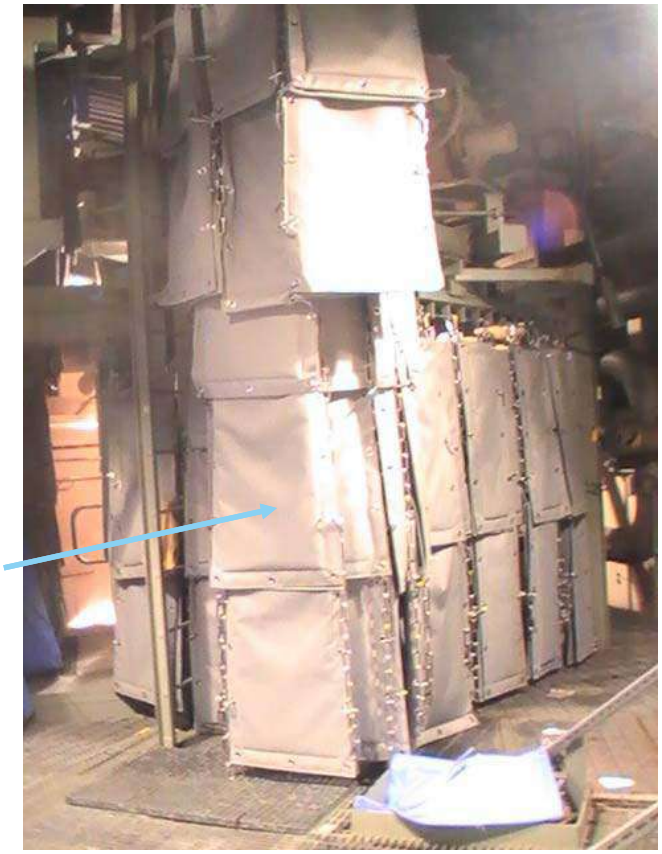
AREA DOSE RATES			
CONTACT ON PIPE	PRE-SHIELDING	POST-SHIELDING	REDUCTION FACTOR
2,05	1,3	0,5	2,6

PERMANENT SHIELDINGS

TEMPORARY

Measurement Point

PERMANENT

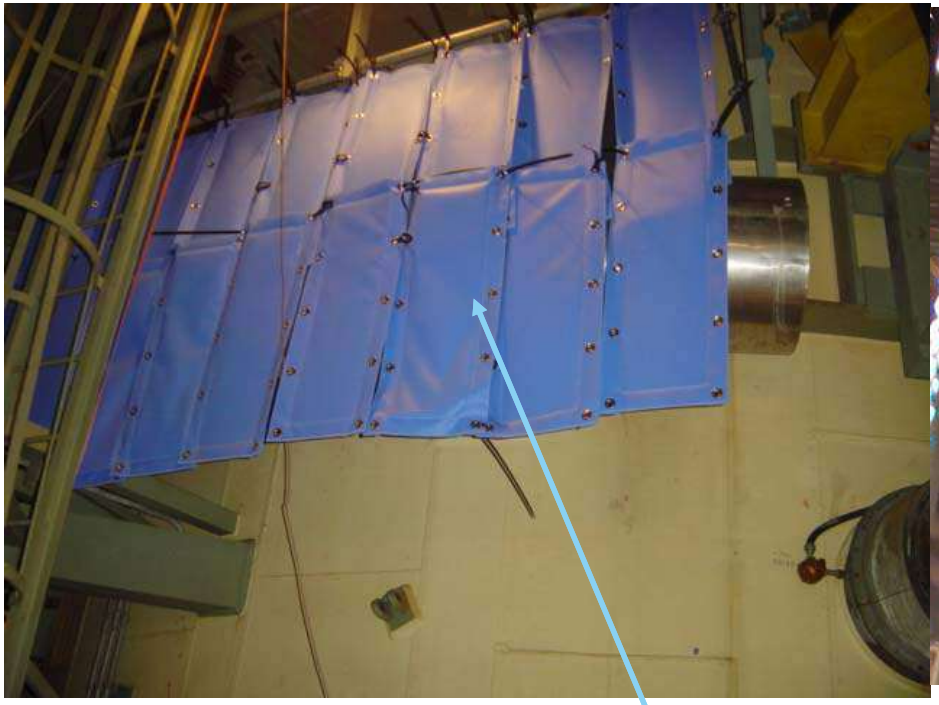


AREA DOSE RATES			
CONTACT ON PIPE	PRE-SHIELDING	POST-SHIELDING	REDUCTION FACTOR
0,5 (After Chem Decon)	0,42	0,2	2,1

PERMANENT SHIELDINGS

TEMPORARY

PERMANENT



Measurement Point

AREA DOSE RATES			
CONTACT ON PIPE	PRE-SHIELDING	POST-SHIELDING	REDUCTION FACTOR
1,5	0,7	0,2	3,5

PERMANENT SHIELDINGS

TEMPORARY

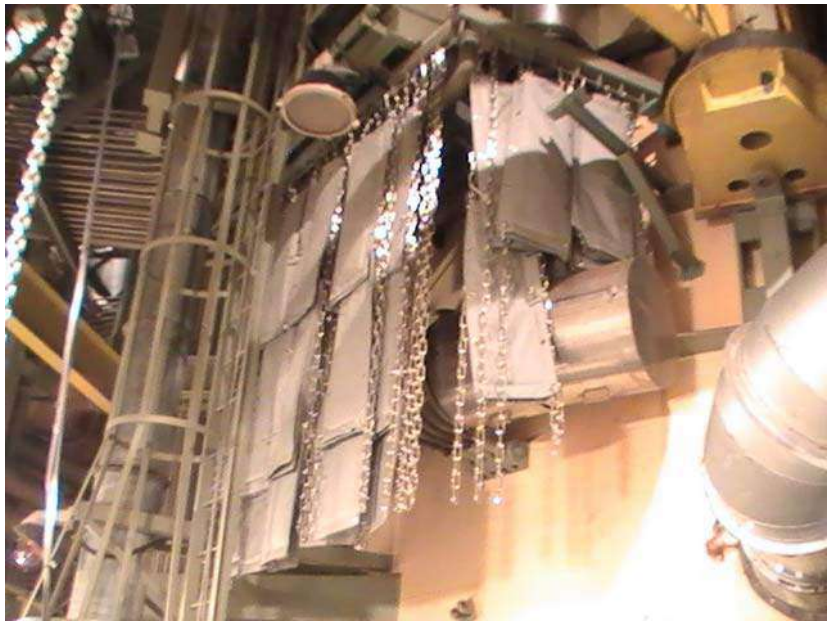
PERMANENT

Measurement Point

AREA DOSE RATES			
CONTACT ON PIPE	PRE-SHIELDING	POST-SHIELDING	REDUCTION FACTOR
1,55	0,85	0,3	2,8

PERMANENT SHIELDINGS

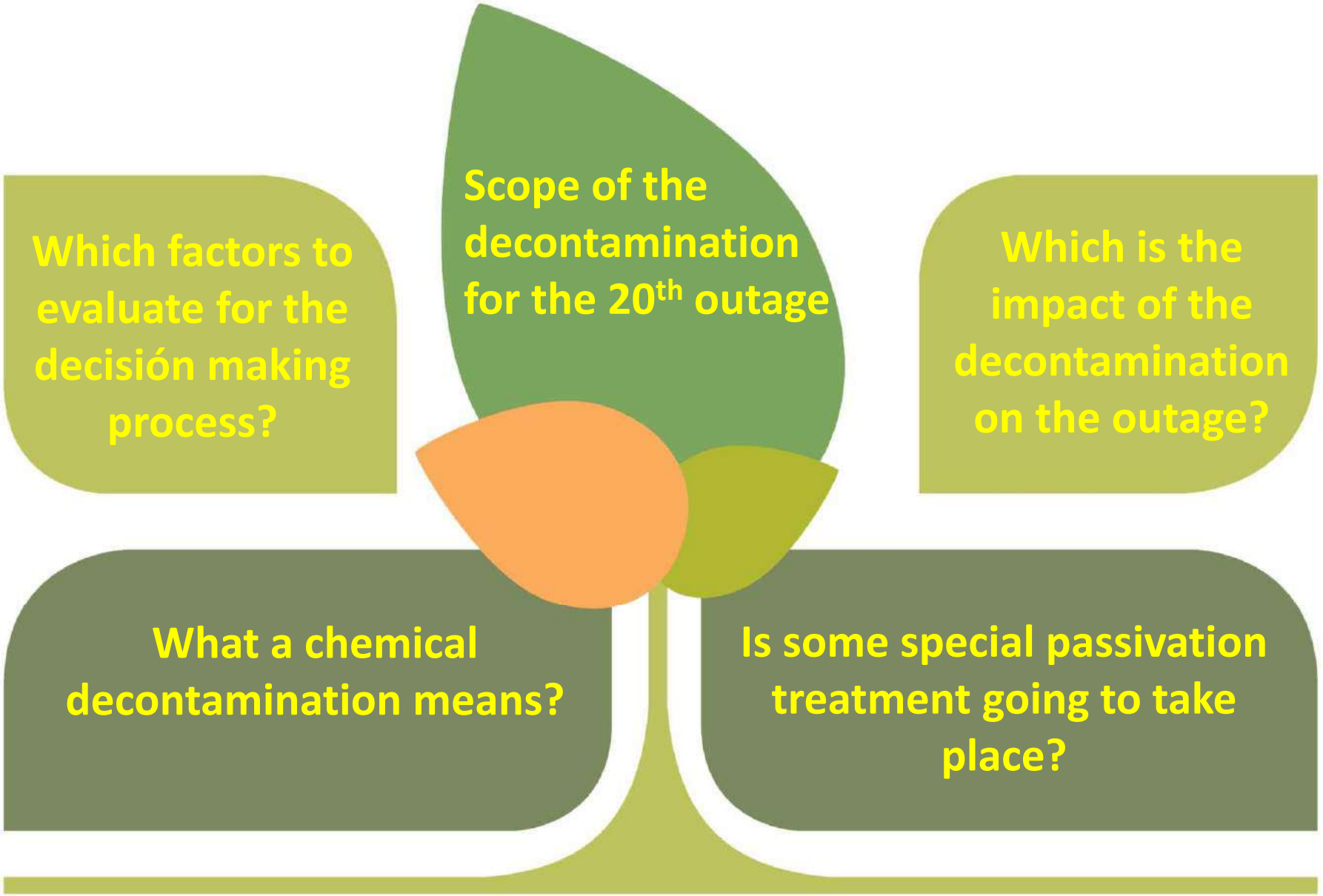
PERMANENT SHIELDINGS



PERMANENT SHIELDINGS

PERMANENT SHIELDINGS

CHEMICAL DECONTAMINATION OF PRIMARY SYSTEM DURING OUTAGE 20TH

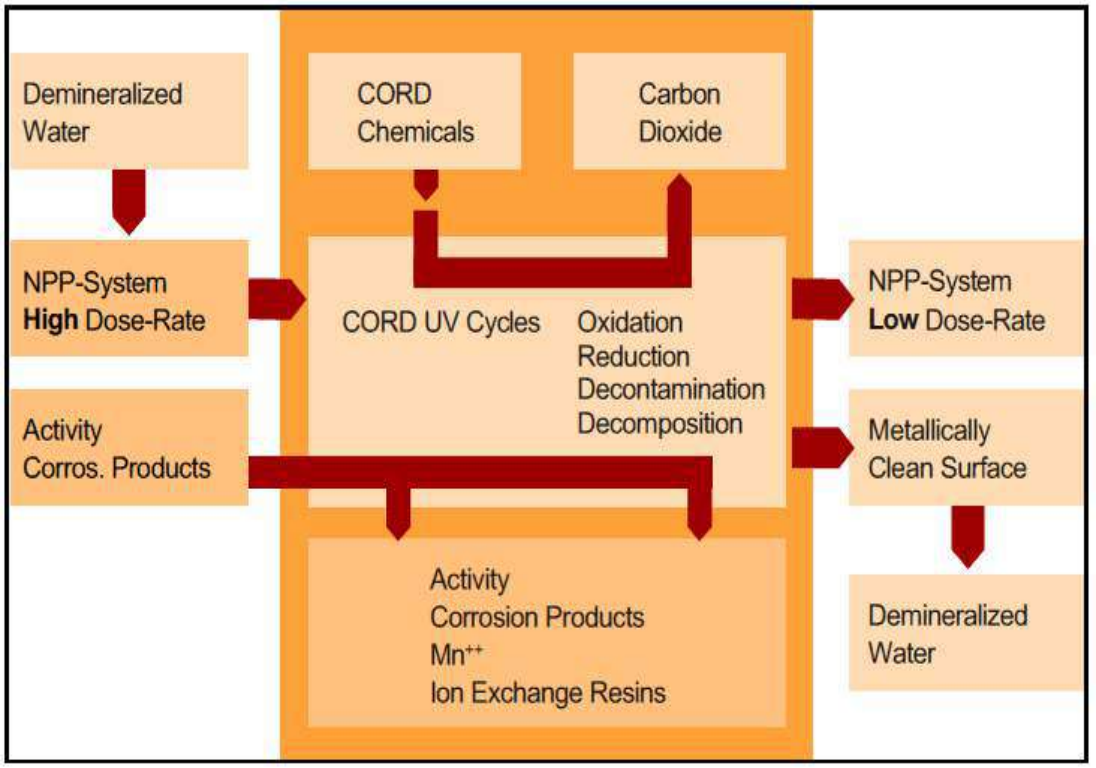

Scope of the decontamination for the 20th outage
Which factors to evaluate for the decisión making process?
Which is the impact of the decontamination on the outage?
What a chemical decontamination means?
Is some special passivation treatment going to take place?

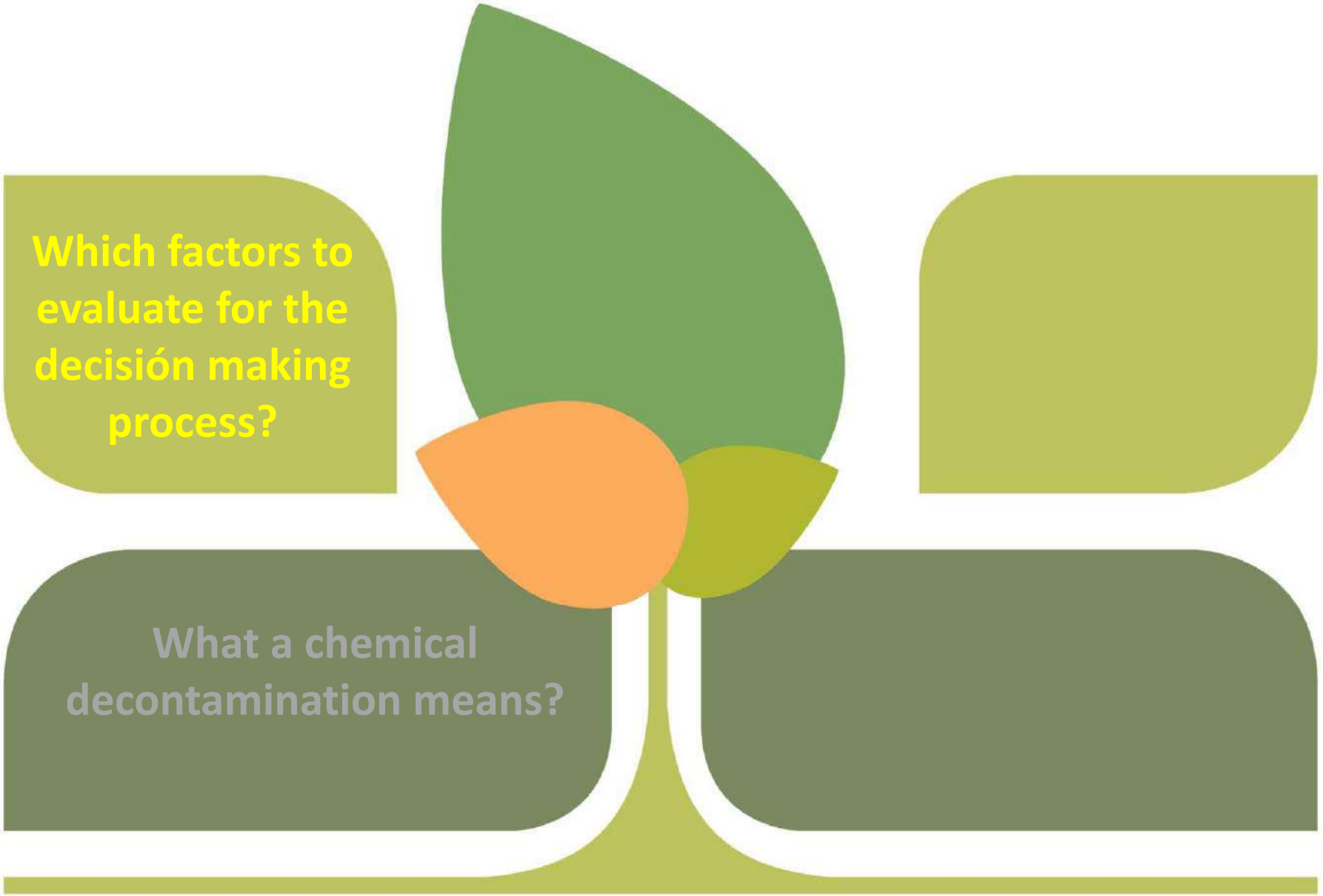
What a chemical decontamination means?

