Radsynch2017 Questionnaire and Survey Results

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I. Purpose

At Pohang Accelerator Laboratory, the safety control policy of synchrotron radiation (SR) user has been changed for following the Korean Nuclear Safety Acts revised in 2016. The access control of the SR users in the view of radiation safety is very common activity in any synchrotron facilities. Depending on national regulation and the facility policy with a radiation level control, the practical procedures of each facility can be different even though the risks to the user at the experimental hall are very similar to each other. So it may be possible to introduce some standard model through comparing the safety rules of each facility. The standard model of safety control of the users is useful to setup the guideline which prevent the excessive requirement of the safety policy and secure users' safety efficiently. The '5 keV' energy is normally used as a criteria to determine which is the radiation to be controlled or not. So the status of photon energy used in beamline of all facilities was also surveyed.
It is also important to understand inherent concept of each facility to set up its policy because it is determined by the safety culture and philosophy of each facility. This survey results may show several unique idea from each facilities or common idea. It will be useful to make the improved safety culture for synchrotron radiation facilities. It is one of main purposes of RADSYNCH workshop.
To get the standard model of the safety policy, the questionnaire including these items is prepared.

- Which category do the SR users belong to in radiation protection policy and what is required for the users including the dose limit?
- Which interlock criteria are applied at each facility?
- What is the control level of experimental hall, especially, the hutch in area classification?
- What is the procedure to install and operate new beamline?

The details of the questionnaire are attached in Appendix 1.

II. Understanding survey results

Totally 15 countries, 21 institutes, and 27 SR facilities have joined this survey as shown in Table 1 where 4 X-ray Free Electron Lasers are also introduced. In the case of institutes which have two SR facilities, both are in the same policy of radiation protection. However, there is the exceptional case to apply different guideline depending on the accelerator parameter. The different limits of personal dose were found in Europe but those were chosen in the maximum limit of European guideline.
The radiation protection rules applied to the SR users are almost the same at different countries. That is, the SR users are classified as the general publics and the place where they access like the experimental hall including beamline hutch are not radiologically-controlled area when the shutter is close. The personal dosimeter is not required in many facilities but the electronic dosimeter is required additionally to access into a hutch in Sweden.

Table 1. List of facility and contributor to this survey

	Facility	**Contributor**
1	MAX IV lab.	Magnus Hörling
2	Elettra	Katia Casarin
3	ALBA	Arnaud Devienne
4	SOLARIS	Justyna Wiklacz
5	BESSY-II	Yvonne Bergmann
6	ANKA	Michael Hagelstein

7	European XFEL	Eric Boyd
8	PETRA III	Albrecht Leuschner
9	SOLEIL	Jean-Baptiste PRUVOST
10	iRSD (formerly LURE)	Jean-Michel Horodynski
11	SSRL LCLS	Sayed Rokni Johannes Bauer
12	CLS	Brian Bewer
13	TLS / TPS	Joseph C. Liu
14	PLS-II / PAL-XFEL	Hee-Seock Lee, Nam Suk Jung
15	Spring-8 / NewSUBARU	Yoshihiro Asano
16	KEK-PF / KEK-PFAR	Hiroshi Iwase
17	SLRI	Methee Sopehn
18	SSLS	Yang Ping
19	Indus-2	Prasanta Kumar Sahani
20	ESRF	Paul Berkvens
21	APS	Bradley Micklich
22	Australian Synchrotron	Hock Ch'ng

Annual Dose Limits

Several countries have different control limits. Even though EU recommended common standard, different limits were surveyed at each institutes. In many SR facilities, dose limits of users seem to be the same to the Public dose, 1mSv/year. However a few facilities including Japanese one apply the dose limit same to radiation workers, 20 mSv/y. Mostly, SR facilities have their own limits lower than the regulatory one.

Detector Interlock Limits

At the emergency condition, the safety system may generate an interlock signal to shut down the accelerator operation or to close a safety shutter of SR beam line. To generate the interlock signal each facilities use the radiation level at the experimental hall and at beam line. European facilities apply 2 μSv per 4 hour as the limits. But it can be total dose of gamma and neutron or be only gamma or neutrons. To avoid frequent unexpected shut-down of facilities by instantaneous high dose rate but small integrated dose, all facilities use the integrated dose as the criteria. Depending on facilities, different standards like 4 hours or 1 hour are used. Some facility doesn't apply the interlock limit for the experimental hutch.

Area classification

Commonly in EU, the experimental area where users access mainly, is classified as the supervised area, not controlled area. Such a policy is found at the other facilities, even though they use a different terminology. The comparison of various criteria of different facilities is also good point in future discussion. The beam line hutch when the safety shutter is opened is classified as 'controlled area', 'Prohibited area', 'exclusion area', etc but all concepts mean that human can not access in the hutch at the case. When the safety shutter is closed, most of facilities say that it is accessible area, unclassified, supervised area, etc. But at MAX IV, it is still controlled area with allowance of human access.

SR User

Commonly SR users are a person who has no long time activity with radioactive isotopes and radiation generators. Except of a few SR users, they are trained and are out of requirement of radiation medial check. So in the survey results, most of facilities assign the SR users as the General publics, and don't request the medical check and their training programs are brief introduction of radiation safety (fundamental level and online training) and usage of beam line.

About the wearing personal dosimeter, more than half facilities keep the policy to wear the dosimeter but several facilities don't require it because experimental hall is classified as the public area or controlled with

lower radiation level. However, MAX IV prepares the alarm dosimeter additional to a passive dosimeter at the front of hutch.

License of Beamline Operation.
It is an issue whether SR beamline is independent device (facility) which require the independent safety review by a governmental authority or not, and how is the review intensity. Many facilities don't need the extra permit but it is required to submit some of safety report with review by the authority. In a few cases, the beam line is assigned as independent device to the accelerator facility and the extra permission is required. In Korea, the safety report should be submitted to the government and the review of only the report is done by inspection institute authorized by government. However the field inspection, which is normally followed after reviewing the report, is exempted. In such case, the license is updated.

III. Summary

This survey is the second activity in Radsynch community after the first survey issued at 6th Radsynch workshop in 2011. The first survey was also very valuable and the results were good reference for each facility policy. This survey also includes the data of SR facilities which experts couldn't attend at 9th Radsynch workshop at TPS where this was issued. At every Radsynch workshop this data can be corrected or updated according to the variation of each SR facility policy. All efforts of Radsynch community will contribute to set up the standard model of radiation safety of SR facility and the good practice. All data of questionnaire and survey results are shown in two appendixes.

Appendix 1 – Questionnaire form
Appendix 2 – Survey results

Appendix 1

Radsynch2017 Questionnaire

Proposed by Hee-Seock Lee, added by *Joseph Liu*

1. Basic Information

Name of Facility	
Location & Country	
Electron Beam Energy	
Stored Beam Current	
Operation Mode	☐*Top-up* ☐*decay* ☐*other* :
Number of Beamlines	(ea) for Used Photon Energy < 5 keV (ea) for Used Photon Energy > 5 keV

2. *Dose limit*

Facility annual dose limit	*Staff :__mSv, User :__mSv, Contractor:__mSv,* *Note:*
Regulatory annual dose limit	*Staff :__mSv, User :__mSv, Contractor:__mSv,* *Note:*
Detector interlock limit for accelerator	*Note:* *At ☐ shielding surface, ☐ experimental floor,* *☐ other :*
Detector interlock limit for beamline	*Note:* *At ☐ hutch surface, ☐ user end station,* *☐ other :*

3. Introduce area (zone) classification in your facility

4. Is the experimental hall of your facility classified to the "radiation control area"?

☐ No ☐ Yes

If yes, what is the reason?

If no, which area category is applied to there?

5. Which area categories are applied to the experimental hutch and optical hutch of your facility?

	Beam On (Shutter Opened)	Beam Off (Shutter Closed)
Optical Hutch		
Experimental Hutch		

- What is the reason of such classification?

6. The SR user classified as

☐ Radiation worker (if multi-level of RW is, please mark)

☐ General public

☐ The other ( )

What is the base policy for classification of the SR user?