Physico-chemical process aims to remove the residual activity deposited on the inner pipe surfaces and other components in close contact with radioactive fluids, improving the radiological conditions of the decontaminated area.

The chemical process chosen is the CORD-UV and is characterized by these FOUR steps

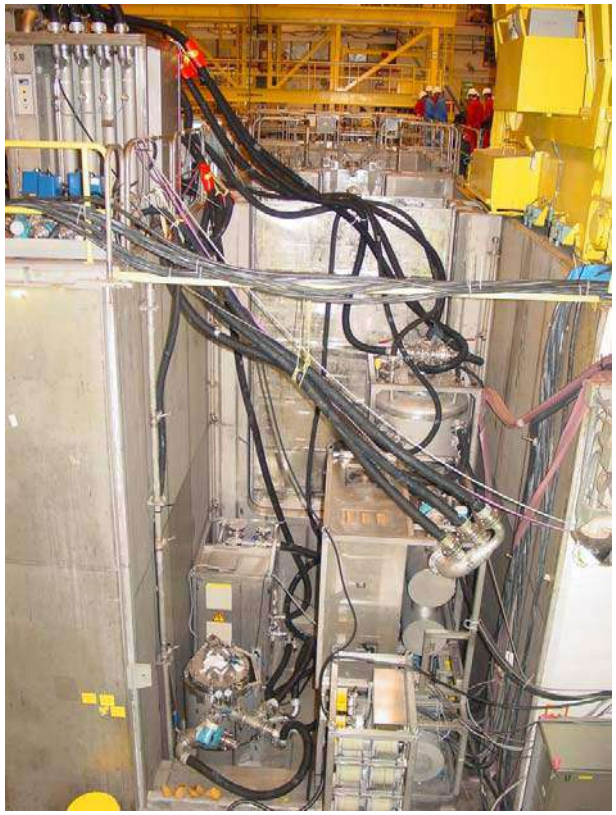
1. PRE-OXIDATION
2. REDUCTION
3. DECOMPOSITION
4. CLEANING

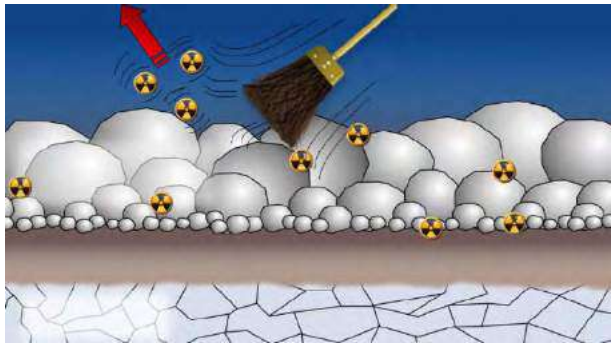



Which factors to evaluate for the decisión making process?
What a chemical decontamination means?

SOURCE TERM REDUCTION IN COFRENTES N.P.P.

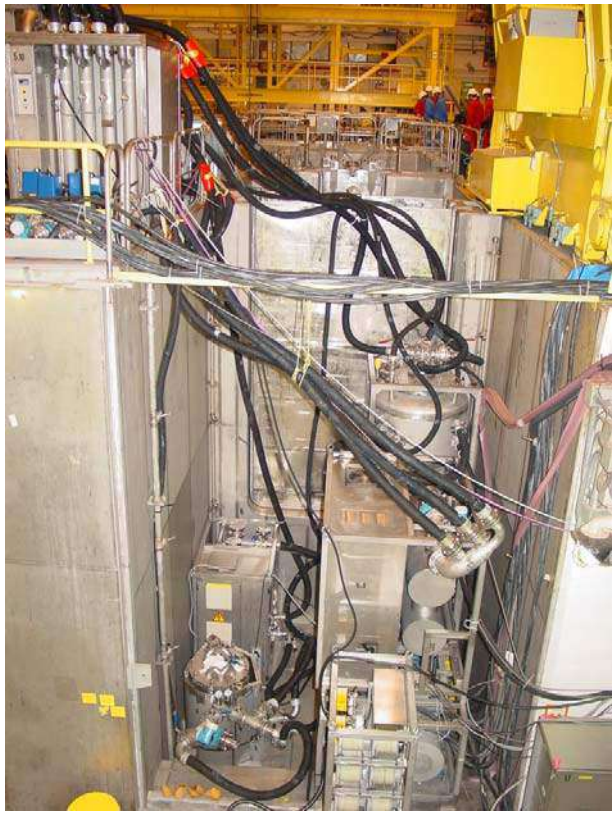
DRY-WELL PERMANENT SHIELDING & CHEMICAL DECONTAMINATION OF THE PRIMARY SYSTEM

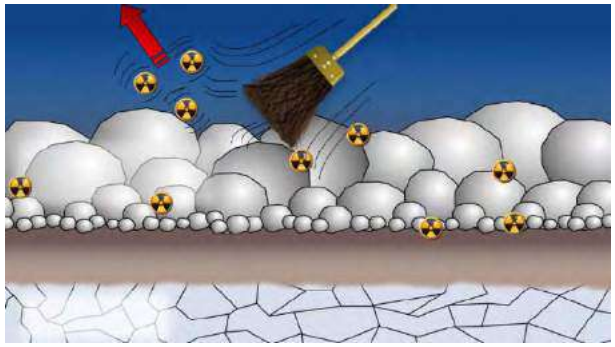




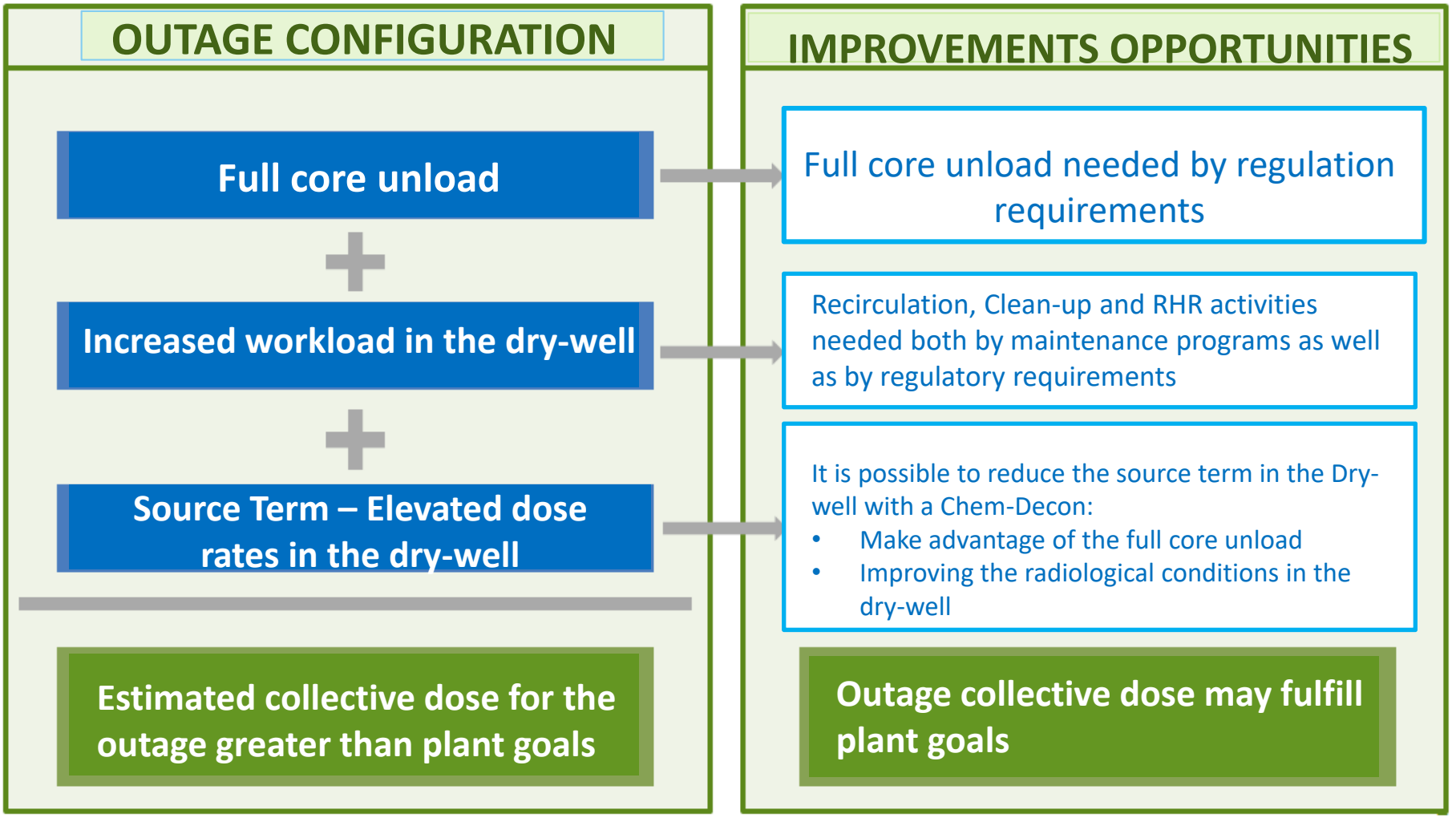
SOURCE TERM REDUCTION IN COFRENTES N.P.P.