7. Requirements for the SR user
   - (annual) Medical Check ☐ No ☐ Yes
   - what kind of training is done for user? ( )
   - Does the SR user wear the personnel dosimeter at the experimental hall?
     ☐ No ☐ Yes, Always ☐ Yes, on special occasions ( )

8. Do you need extra operation permit from governmental authority to install or use new SR beamline?

Appendix 2

Survey Results of Radsynch2017 Questionnaire

September, 2017

1. Basic Information

Name	Location & Country	E- Beam Energy [GeV]	Stored Beam Current [mA]	Operation Mode	Number of Beamlines	
						E_{photon} > 5 keV
MAX IV lab.	Lund, Sweden	3	500 (nominal)	Top-up & Decay	2	E_{photon} < 5 keV
Elettra	Trieste, Italy	2 & 2.4	310@2 GeV, 160@2.4 GeV	Top-up	16	11
ALBA	Barcelona, Spain	3	400 (Design), 150 (Current)	Top-up	4	4
SOLARIS	Krakow, Poland	1.5	500 (Design), 300 (Current)	Decay	2	0
BESSY-II	Berlin, Germany	1.7	300	Top-up	43	7
ANKA	Karlsruhe, Germany	2.5	200	Decay	4	15
European XFEL	Hamburg, Germany	17.5	N/A	SASE linac	2	2
PETRA III	Hamburg, Germany	6	100	Top-up	1	16
SOLEIL	Saint-Aubin, France	2.75	500	Top-up	12	17
iRSD (formerly LURE)	Orsay, France	SuperACO : 0.8 (e+) DCI : 1 (e+)	SuperACO : 200 ~ 400 DCI : 300	Decay	20 (SuperACO)	18 (DCI)
SSRL LCLS	California, USA	3 2.3-17.1	500 N/A	Top-up SASE & Seeded linac	4 2 (< 2 keV)	12 5 (> 2 keV)
CLS	Saskatoon, Canada	2.9	250	Decay	7	14
TLS TPS	Hsin-Chu, Taiwan	1.5 3	360 300~400	Top-up	10 2	8 5
PLS-II PAL-XFEL	Pohang, Korea	3 10	400 N/A	Top-up SASE linac	10 1	23 1
Spring-8 NewSUBARU	Hyogo, Japan	8 1.5	100 (max.200) 500	Top-up		57 9
KEK-PF KEK-PFAR	Tsukuba, Japan	2.5 6.5	450 450	Top-up	30	30
SLRI	Korat, Thailand	1.2	150	Decay	2	8
SSLS	Singapore	0.7	230	Decay	5	3
Indus-2*	Indore, India	2.5	200	Decay	3	5
ESRF	Grenoble, France	6	200	Decay		45
APS	ANL, USA	7.0	100	Top-up/Decay	2	67
Australian Synchrotron	ANSTO, Australia	3.0	200	Top-up	1	8

2-1. Annual Dose Limit

Name	Facility annual dose limit (Unit : mSv)			Regulatory annual dose limit (Unit : mSv)		
MAX IV lab.	Staff : 1	User : 1	Contractor : 1	Staff : 6	User : 6	Contractor : 6
Elettra	Staff: See Note	User: 0.5	Contractor: 0.5	Staff: See Note	User :1	Contractor: 1
	Note: - 0.5 mSv for not-exposed personnel - 2 mSv for B-classified radiation workers - 5 mSv for A-classified radiation workers The facility annual dose limit reported above are lower than the regulatory annual dose limit due to the application of the optimization principle.			Note: - 1 mSv for not-exposed personnel - 6 mSv for B-classified radiation workers - 20 mSv for A-classified radiation workers		
ALBA	Staff : 1	User : 1	Contractor : 1	Staff : 1	User : 1	Contractor : 1
	Note: for radiation worker - Category A: 50 mSv/year but no more than 100 mSv/5 years - Category B: 6 mSv/year			Note: for radiation worker - Category A: 50 mSv/year but no more than 100 mSv/5 years - Category B: 6 mSv/year		
SOLARIS	Staff : 6*	User : 1	Contractor : 1	Staff : 20*	User : not defined	Contractor : 1 & 20**
	Note: *authorities permission up to 20 mSv, internal limitation 6 mSv			Note: * max. 50 mSv in one year, but not more than 100 mSv in 5 years ** depending on the external company's classification policy (Radiation workers - 20 mSv, Non-radiation workers -1 mSv)		
BESSY-II	Staff : 6	User : 6	Contractor : 6	Staff : 6	User : 6	Contractor : 6
	Note:			Note:		
ANKA	Staff : 1*	User : 1	Contractor : 1	Staff : 1	User : 1	Contractor : 1
	Note: for Staff Category B personnel, dose > 1 mSv (acceptable)			Note:		
European XFEL	Staff : 1	User : 1	Contractor : 1	Staff : 1	User : 1	Contractor : 1
	Note:			Note:		
PETRA III	Staff : 1	User : 1	Contractor : 1	Staff : 1 or 6	User : 1	Contractor : 1 or 6
				Note: 6 mSv for radiation workers in controlled areas		
SOLEIL	Staff : 1	User : 1	Contractor : 1	Staff : 1	User : 1	Contractor : 1
	Note: any workers at SOLEIL is to be classified as non-radiation workers			Note: French Regulation radiation dose limits are as follow - 1 mSv for not-exposed personnel - 6 mSv for B-classified radiation workers - 20 mSv for A-classified radiation workers		
iRSD (LURE)	Staff : 6	User : 1	Contractor : 1	Staff : 6	User : 1	Contractor : 1
	Note:			Note: Same as the facility annual dose limits		

SSRL LCLS	Staff: See Note	User : 1	Contractor : 1	Staff : 50	User : 1	Contractor : 1
	Note: SLAC has set several values: - Administrative Control Level of 5 mSv/y for all person, - An ALARA Dose Management Level of 3.6 mSv/y for radiological workers, shielding design limit of 10 mSv/y for areas accessible by only radiological workers, - Shielding design limit of 1 mSv/y for areas accessible by only non-radiological workers (such as SSRL experimental hall) and 1 mSv/y for public.			Note: most users and contractors to SSRL have basic training only and have the dose limit as public.		
CLS	Staff : 0.8*	User : 0.8	Contractor : 0.8	Staff : 1*	User : 1	Contractor : 1
	Note: *for NEWs the facility limit is 2 mSv			Note: *for NEWs the facility limit is 20 mSv		
TLS TPS	Staff : 1	User : 1	Contractor : 1	Staff : 20 & 1	User : 1	Contractor : 1
	Note: design dose limit for radiation control			Note: 20 mSv for staff as radiation worker, 1 mSv for non-radiation worker.		
PLS-II PAL-XFEL	Staff : 20	User : 1*	Contractor: 1*	Staff : see note20	User : not defined	Contractor : 6
	Note: * In special case like long-term or work in tunnel, 6 mSv is applied			Note: Radiation Worker : 100 mSv in 5 year (Max. 50 mSv in a year), General Public: Avg. 1 mSv/yr in 5 year, (Max. 1mSv in a year) Frequent Visitor: 6 mSv in a year		
SPring-8 NewSUBARU	Staff : 20	User : 20	Contractor : 20	Staff : 50	User : 50	Contractor :
	Note:			Note:		
KEK-PF KEK-PFAR	Staff : 20	User : 20	Contractor :	Staff : 50	User :	Contractor :
	Note:			Note:		
SLRI	Staff : 20	User : 20	Contractor : 20	Staff : 20	User : 20	Contractor : 20
	Note:			Note:		
SSLS	Staff : 1	User : 1	Contractor : 1	Staff : 1	User : 1	Contractor : 1
	Note:			Note:		
Indus-2	Staff : 20	User : 20	Contractor : 15	Staff : 20	User : 20	Contractor : 15
ESRF	Staff : 1	User : 1	Contractor : 1	Staff : 1	User : 1	Contractor : 1
APS	Staff : 5	User : 1	Contractor : 1	Staff : 50	User : 1	Contractor : 1
	Note: Staff(non-radiation worker) – 1 mSv			Note:		
Australian Synchrotron	20	20	1	20	20	1
	Note: The facility, however, has a dose constraint of 1 mSv/y. This is the personal radiation dose limit for staff & users. (ALARA)			Note:		

2-2. Detector Interlock Limit

Name	Detector interlock limit for accelerator	Detector interlock limit for beamline
MAX IV lab.	2 μSv/4h at experimental floor	2 μSv/4h at hutch surface
Elettra	The only radiation detectors which are in interlock with the accelerator are the SR beamlines' radiation monitors. They can inhibit or interrupt electron beam injection if an Alarm state is triggered. See next point for more details.	Each beamline has a gamma radiation monitor connected to the beamline Personnel Safety System (PSS). Each radiation monitor has 3 types of PreAlarms /Alarms: - PreAlarm on integrated dose: 2μSv over 4 hours - PreAlarm on dose rate: 3μSv/h for more than 360s - Alarm on dose rate: 6μSv/h for more than 180s *PreAlarm triggers:* - automatic closing of the beamline stoppers - inhibition of access to the hutches *Alarm triggers:* - automatic closing of the beamline stoppers - inhibition of access to the hutches - inhibition of electron beam injection* from the booster to the ring *Here we refer to the injection carried out with all beamlines' stoppers closed, not to top-up injection. Top-up injection is continuously monitored (and eventually inhibited or stopped) by the accelerator Personnel Safety System.
ALBA	2 μSv/4h (shift dose) at all experimental hall detectors (at floor & shielding surface)	1.5 μSv/4h (shift dose) at detector associated to the beamline (at hutch surface)
SOLARIS	At shielding surface	At hutch surface
BESSY-II	No	No
ANKA	2 μSv/4h at experimental floor (not interlocked)	2 μSv/4h at experimental floor (not interlocked)
European XFEL	At shielding surface	At hutch surface
PETRA III	2 μSv/4h at shielding surface, at experimental floor	0.5 μSv/h, ~ 2 μSv/h for areas difficult to access
SOLEIL	2 μSv within 4 hours for both γ & n at experimental floor & shielding surface	2 μSv within 4 hours for both γ & n at hutch surface