DRY-WELL PERMANENT SHIELDING & CHEMICAL DECONTAMINATION OF THE PRIMARY SYSTEM



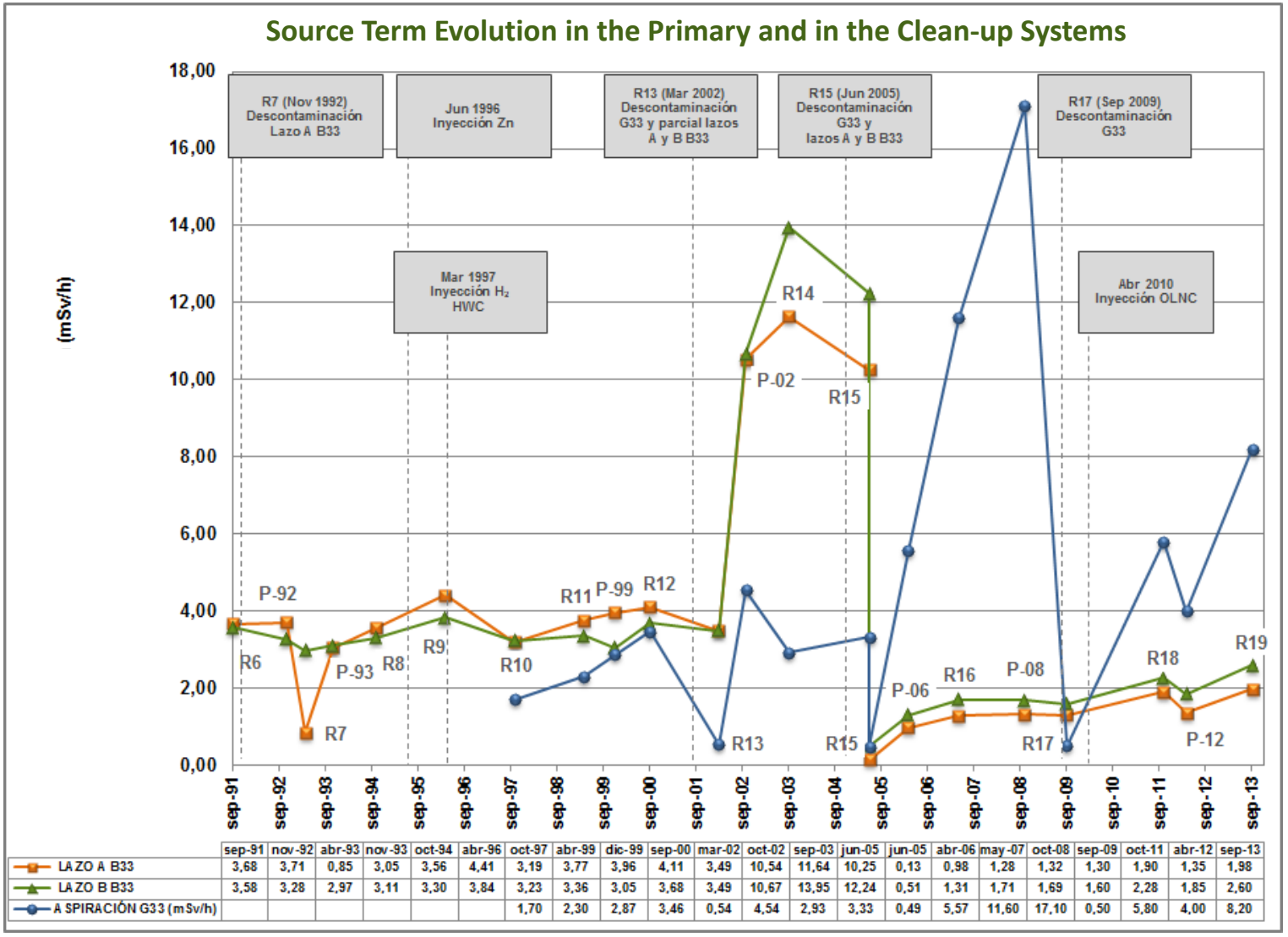


OUTAGE CONFIGURATION



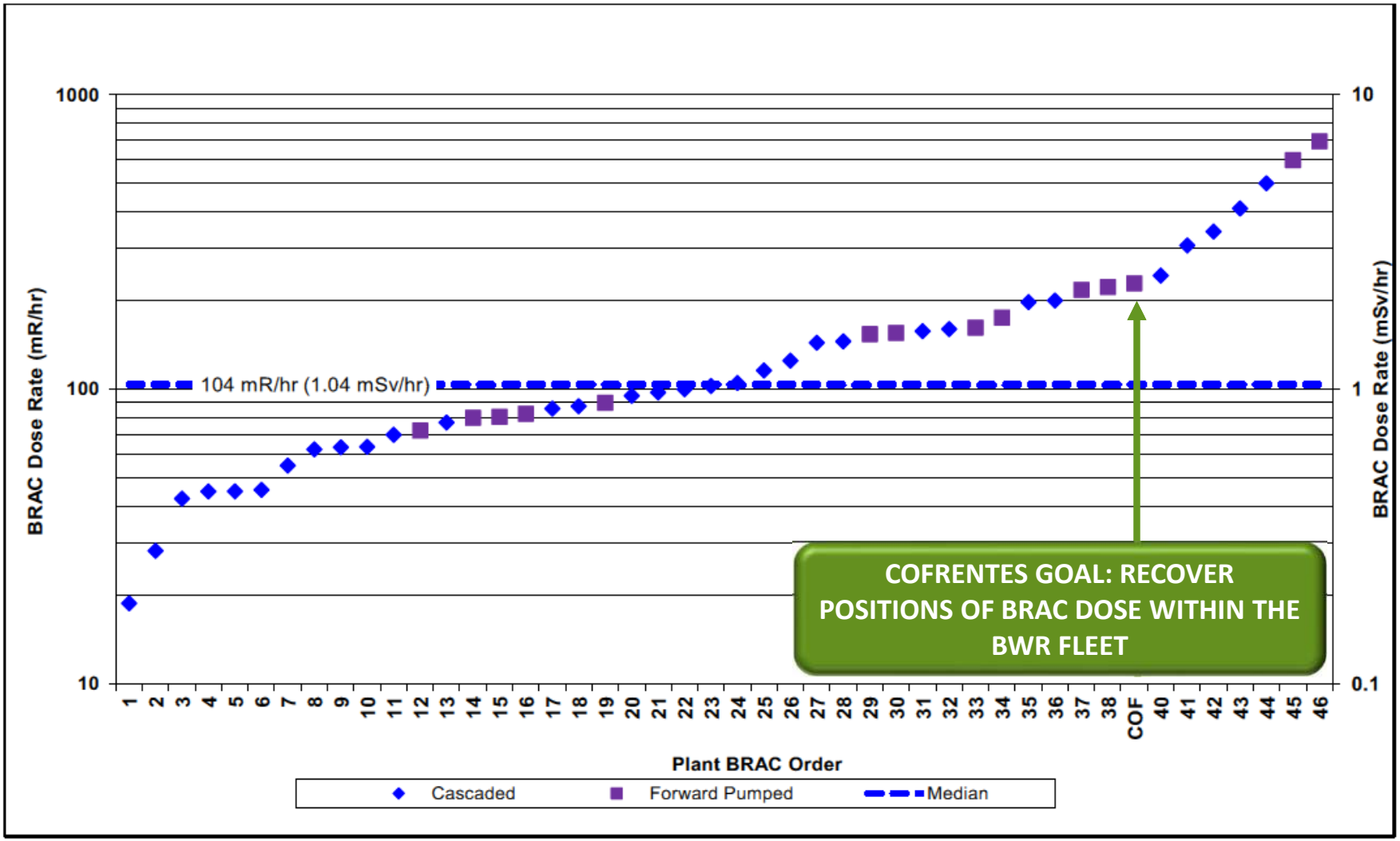
SOURCE TERM HISTORY

Source Term Evolution in the Primary and in the Clean-up Systems



	sep-91	nov-92	abr-93	nov-93	oct-94	abr-96	oct-97	abr-99	dic-99	sep-00	mar-02	oct-02	sep-03	jun-05	jun-05	abr-06	may-07	oct-08	sep-09	oct-11	abr-12	sep-13
LAZO A B33	3,68	3,71	0,85	3,05	3,56	4,41	3,19	3,77	3,96	4,11	3,49	10,54	11,64	10,25	0,13	0,98	1,28	1,32	1,30	1,90	1,35	1,98
LAZO B B33	3,58	3,28	2,97	3,11	3,30	3,84	3,23	3,36	3,05	3,68	3,49	10,67	13,95	12,24	0,51	1,31	1,71	1,69	1,60	2,28	1,85	2,60
ASPIRACIÓN G33 (mSv/h)							1,70	2,30	2,87	3,46	0,54	4,54	2,93	3,33	0,49	5,57	11,60	17,10	0,50	5,80	4,00	8,20

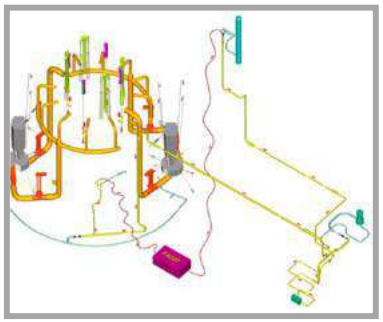
SOURCE TERM HISTORY

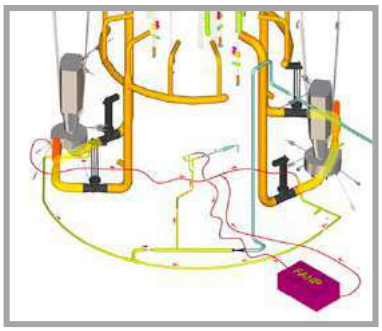


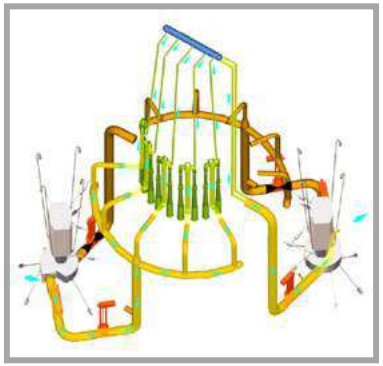
METHODOLOGY TO EVALUATE THE RADIOLOGICAL COST-BENEFIT

- SCOPE OF THE DECONTAMINATION
- SOURCE TERM EVOLUTION
- OUTAGE WORK LOAD
- RDIOLOGICAL COST-BENEFIT IN OUTAGE 20TH
- POST OUTAGE RADIOLOGICAL BENEFIT

- Several steps in the methodology to evaluate the radiological cost-benefit of the decontamination
- A sensitivity analysis is performed regarding several choices:
  A. Radiological cost with no decontamination
  B. Radiological cost of the clean-up
  C. Radiological cost of recirculation loop A
  D. Radiological cost of recirculation loops A & B
  E. Radiological cost of both recirculation Loops A & B and Clean-up system



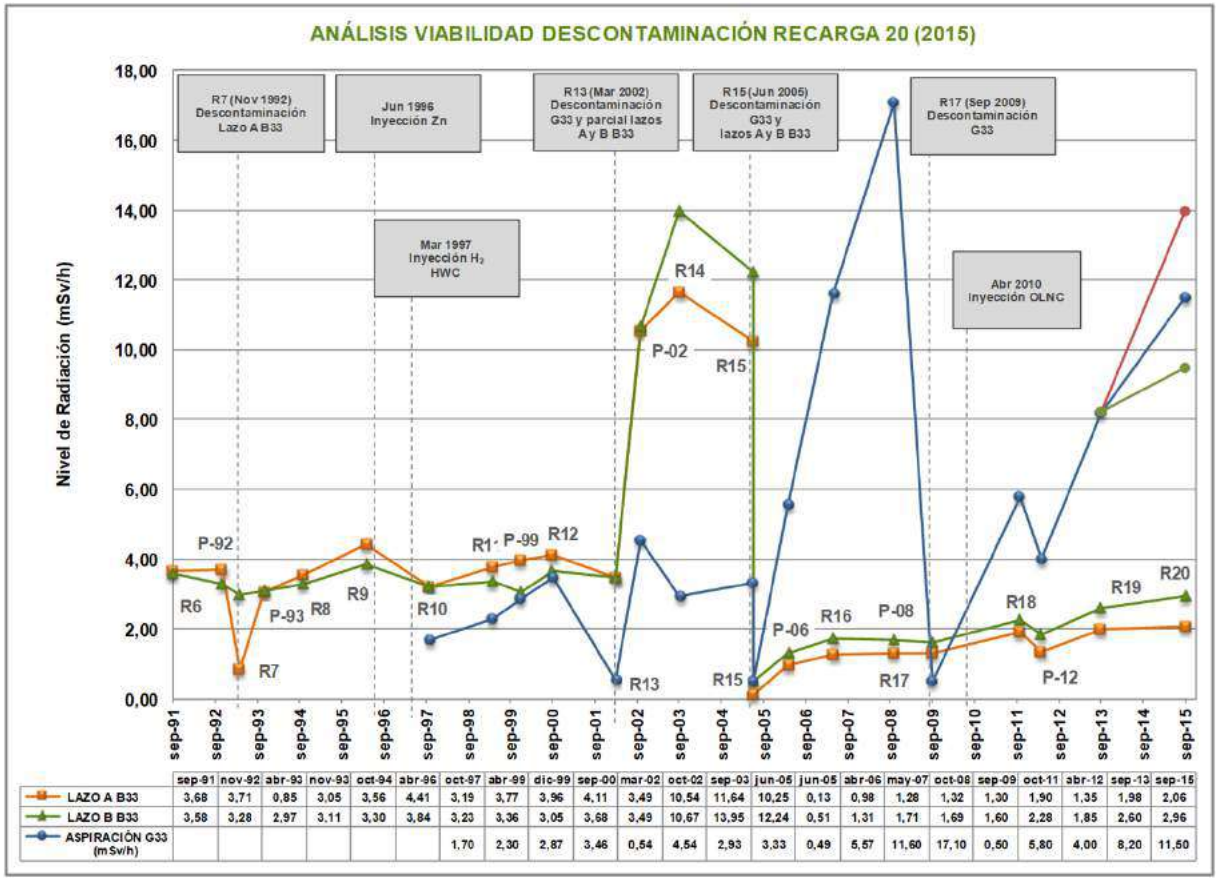




METHODOLOGY TO EVALUATE THE RADIOLOGICAL COST-BENEFIT

- TYPE OF DECONTAMINATION
- SOURCE TERM EVOLUTION
- OUTAGE WORK LOAD
- RDIOLOGICAL COST-BENEFIT IN OUTAGE 20TH
- POST OUTAGE RADIOLOGICAL BENEFIT

❖ Several scenarios are considered about the probably evolution of the source term: ADVERSE - LIKELY - POSITIVE



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METHODOLOGY TO EVALUATE THE RADIOLOGICAL COST-BENEFIT

- TYPE OF DECONTAMINATION
- SOURCE TERM EVOLUTION
- **OUTAGE WORK LOAD**
- RDIOLOGICAL COST-BENEFIT IN OUTAGE 20TH
- POST OUTAGE RADIOLOGICAL BENEFIT

❖ **Outage works are studied regarding their dose and potential dose reduction if Chem-Decon is carried out**

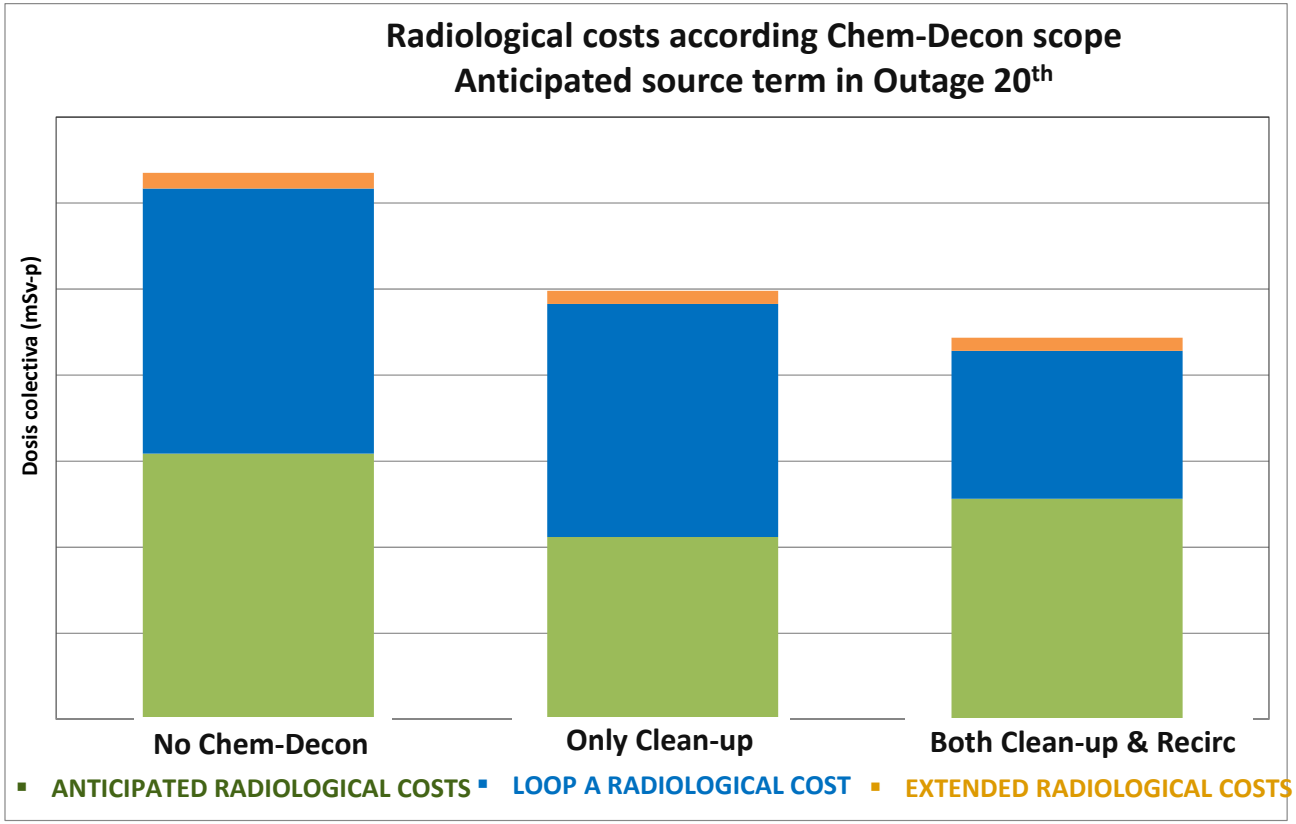
Ubicación	Trabajo	Tipo trabajo	Coste Dosis	Beneficio G33	Beneficio B33
R.6.01	Movimiento de combustible	Obligatorio	ALTO	NO	NO
R.6.02	Tapado, destapado, IVVI, descontaminación cavidad	Obligatorio	ALTO	NO	NO
R.1.01	Descontaminación G33 y/o B33	Opcional	ALTO	NO	NO
A.3.13	Mantenimiento bomba G33C002	Obligatorio	ALTO	ALTA	NO
R.0.04	Sustitución CRD's	Obligatorio	ALTO	NO	BAJA
	Extracción y corte LPRM's	Obligatorio	MEDIO	NO	BAJA
	Revisión IRM's – SRM's	Obligatorio	MEDIO	MEDIA	MEDIA
R.0.03	B33F023A, B33F060A, B33F067A	Opcional	ALTO	ALTA	ALTA
	G33F100, G33F102, G33F106	Obligatorio	MEDIO	ALTA	MEDIA
	G17C001A/B, G17C381A/B + Válvulas	Obligatorio	MEDIO	ALTA	ALTA
	Recuperación zona TIP	Opcional	BAJO	ALTA	ALTA
	Recuperación zona frente pedestal	Opcional	BAJO	NO	ALTA
	Inspección ISI de G33 y/o B33	Obligatorio	BAJO	ALTA	ALTA
	Aislamiento + andamios	Obligatorio	MEDIO	ALTA	ALTA
	Mantenimiento en indexer	Opcional	BAJO	ALTA	ALTA
R.1.01	Sustitución motor B33C001A	Opcional	ALTO	MEDIA	ALTA
	Sustitución G33F001	Obligatorio	MEDIO	ALTA	MEDIA
	Recuperación zona B33F120	Opcional	BAJO	MEDIA	MEDIA
	Inspección ISI	Obligatorio	MEDIO	ALTA	ALTA
	Instalación blindajes permanentes fase IV	Obligatorio	MEDIO	MEDIA	ALTA
	Mantenimiento en indexer	Opcional	BAJO	MEDIA	MEDIA
	Aislamiento + andamios	Obligatorio	MEDIO	ALTA	ALTA

Benefit: High ALTA Medium MEDIO Low BAJA

METHODOLOGY TO EVALUATE THE RADIOLOGICAL COST-BENEFIT

- TYPE OF DECONTAMINATION
- SOURCE TERM EVOLUTION
- OUTAGE WORK LOAD
- **RDIOLOGICAL COST-BENEFIT IN OUTAGE 20TH**
- POST OUTAGE RADIOLOGICAL BENEFIT

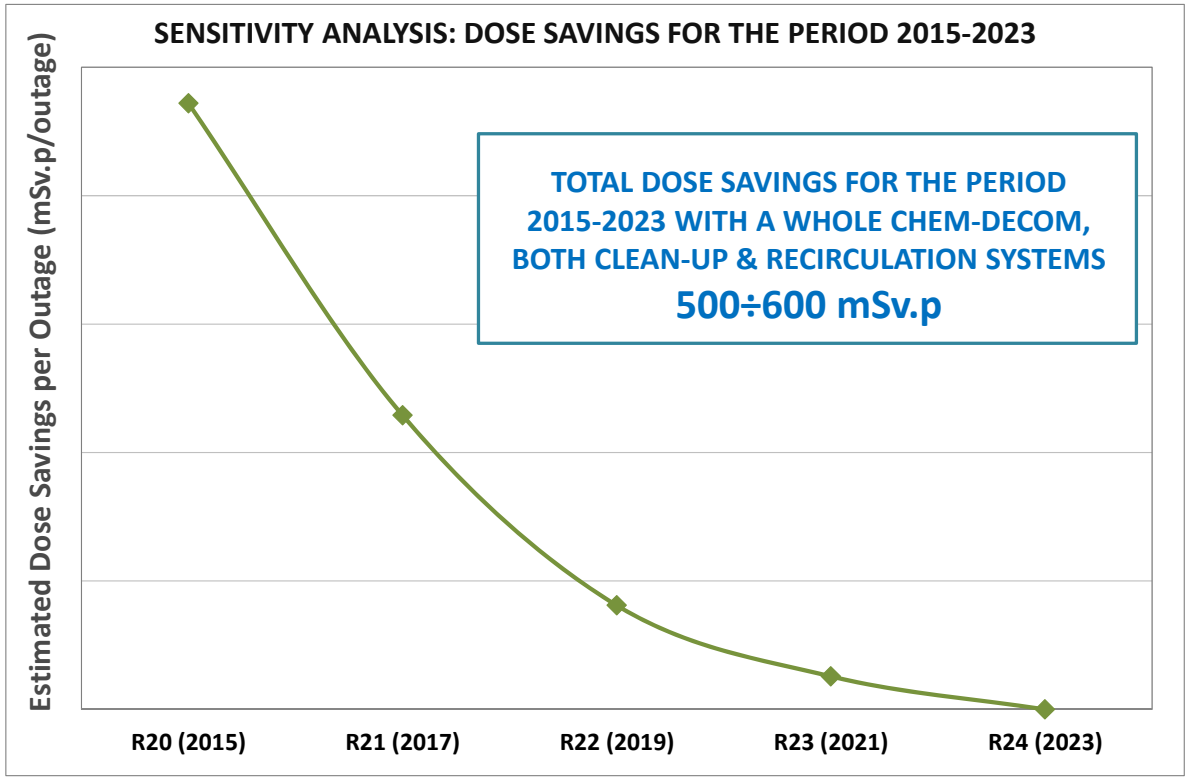
- Dose savings are estimated regarding the scope of the Chem-Decon
- Net benefit of the Chem-Decon in outage 20th is estimate in 25-30%

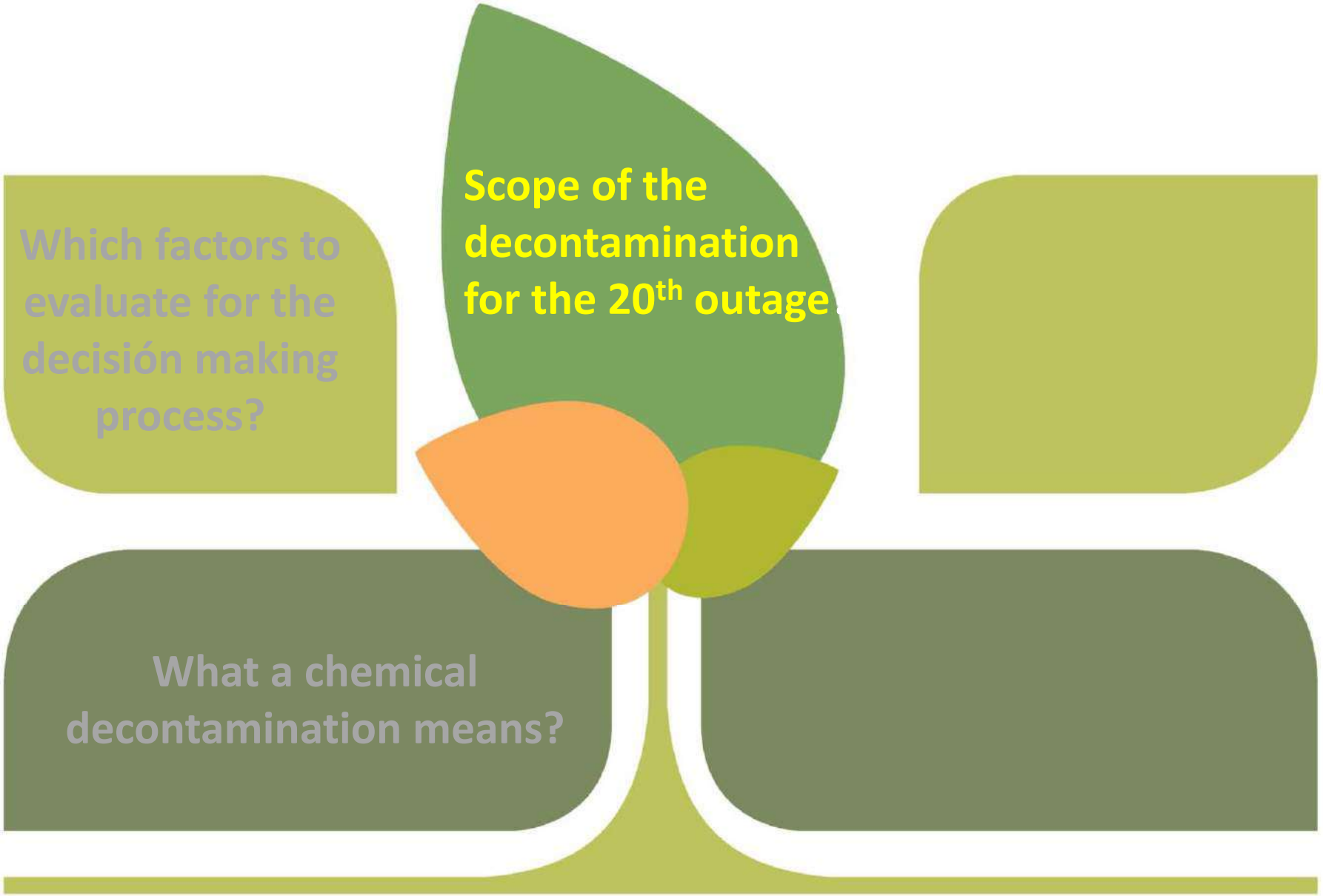


METHODOLOGY TO EVALUATE THE RADIOLOGICAL COST-BENEFIT

- TYPE OF DECONTAMINATION
- SOURCE TERM EVOLUTION
- OUTAGE WORK LOAD
- RDIOLOGICAL COST-BENEFIT IN OUTAGE 20TH
- **POST OUTAGE RADIOLOGICAL BENEFIT**

- Dose savings are extrapolated for a long-term perspective taking into account future maintenance works
- Net dose savings of the Chem-Decon for the next 5 outages are estimated in 500÷600 mSv-p

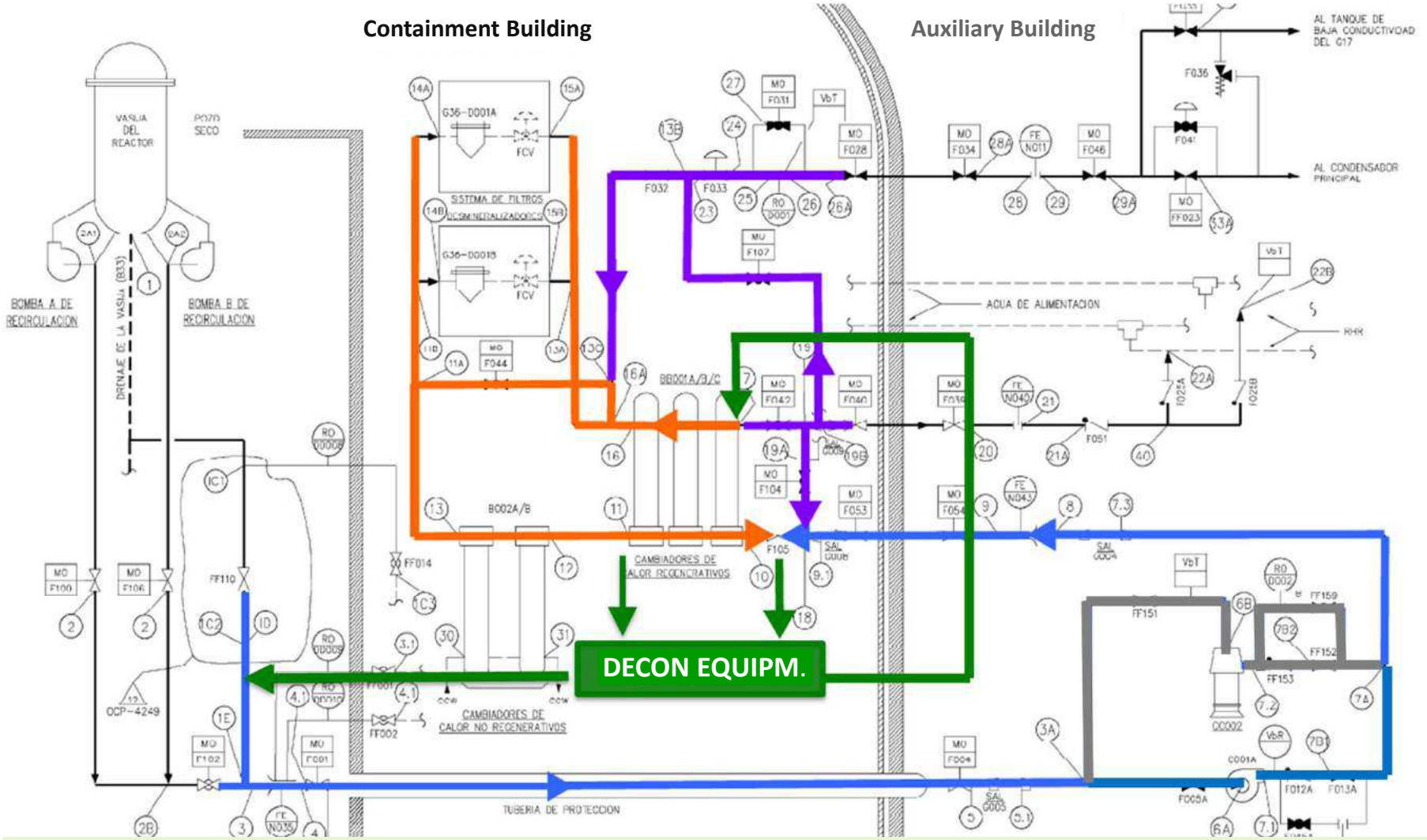



Scope of the decontamination for the 20th outage
Which factors to evaluate for the decisión making process?
What a chemical decontamination means?

SCOPE OF THE CHEM-DECON IN THE OUTAGE 20TH

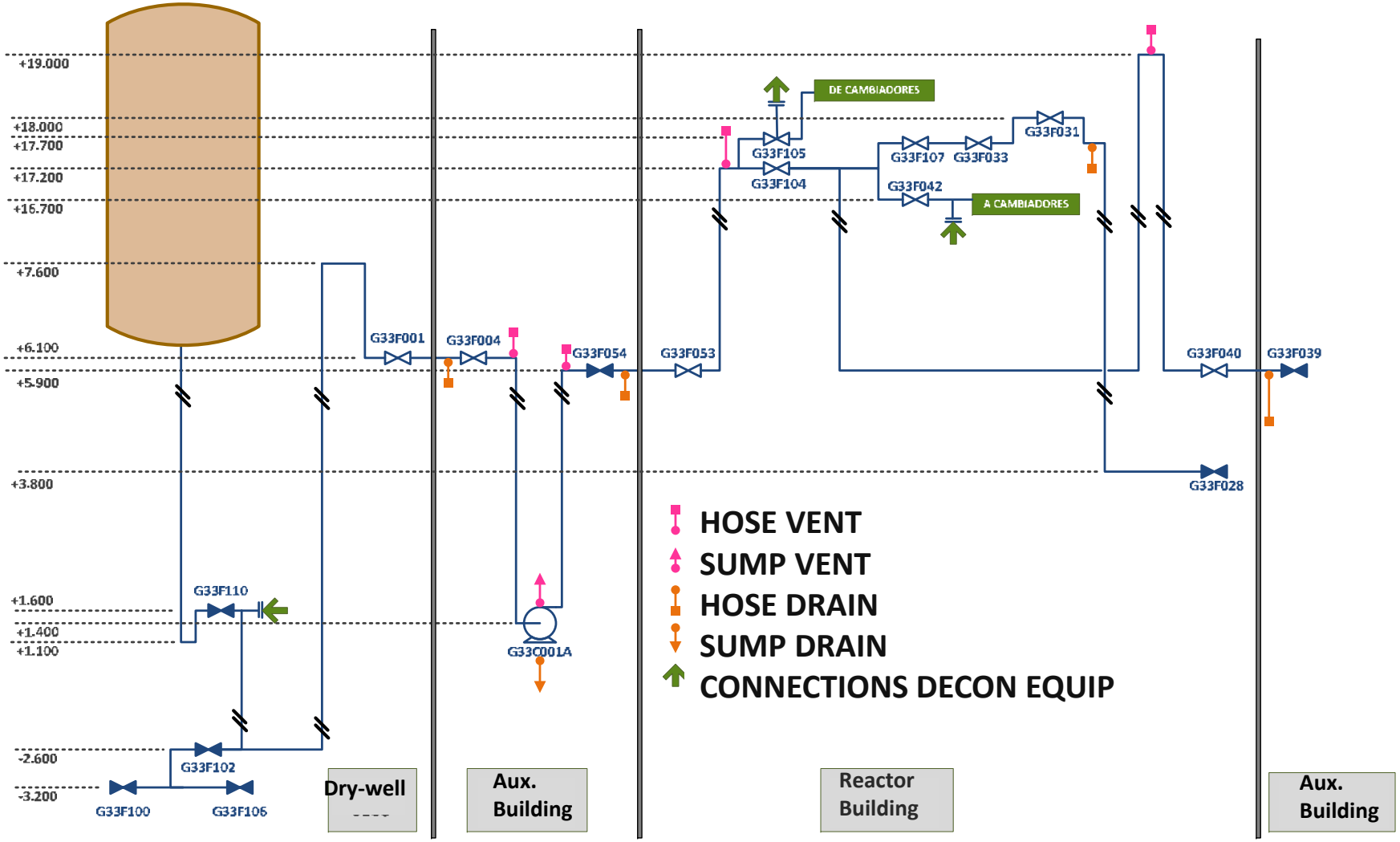
- **SYSTEMS:** Recirculation and Clean-up
- **CIRCUITS:** Inside and outside the Dry-well
- **BUILDINGS AFFECTED:** Dry-Well, Auxiliary, Reactor and Auxiliary Steam Tunnel and Reactor
- **SURFACE TO DECONTAMINATE:** ≈ 200 m^2 of inner surface pipes for recirculation and ≈ 800 m^2 of inner surface pipes for clean-up
- **IMPACT ON CRITICAL PATH:** None in the inner circuit and 6,5 days in the outer circuit
- **RADIOLOGICAL COST OF THE DECONTAMINATION:** About 5% of all outage collective dose
- **BENEFIT OF THE DECONTAMINATION:** Outage dose will be 25-30% lower than if Chem-Decon is not carried out
- **DESCONTAMINATION FACTORS:** It is expected a decon factor of 15-25 based upon the affected systems
- **OPERATION OF MORE THAN 300 VALVES IN HIGH RADIATION AREAS**