iRSD (LURE)	25 μSv/h at experimental floor & shielding surface	25 μSv/h at user end station
SSRL LCLS	50 μSv/h (photon dose rate) at shielding surface 50 μSv/h (photon dose rate) at shielding surface	20 μSv/h (photon dose rate), 20 μSv/day (integral dose) at hutch surface 50 μSv/h (photon dose rate) at shielding surface
CLS	5 μSv/h on any AARMs at experimental floor	ACIS interlock at user end station
TLS TPS	2 μSv every 4 hours for interlocked monitor at shielding surface	0.5 μSv/h at hutch surface & 2 μSv every 4 hours for interlock monitor on hutch surface or at user end station
PLS-II PAL-XFEL	5 μSv during 1 hr (time-shifted accumulate dose) at shielding surface	5 μSv during 1 hr (time-shifted accumulate dose) at hutch surface or user end station
SPring-8 NewSUBARU	10 μSv/h (controlled area), 1 μSv/h (boundary of controlled area) at experimental floor	No interlock detectors for beamlines
KEK-PF KEK-PFAR	20 μSv/h at experimental floor & shielding surface	
SLRI	At experimental floor	At user end station
SSLS	Not available	Not available
Indus-2	No limit, Alarm level kept at 1 μSv/h	25 μSv/h at user end station
ESRF	2 μSv/4h 64 neutron monitors (active bubble detectors) on storage ring tunnel roof	2 μSv/4h 1 ionisation chamber outside optics hutches
APS	0.03 mSv/h for neutron, 0.1 mSv/h photon	None
Australian Synchrotron	There are no detector interlock limits.	There are no detector interlock limits.

3. Area (zone) classification in each facilities

Name	Area (Zone) Classification
MAX IV lab.	- Controlled area: Accelerator enclosures and beamline hutches. Definition in Swedish regulation: *"A workplace where the workers may receive any of the annual radiation doses stated in…"* - Supervised area: Experimental floor etc. Definition in Swedish regulation: *"A workplace that is not a controlled area … but to which these regulations apply..."*
Elettra	- Interdicted areas: · booster/ring tunnels during operation with the beam · ring tunnel when the (high power) radiofrequency (RF) cavity positioned in section n.9 of the ring is ON · beamlines' hutches during operation with the beam - Controlled areas: · booster/ring tunnels when the accelerator is in the OFF status (i.e. accelerator turned off but ready to start-up) · fenced areas around (low power) RF cavities in sections n.2,3,8 of the ring tunnel, when the plants are on · fenced areas around pre-injector klystrons, located in the pre-injector Service Area, when the klystrons are on - Supervised areas: · ring Service Area when the booster or the ring are in operation with the beam - Not-classified areas: · Experimental Hall and nearby laboratories · booster/ring tunnels in shutdown, exception done for the areas affected by induced radioactivity, which are fenced and signaled.
ALBA	- Offices, Experimental Area and Service Area classified as "public area". - Accelerator bunkers and Beamlines hutches classified as "prohibited access" when the space is in INTERLOCKED state for PSS - Beamlines hutches classified as "public area" when the space is in OPEN state from PSS. - Accelerator bunkers is classified depending on activation measurements when the space is in RESTRICTED state or OPEN state for PSS: · Below 0.5 μSv/h ⇒ "Public area" · From 0.5 μSv/h to 3 μSv/h ⇒ "Supervised area" · Above 3 μSv/h ⇒ "Controlled area"
SOLARIS	- Unclassified area (< 1mSv/year): part of the experimental hall, control room, offices - Supervised area (< 6mSv/year): ring service gallery, ring roof, linac klystron gallery - Controlled area (> 6mSv/year): linac and ring tunnels (access forbidden during machine operation), optical hutches (access forbidden during beamline operation and during electrons injection into the ring), temporarily experimental hall near injection region during machine operation
BESSY-II	- Experimental Hall: radiation controlled area (> 6 mSv/a) - Accelerator Tunnels, hutches, front ends: exclusion area (> 3 mSv/h) - Office: general public (< 1mSv/a)