SCOPE OF THE CHEM-DECON IN THE OUTAGE 20TH



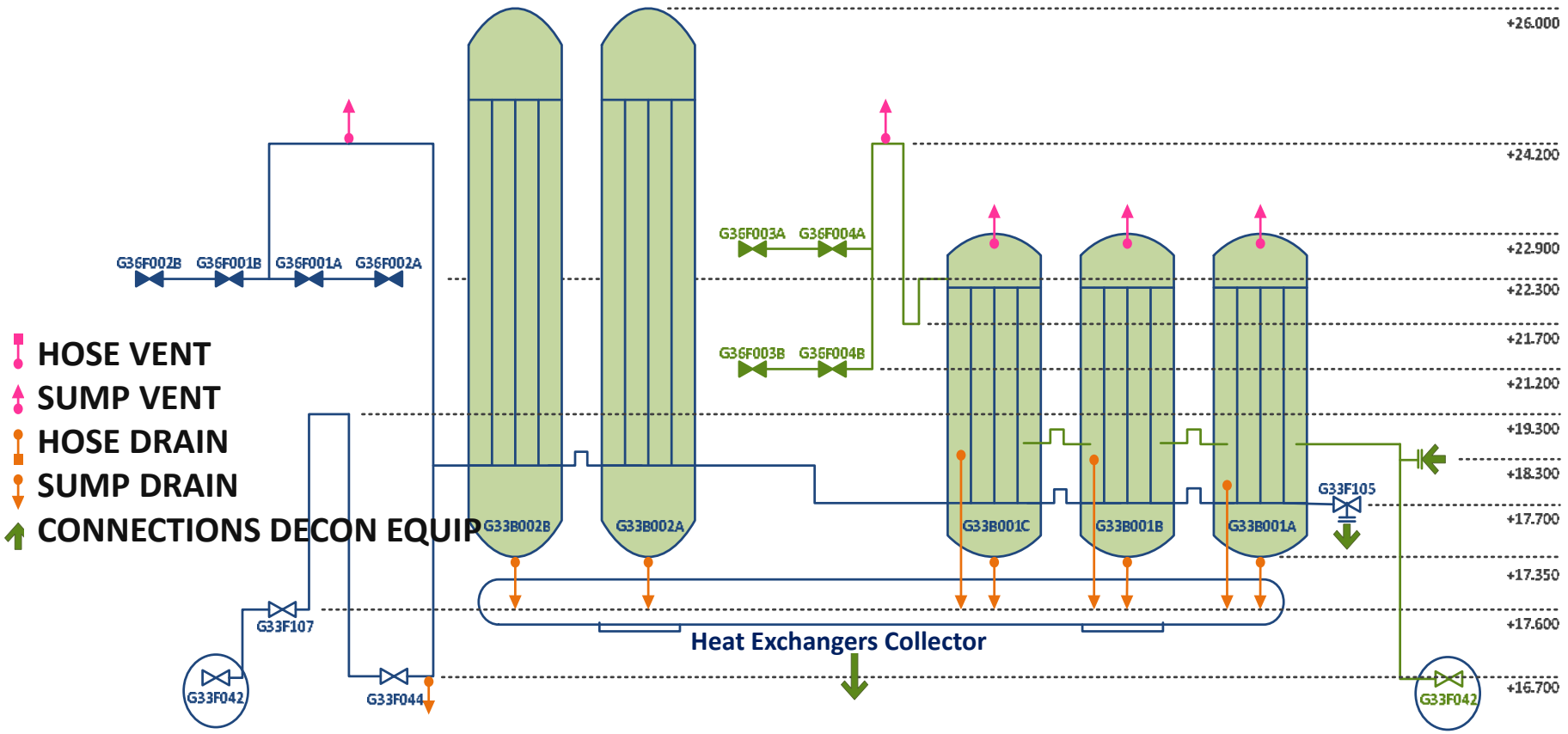
DRY-WELL OUTER CIRCUIT OF THE CLEAN-UP SYSTEM

SCOPE OF THE CHEM-DECON IN THE OUTAGE 20TH



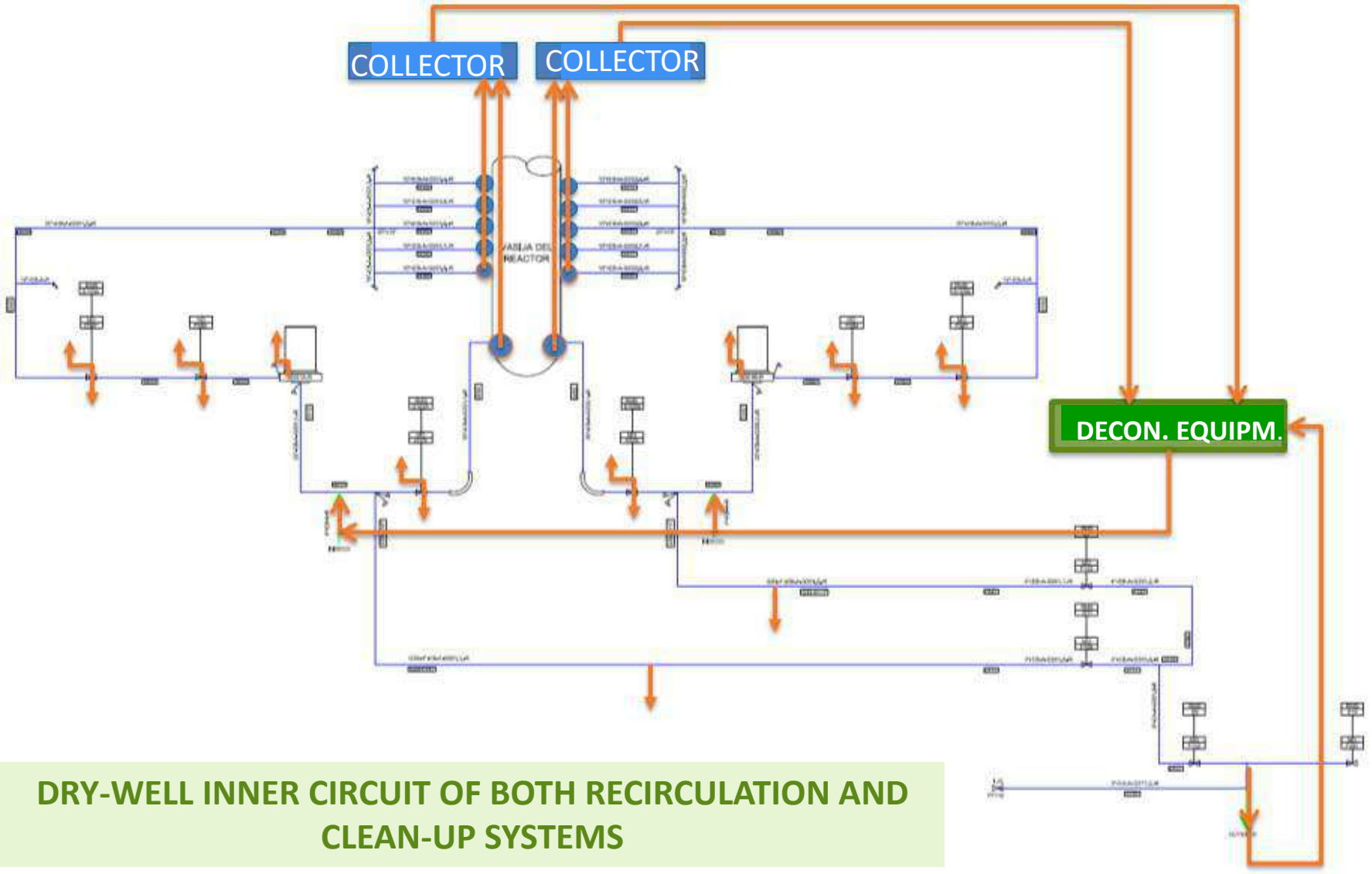
DRY-WELL OUTER CIRCUIT OF THE CLEAN-UP SYSTEM

SCOPE OF THE CHEM-DECON IN THE OUTAGE 20TH



DRY-WELL OUTER CIRCUIT OF THE CLEAN-UP SYSTEM

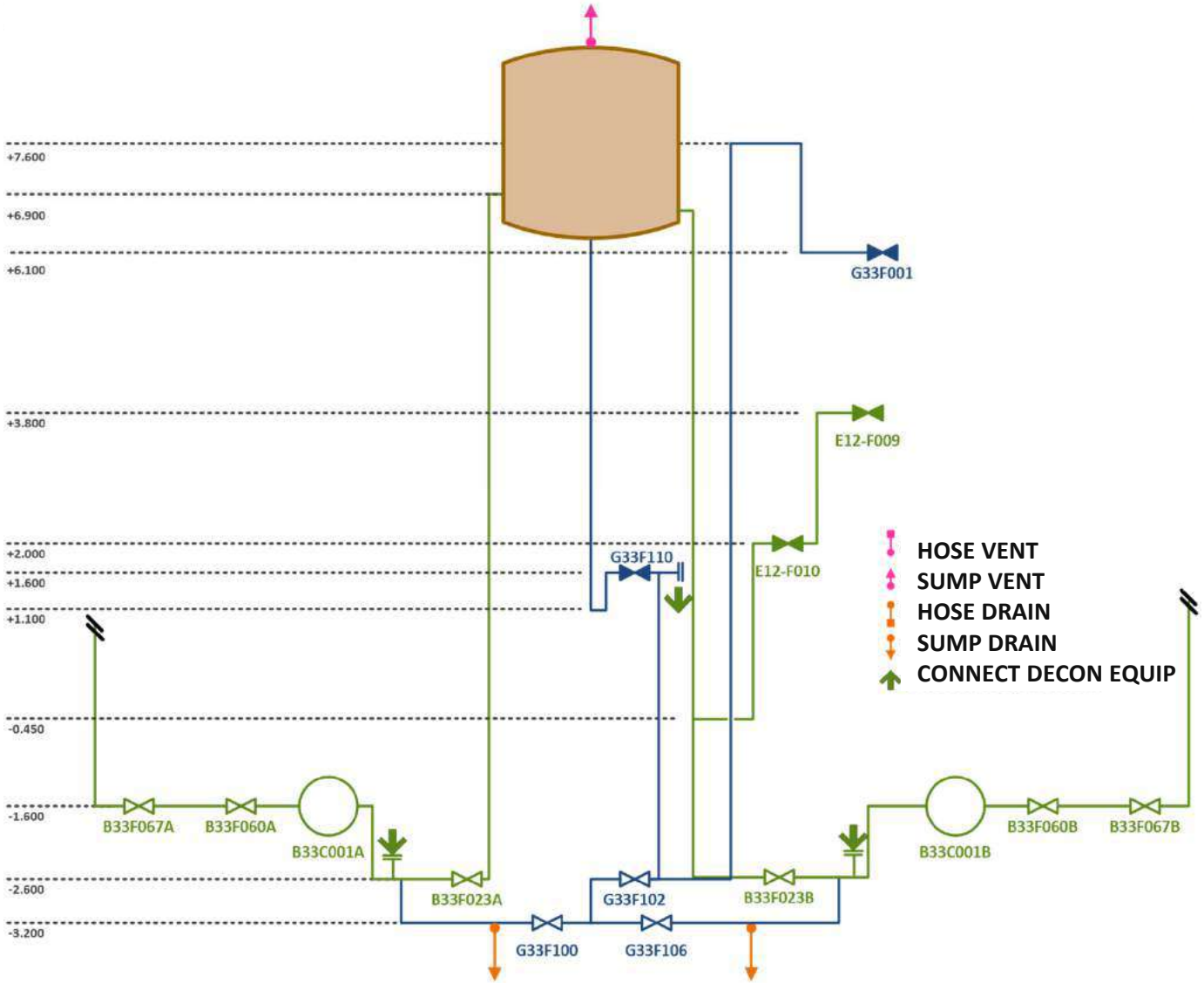
SCOPE OF THE CHEM-DECON IN THE OUTAGE 20TH

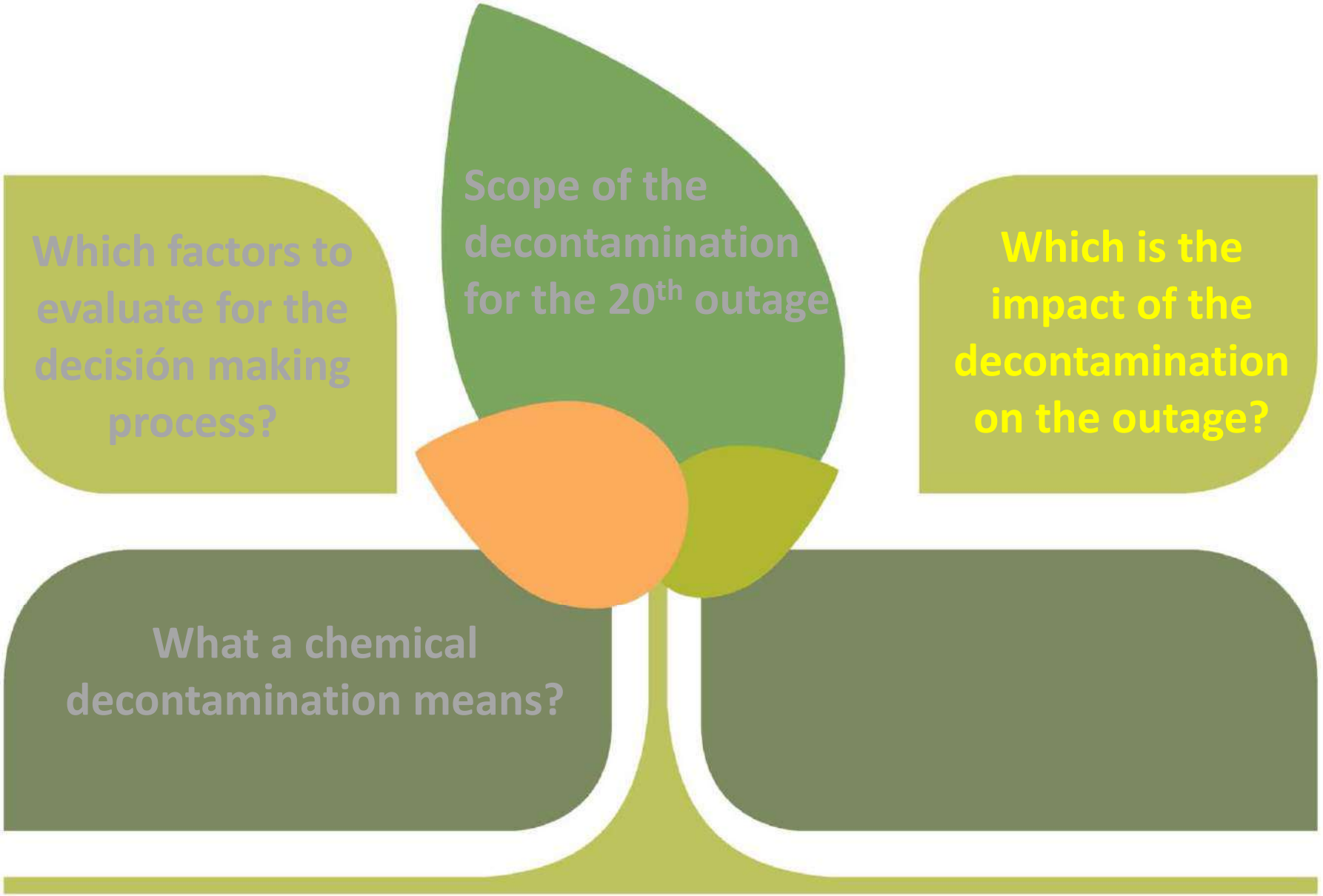


DRY-WELL INNER CIRCUIT OF BOTH RECIRCULATION AND CLEAN-UP SYSTEMS

SCOPE OF THE CHEM-DECON IN THE OUTAGE 20TH

DRY-WELL INNER CIRCUIT OF BOTH RECIRCULATION AND CLEAN-UP SYSTEMS

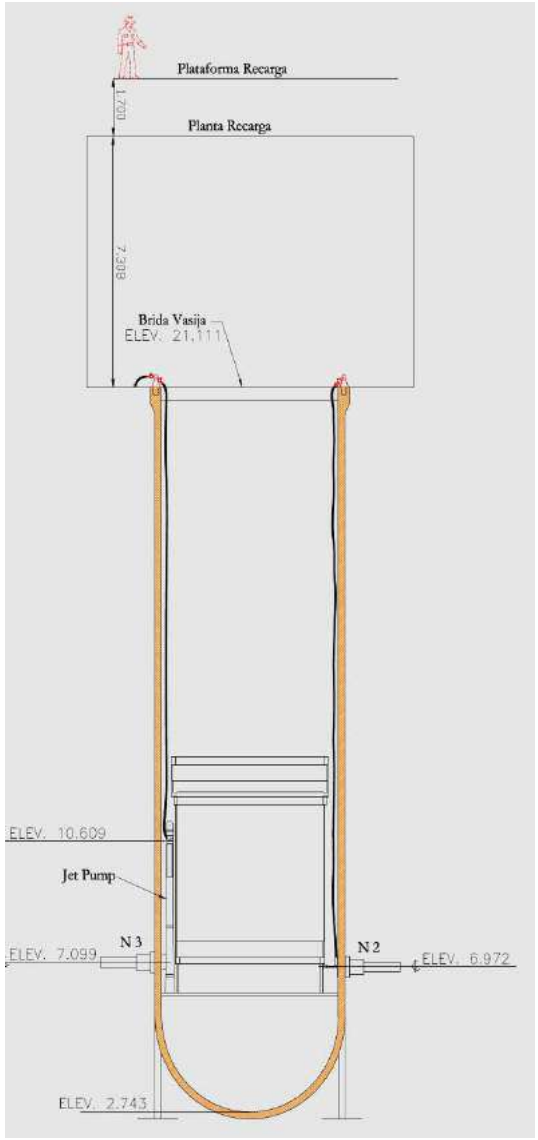


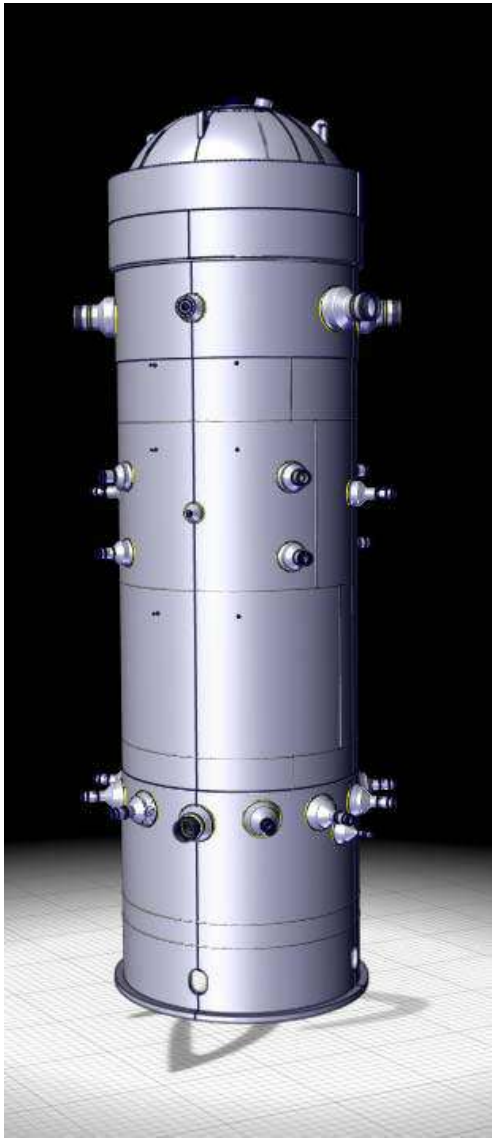

Scope of the decontamination for the 20th outage
Which factors to evaluate for the decisión making process?
Which is the impact of the decontamination on the outage?
What a chemical decontamination means?

IMPACT OF THE CHEM-DECON IN THE OUTAGE 20TH

- Driven plugs in recirculation nozzles
- Driven plugs in jet pumps
- Water level drops in reactor to assembly decontamination hoses

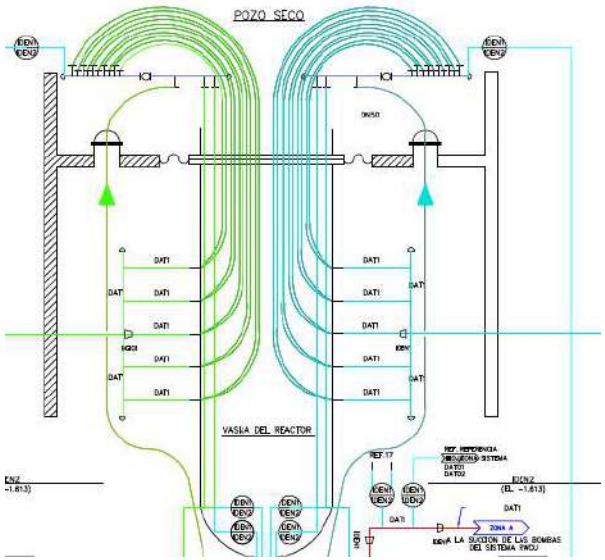
Driven plugs are needed to conduct back the decon solution from recirculation nozzles to the decontamination equipments

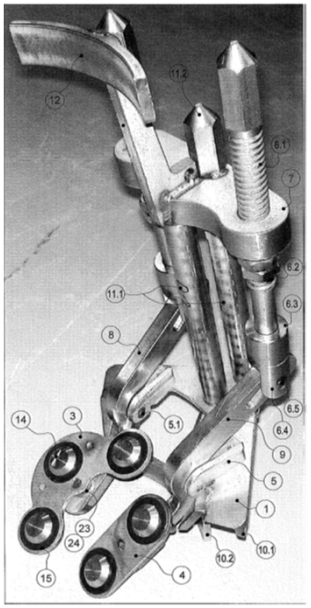


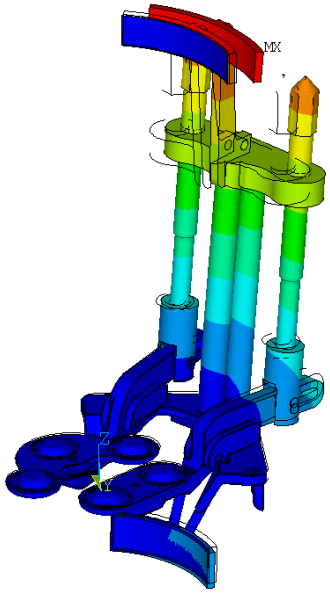


IMPACT OF THE CHEM-DECON IN THE OUTAGE 20T

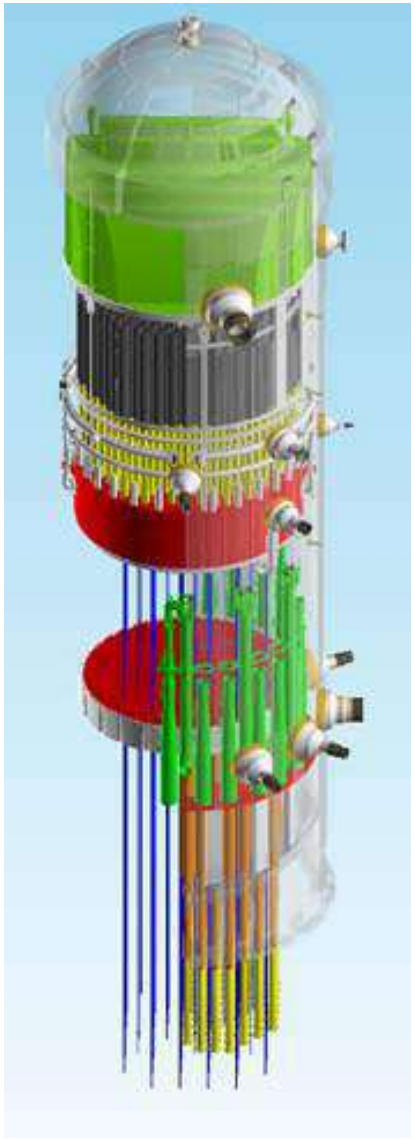
- Driven plugs in recirculation nozzles
- **Driven plugs in jet pumps**
- Water level drops in reactor to assembly decontamination hoses







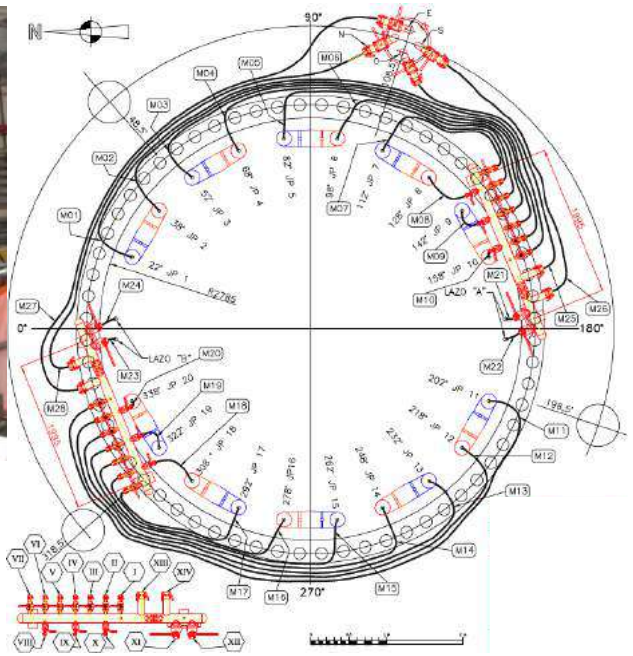
Driven plugs are also needed to conduct back the decon solution from jet pumps to the decontamination equipments

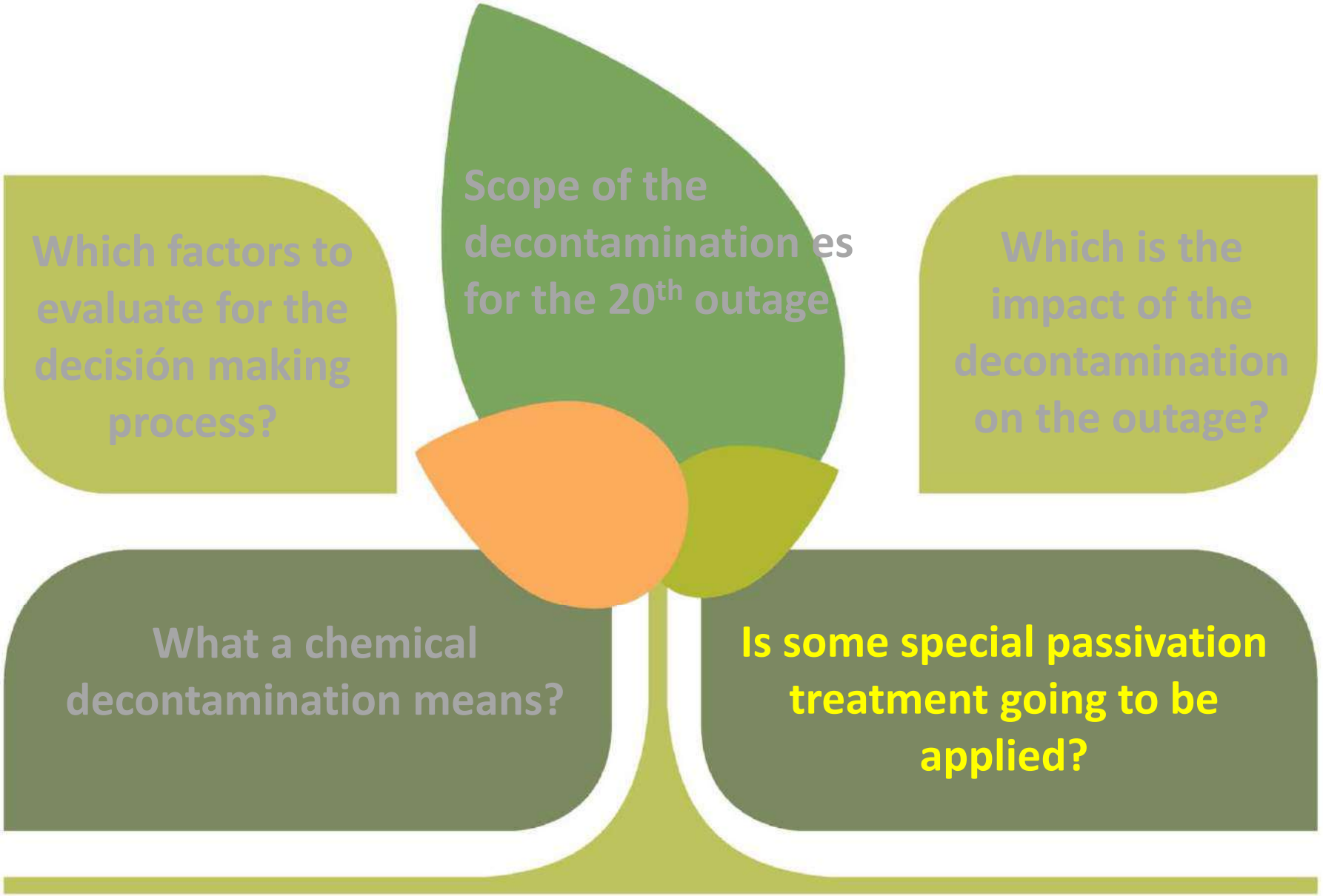


IMPACT OF THE CHEM-DECON IN THE OUTAGE 20T

- Driven plugs in recirculation nozzles
- Driven plugs in jet pumps
- Water level drops in reactor cavity to assembly decontamination hoses

These hoses and manifolds are distributed inside the reactor cavity and then rerouted to the Dry-Well by means of two collectors



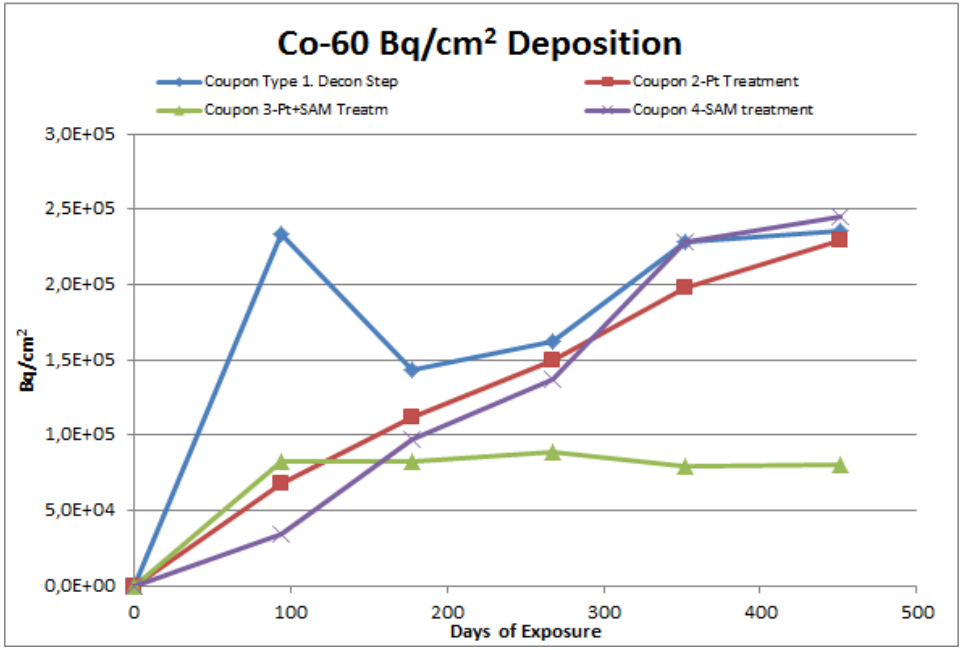

Scope of the decontamination es for the 20th outage
Which factors to evaluate for the decisión making process?
Which is the impact of the decontamination on the outage?
What a chemical decontamination means?
Is some special passivation treatment going to be applied?