ANKA	Experimental area is freely accessible since the annual effective dose due to the operation of the accelerator is < 1 mSv.
European XFEL	There are no radiation controlled areas of the experimental hall. The only controlled area are those portions of the tunnel exposed to the electron beam.
PETRA III	Experimental halls: supervised area (no access restrictions) Accelerator (off): supervised area, certain controlled areas due to activation and neighboring accelerators (personal dosimeter required) Accelerator and experimental hutches (beam on): Prohibited areas (no access) Experimental hutches (beam off): supervised area
SOLEIL	LINAC/BOOSTER/SR : forbidden area during operation (beam on) Experimental hall : Not classified area Beam line hutches : not classified area (beam off) – forbidden area (beam on)
iRSD (LURE)	French regulations define 3 regulated zones and 2 specially-regulated zones where there are radiological risks. For the LURE plant, the radiation protection zoning was defined as followed: - When the LINAC was ON: the corridor of the LINAC was classified as a forbidden zone (efficient dose superior to 2,5 $Sv.h^{-1}$). - When the LINAC was OFF: the corridor of the LINAC was classified as a monitored area (efficient dose inferior to 7,5 µSv in one hour and superior to 80 µSv per month) excepted the convertor area, classified as a green controlled area (superior to 7,5 µSv in one hour and inferior to 25 µSv in one hour). - When Super ACO was ON: The tunnel was classified as forbidden area. - When Super ACO was OFF: the tunnel was classified as a monitored area. The hutches for X-rays beamlines were not accessible if the X-rays were present in the hutch.
SSRL LCLS	- Controlled Area (CA): Following DOE regulation, areas where an individual would receive < 1 mSv in 1 year (no dosimeter is needed for entry). - Radiologically Controlled Area (RCA): This is special term at SLAC for dosimeter requirement. At SLAC, a RCA is a Controlled Area that requires personnel dosimeter for entry. Individuals who enter only RCAs without entering Radiological Areas are not expected to receive > 1 mSv in a year. - Radiation Area (RA): Areas where an individual could receive a dose of ≥ 0.05 mSv in 1 hour at 30 cm from the source
CLS	- Public Access Zone (< 50 µSv/yr) - Free Access Zone (< 0.5 µSv/hr) - Controlled Access Zone (< 5 µSv/hr) - Restricted Access Zone (< 100 µSv/hr) - Prohibited Access Zone (> 1 mSv/hr)
TLS TPS	- Radiation control area: High radiation area, such accelerator tunnel or hutch that requires interlock system to ensue no access during beam on stage. - Radiation supervised area: Notable radiation may exist during operation, such as experimental floor and end station areas where frequent access is granted after safety training. In NSRRC, we deploy interlocked radiation monitor and personnel dosimeter to ensure annual dose limit of 1 mSv is achievable. - Non radiation area: The area where visitors or non-radiation worker can access freely without limitation.
PLS-II PAL-XFEL	- Restricted Area (0.25 mSv/y < Dose < 1 mSv/y): Inside of PAL boundary and outside of accelerator building - Generally-Controlled Area (1 mSv/y < Dose < 20 mSv/y): Klystron Gallary, Experimental area, Beamline hutches with shutter closed.

	- Radiologically-Controlled Area (20 mSv/y < Dose < 1 mSv/h): Infield area of storage ring during beam operation, Accelerator enclosure and beamline hutches after end of beam operation, etc. - High Radiation Area (Dose > 1 mSv/h) : Accelerator enclosure and beamline hutches during beam operation
SPring-8 NewSUBARU	- Radiation controlled area (experimental hall, and inside the shield tunnel)
KEK-PF KEK-PFAR	- Controlled Area (1) Forbidden Area (Dose above 100 mSv/h) - Controlled Area (2) Restricted Area (Dose between 20 μSv/h to 100 mSv/h) - Controlled Area (3) General radiation Area (Dose between 1.5 to 20 μSv/h) - Warning Area (Dose between 0.2 to 1.5 μSv/h) - General Area (Dose below 0.2 μSv/h)
SLRI	- Controlled area: Radiation level ≥ 6 mSv/y - Supervised area: 1 mSv/y < Radiation level < 6 mSv/y
SSLS	- Prohibited Area：inside the accelerator vault, vault roof, building roof and inside the experimental hutch. (estimated dose rate > 1 mSv/h in the worst case except on the roof) - Supervised Area：experimental floor outside the hutch (< 1mSv/y).
Indus-2	- Zone 1 (Normally Accessible Area): < 1 μSv/hour (No procedures required) - Zone 2 (Restricted Entry Area): 1 ~ 10 μSv/hour (Dosimetry devices and procedures required) 10 ~ 100 μSv/hour (Investigation Level) - Efforts made to reduce radiation level < 10 μSv/hour - Zone 3 (Prohibited Area): > 100 μSv/hour (No entry permitted)
ESRF	All areas are either public areas (but always subject to access control, with only people authorized who have valid safety training, and in some cases administrative control, e.g. accelerator tunnels) or prohibited areas (accelerator tunnels and beamline hutches when beam on).
APS	Radiation area > 0.05 mSv/h
Australian Synchrotron	1. Radiation Area - D >25 μSv/h with restricted access or D >25 μSv/h with unrestricted access and with an occupancy factor of > 0.1. 2. Controlled Area - where a person is required to follow specific procedures designed to control their radiation exposure. Induction training for entering controlled area unescorted. All other persons must be supervised by an appropriately trained person. 3. Supervised Area - where access must be supervised by a person who has completed the appropriate induction 4. Unsupervised Area - where there is no restriction to entry in respect of radiation exposure.

4. Is the experimental hall classified as a "Radiation Control Area"?

Name	Answer	Reason (if YES) or Applied area category (if NO)
MAX IV lab.	NO	Supervised Area
Elettra	NO	The Experimental Hall is a not-classified area with a regulatory annual dose limit of 1 mSv/year and an optimization target limit of 0.5 mSv/year.
ALBA	NO	Since 2015, the experimental hall is classified as "public area" all the year. Between 2012 and 2015, during the first 3 years operation, the experimental hall was classified as "Supervised area" only during Machine days, and "public area" during Beamlines and Shutdown days
SOLARIS	YES (Current) NO (Future)	Presently during the commissioning some part of the experimental hall near injection region is a radiation control area because of radiation levels, the rest of it is the unclassified area. Ultimately the entire experimental hall will be the unclassified area.
BESSY-II	YES	Test operating license for top up and first cryogenic in vacuum undulator.
ANKA	NO	Accessible. Two of the experimental hutches are controlled area (Überwachungsbereich/Kontrollbereich) in case of radioactive material is handled.
European XFEL	NO	Supervised Area
PETRA III	NO	Supervised area (no restrictions)
SOLEIL	NO	Non regulated area, so called "ZNR".
iRSD (LURE)	NO	Only hutches for X-ray beamlines are classified if beam is present.
SSRL LCLS	NO	The experimental hall is classified as a "Controlled Area" as the dose in the experimental hall is less than 1 mSv per year and no dosimeter is needed for access.
CLS	YES	Because the annual dose for full work occupancy (2000 hrs/yr) would result in more than 1 mSv.
TLS TPS	NO	Radiation supervised area in NSRRC requires safety training to users and contractor workers before access card is functional. TLD is issued for personal radiation monitoring. Short term visitors without TLD must be escorted by staff member to access the radiation supervised area.