PASSIVATION TREATMENT AFTER DECONTAMINATION

- **Clean-up system– Carbon Steel → High degree of recontamination**
  - A passivation process is needed (Build-up of a oxide layer free of radioactivity and resistant to the uptake (deposits) of new radioactivity materials)
  - Process not yet thoroughly investigated within the industry

- **Tests performed in carbon steel specimens with 4 post-decontamination treatments:**

1. Convencional Decontamination **CORD-UV**
2. Platine Treatment **Pt**
3. Filming Amine Teatment **FFA**
4. Combined treatment **Pt+FFA**



CHEMICAL DECONTAMINATION RESULTS

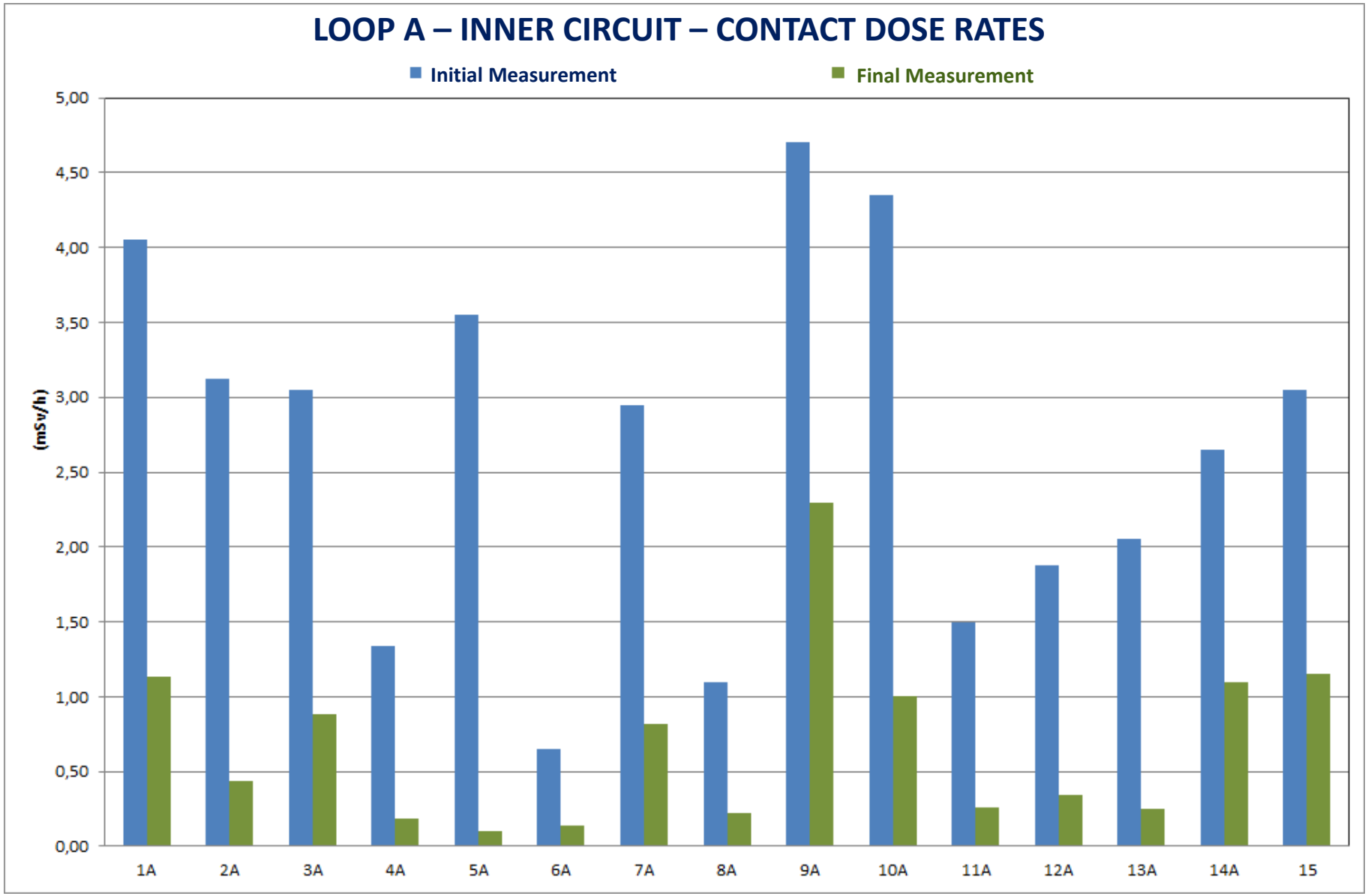
OUTER CIRCUIT RESULTS		
	DECON FACTOR	DURATION
ESTIMATED VALUES	20 ÷ 30	4 days
REAL VALUES	34	4 days 18 hours

INNER CIRCUIT RESULTS		
	DECON FACTOR	DURATION
ESTIMATED VALUES	15 ÷ 25	6 days 12 hours
REAL VALUES	27 (8 B33 – 68 G33)	5 days 12 hours

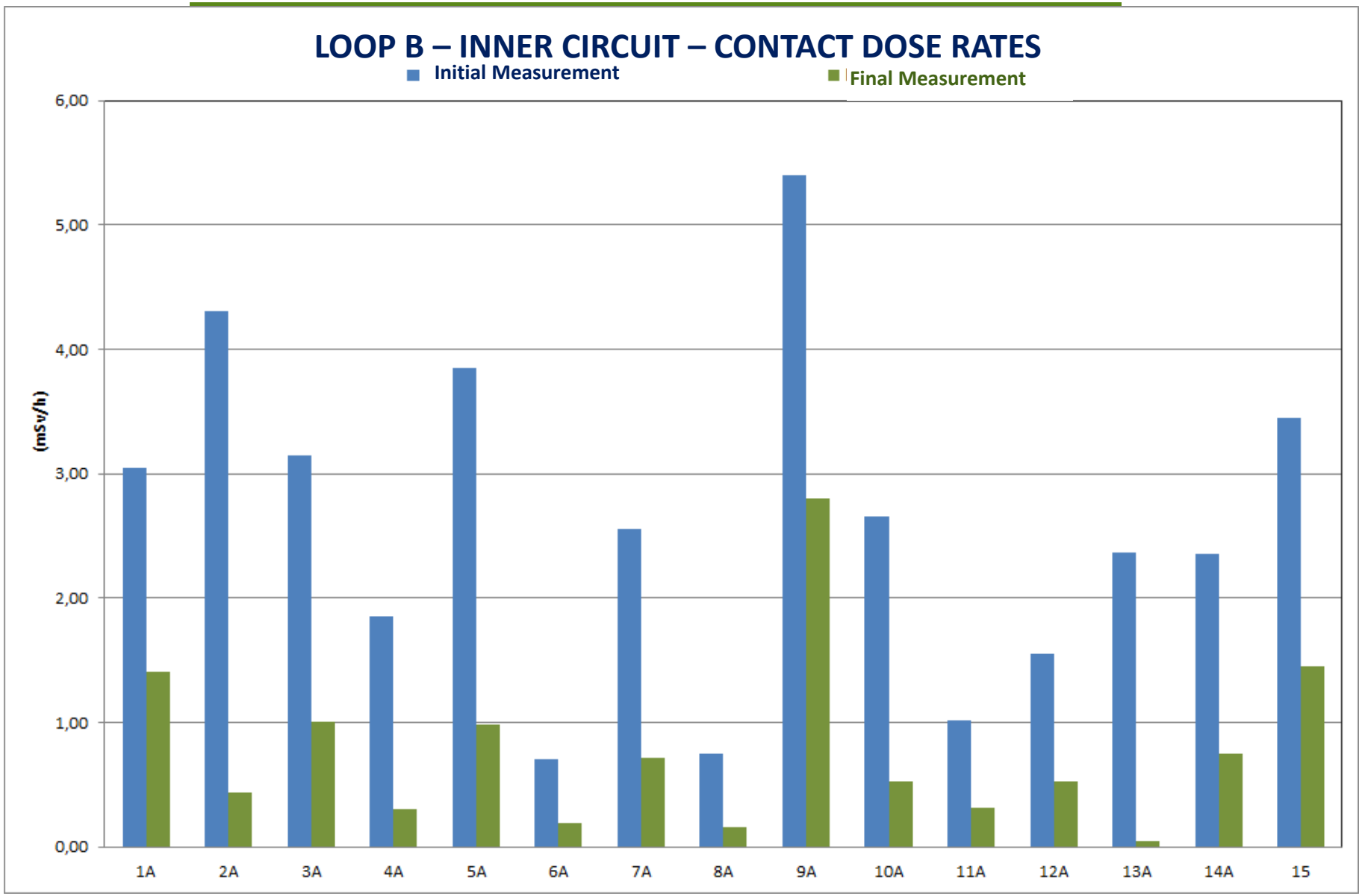
OTHER RELEVAN INFORMATION:

- Collective Dose: 105 mSv-p (110 mSv-p estimated)
- Maximum Individual Dose: 7,2 mSv, two persons (8 mSv estimated)
- Generated Wastes: 1000 liters or resins (2600 liters estimated)
- Non leakages found either in plugs nor in flange connections

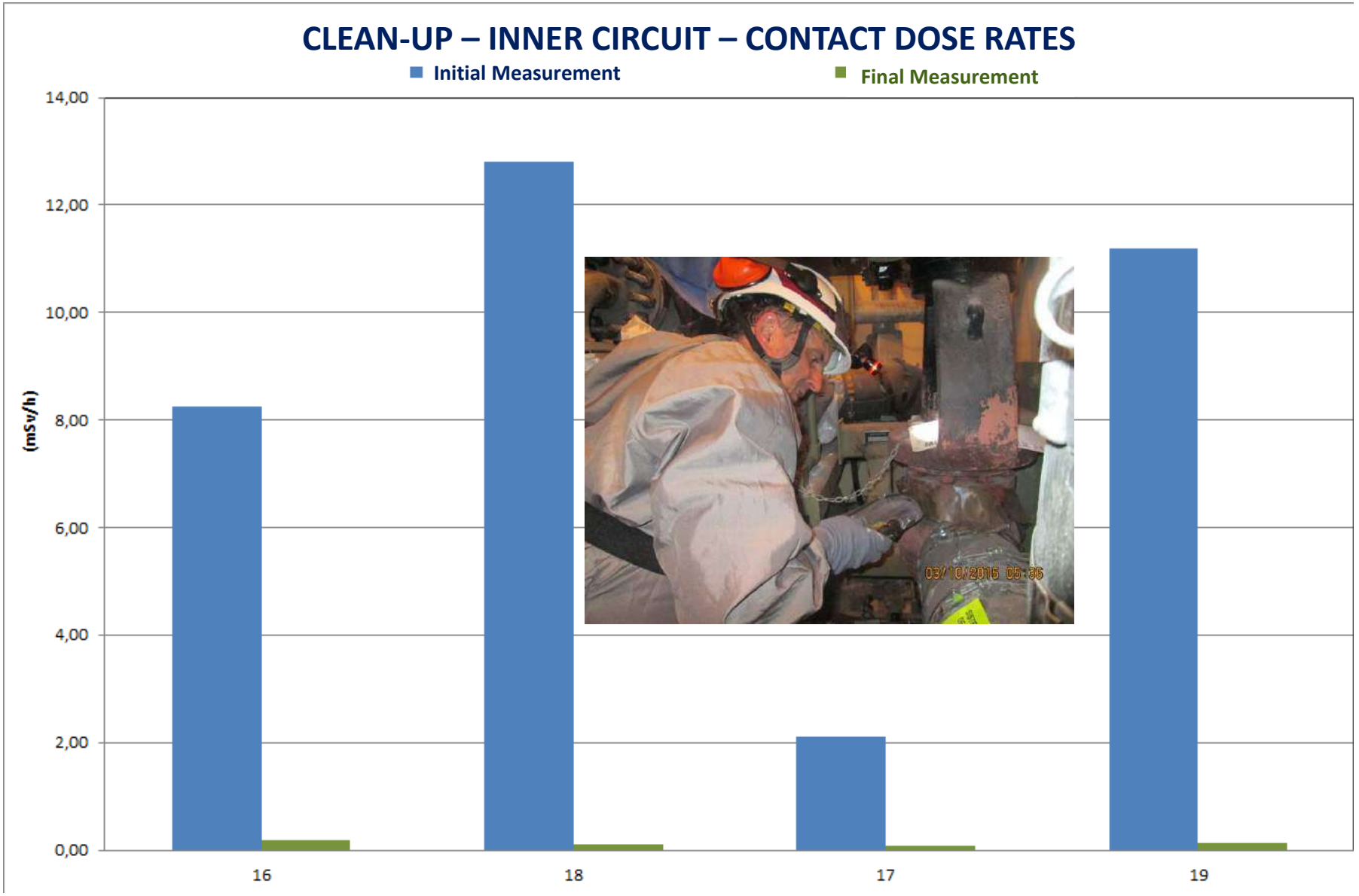
CHEMICAL DECONTAMINATION RESULTS



CHEMICAL DECONTAMINATION RESULTS

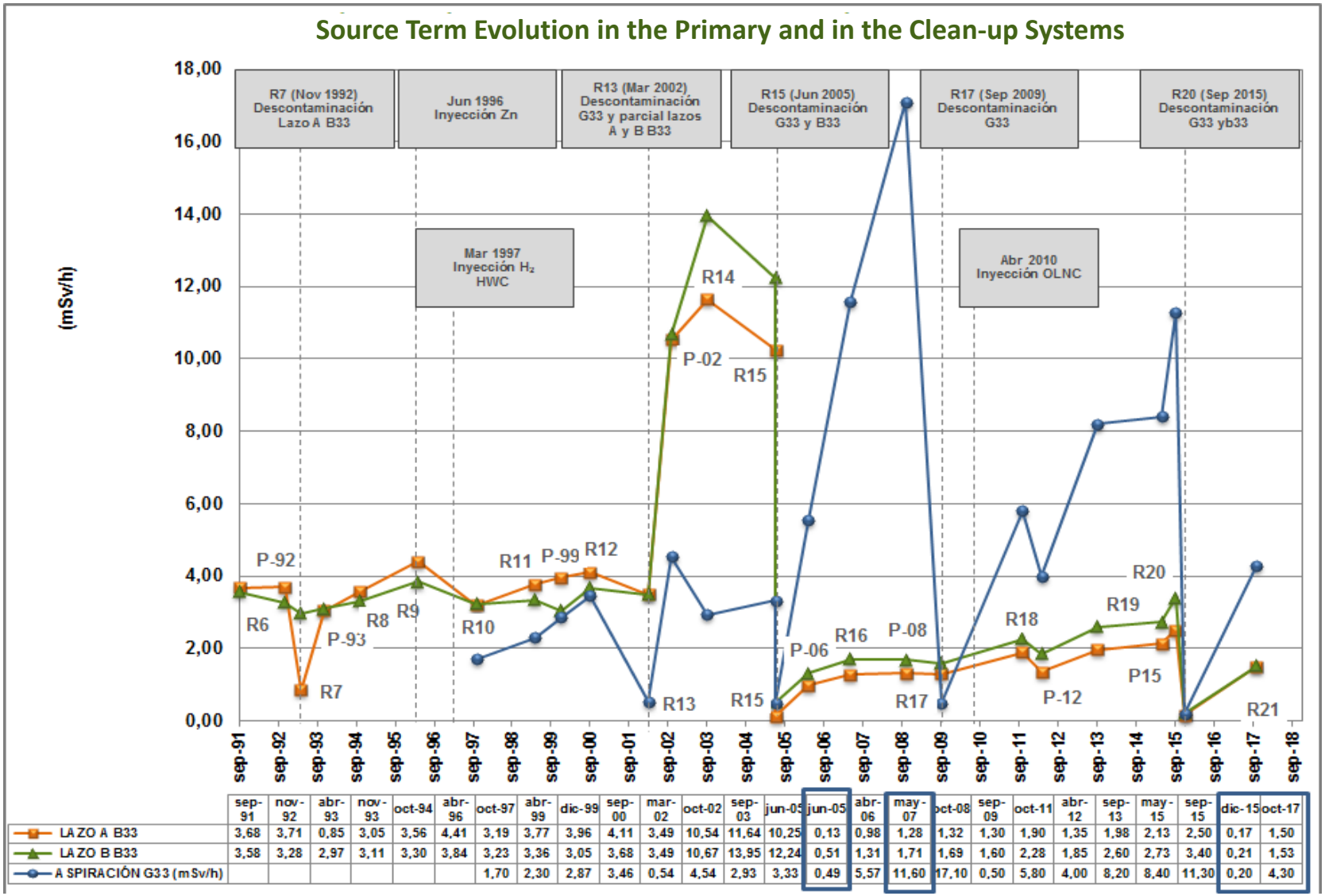


CHEMICAL DECONTAMINATION RESULTS



SOURCE TERM AFTER DECONTAMINATION (OUTAGE 21th)

Source Term Evolution in the Primary and in the Clean-up Systems



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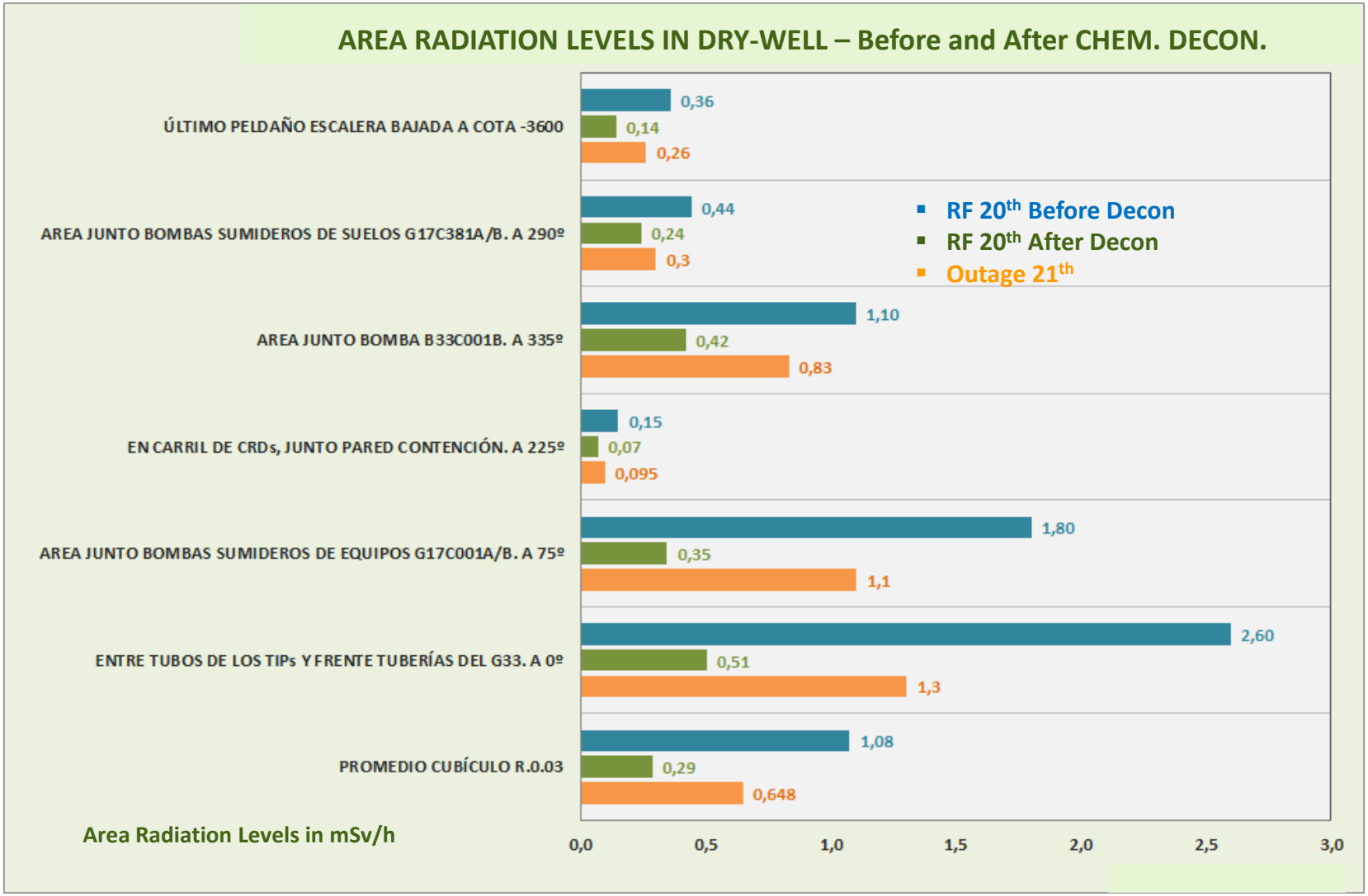
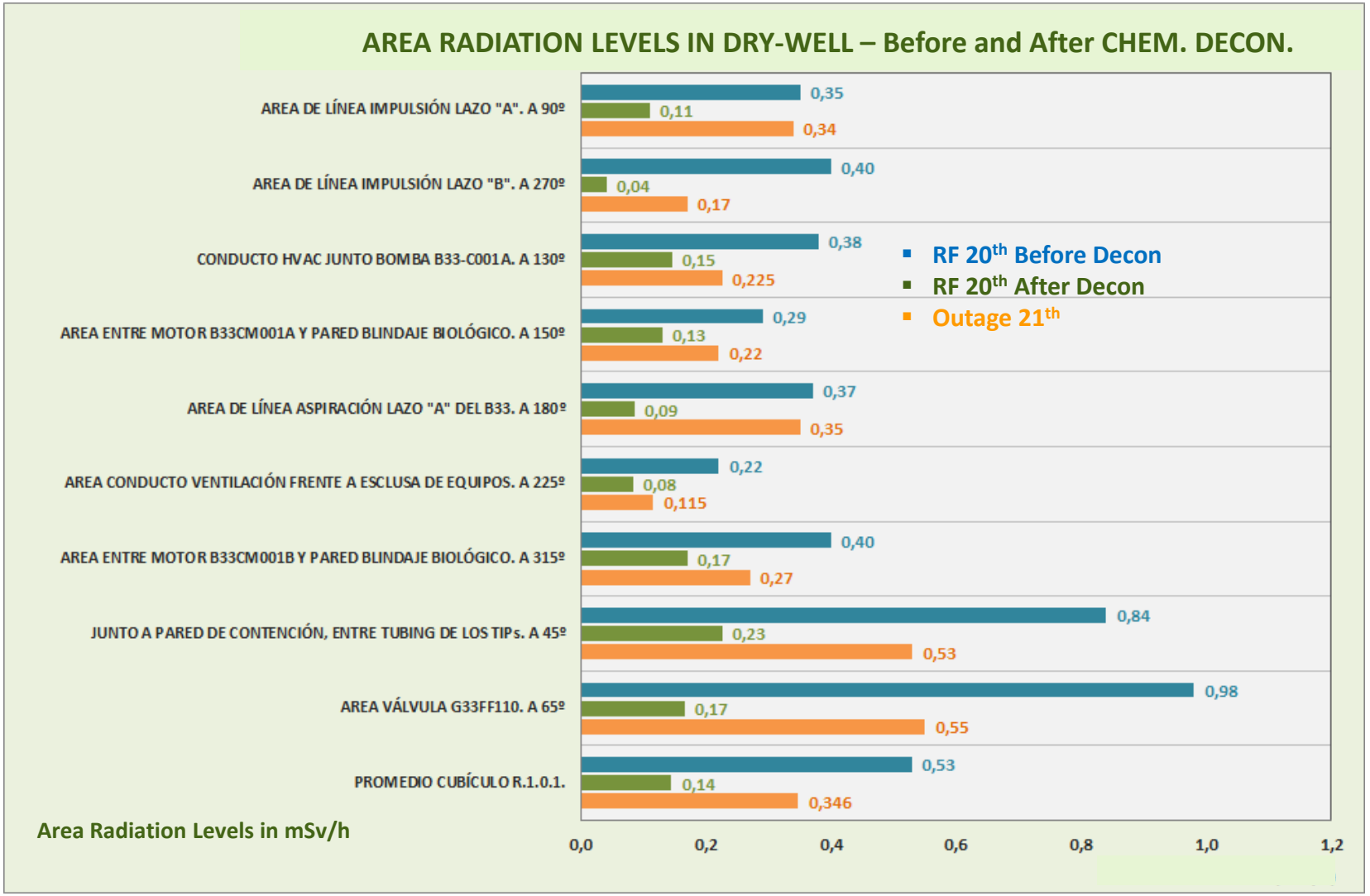
LAZO A B33	3,68	3,71	0,85	3,05	3,56	4,41	3,19	3,77	3,96	4,11	3,49	10,54	11,64	10,25	0,13	0,98	1,28	1,32	1,30	1,90	1,35	1,98	2,13	2,50	0,17	1,50
LAZO B B33	3,58	3,28	2,97	3,11	3,30	3,84	3,23	3,36	3,05	3,68	3,49	10,67	13,95	12,24	0,51	1,31	1,71	1,69	1,60	2,28	1,85	2,60	2,73	3,40	0,21	1,53
ASPIRACIÓN G33 (mSv/h)							1,70	2,30	2,87	3,46	0,54	4,54	2,93	3,33	0,49	5,57	11,60	17,10	0,50	5,80	4,00	8,20	8,40	11,30	0,20	4,30

SOURCE TERM AFTER DECONTAMINATION (OUTAGE 21th)

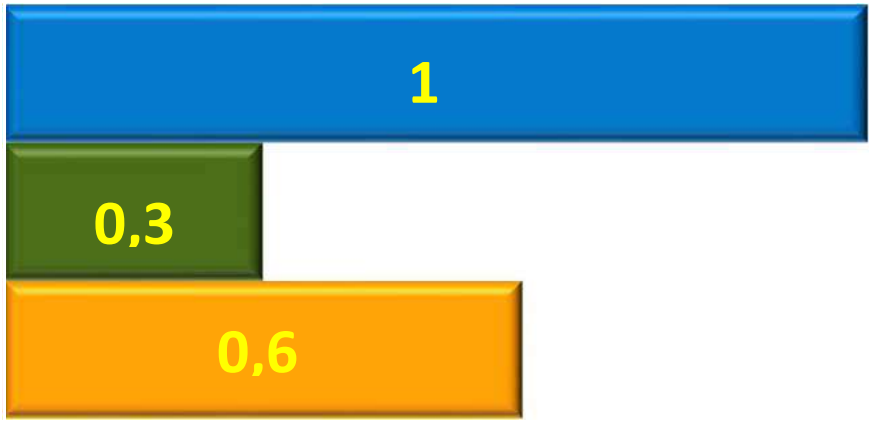


SOURCE TERM AFTER DECONTAMINATION (OUTAGE 21th)



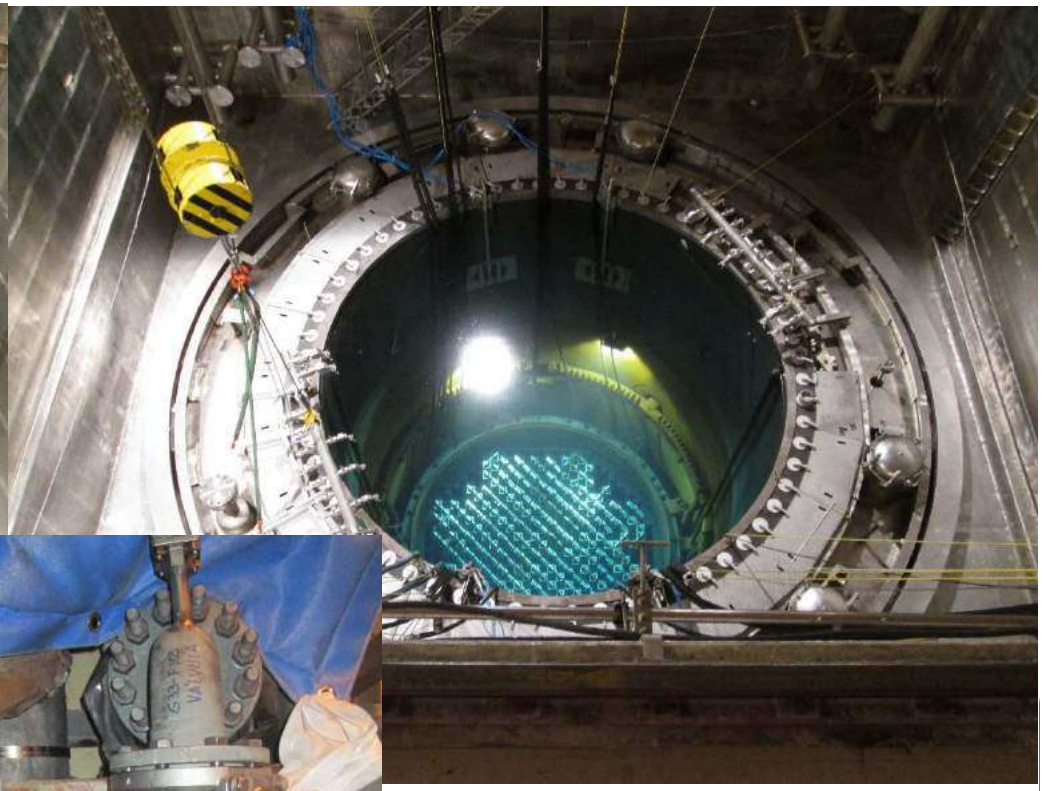
SOURCE TERM AFTER DECONTAMINATION (OUTAGE 21th)

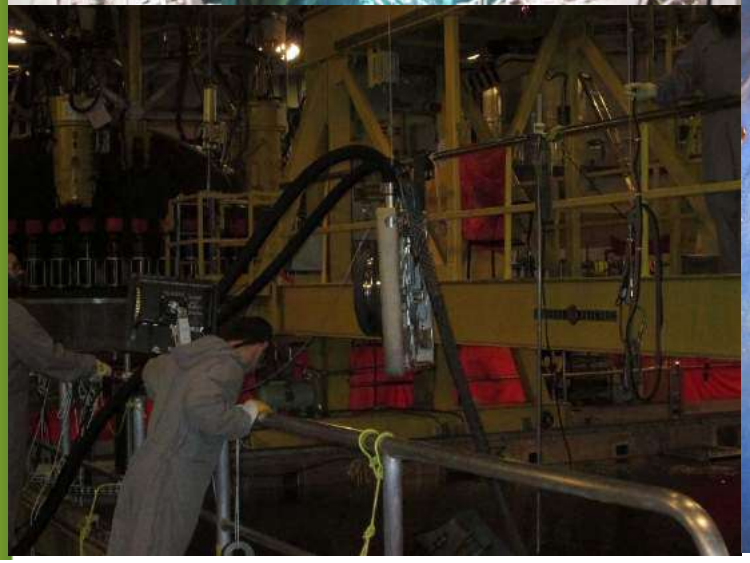
AREA RADIATION LEVELS IN DRY-WELL (Average normalized values) – Before and After CHEM. DECON.



- RF 20th Before Decon
- RF 20th After Decon
- Outage 21th

DECONTAMINATION EQUIPMENTS





DECONTAMINATION EQUIPMENTS

SEPR
SOCIEDAD ESPAÑOLA DE PROTECCIÓN RADIOLÓGICA

Thank you

eduardo.sollet@telefonica.net