PLS-II PAL-XFEL	NO	Generally-Controlled Area. Related to our SR user issues, we have the plan to divide this area as the SR user accessible area and non-accessible area. The annual dose level will be less than 1 mSv for the SR user accessible area.
SPring-8 NewSUBARU	YES	Based on the Japanese law, we need access control to the beam control system, and we need check the dose for any person who enter the area with the possibility of the exposure.
KEK-PF KEK-PFAR	YES	The high-power linac is used as an injector to the ring. During a few days after the long shut down of the ring, dose rates in the experimental hall are high.
SLRI	NO	Supervised area is applied to experimental hall but everyone are not allowed access to this area during the electron beam injection and dumping.
SSLS	NO	Supervised area
Indus-2	YES	Radiation level in experimental hall is maintained at background level due to storage ring operation. However, there may a possibility streaming of radiation from the shield penetrations and from beamline hutches due to modifications in the structures. The radiation monitors kept in the sitting area/control panel area of beam lines are interlocked with beam line safety shutter to prohibit such inadvertent situations.
ESRF	NO	Public area, but subject to access control, with only people authorized who have valid safety training or to visitors, only when accompanied by authorized staff members
APS	NO	The experiment hall floor at the APS is not a radiation controlled area. Dosimeter readings taken over many years showed only background doses in occupied areas. Some of the experimental enclosures are controlled areas if radioactive material is present for experiments or when sealed sources are used for instrument calibration. There is no category applied to the experimental hall. However, personnel must have the required training as given in #7 below. Dose is less than 1 mSv/y and no dosimeter is required for access
Australian Synchrotron	NO	1. Radiation Area- Inside the accelerator tunnels./ Inside the beamline hutches (enclosures). 2. Controlled Area - Beamlines floor (including workshops and laboratories). Accelerator tunnel roofs. Crescent Area. ″Bull ring” (the open centre area of the main building, i.e. the inner area within the Booster Ring shield walls). 3. Supervised Area - Mezzanine floor. Buildings connected to the mezzanine floor i.e. the engineering building and the ‘Pod’ structure. 4. Unsupervised Area - Foyer and viewing gallery. Mezzanine conference rooms. National Centre for Synchrotron Science

5. Which area categories are applied to the experimental hutch (EH) and optical hutch (OH) of your facility?

Name	Hutch	Beam On (Shutter Opened)	Beam Off (Shutter Closed)	Reason
MAX IV lab.	OH	Controlled Area	Controlled Area	Annual dose limits may be exceeded. The area categorization is independent of status of equipment (e.g., shutters), i.e., it is not "dynamic".
	EH	Controlled Area	Controlled Area	
Elettra	OH	Interdicted Area	Not-classified Area	When the beam is off, personnel entering the hutches are not exposed to radiological risk, and therefore the area is not-classified. When the beam is on, access to the hutches is prevented by the beamline Personnel Safety System and therefore the area is "classified" interdicted.
	EH	Interdicted Area	Not-classified Area	
ALBA	OH	Prohibited Area	Public Area	When the hutches are in interlocked state for PSS, there is radiological hazard inside the Hutches, so the area is classified as "prohibited area". When the hutches are in open state for PSS, since the radiation levels are below public levels and no activation is measured in the beamline, the area is classified like the rest of the Experimental Hall as "public area".  
	EH	Prohibited Area	Public Area	
SOLARIS	OH	Controlled Area	Unclassified Area	Increased radiation levels during beamline operation inside the optical hutch.
	EH	-	-	
BESSY-II	OH	Exclusion area	Same status like exp. hall	possible high dose rates (vacuum system is not sufficient to absorb synchrotron radiation)
	EH	Exclusion area	Same status like exp. hall	
ANKA	OH	Closed area	Accessible	
	EH	Closed area	Accessible	
European XFEL	OH	Prohibited Area	Supervised area	Radiation levels when the shutters are closed are less than 0.5 µSv/h. When the shutter is open radiation levels are too high to be occupied.
	EH	Prohibited Area	Supervised area	
PETRA III	OH	Prohibited Area	Supervised area	No increased radiation level if shutters are closed.

	EH	Prohibited Area	Supervised area	
SOLEIL	OH	Controlled area (orange) Prohibited access	ZNR (free access)	Dose rate levels with respects to regulation's limit values.
	EH	Controlled area (orange) Prohibited access	ZNR (free access)	
iRSD (LURE)	OH	Access forbidden	Access not restricted	
	EH	For X-ray: Access forbidden, Otherwise access not restricted	Access not restricted	
SSRL LCLS	OH	Controlled Area	Controlled Area	No special classification for hutches. All hutches follow the classification of the experimental hall. Doses outside hutches are designed to meet the limit of 1 mSv/year.
	EH	Controlled Area	Controlled Area	
CLS	OH	Prohibited Access Zone	Controlled Access Zone	The ALARA principle requires that there be no access to any optical or experimental hutch when the shutter is open. When the shutter is closed it has the same classification as the experimental floor which surrounds it.
	EH	Prohibited Access Zone	Controlled Access Zone	
TLS TPS	OH	Radiation control area	Supervised area when accelerator is operating, non- radiation area when accelerator is shut down.	The area classification is specifically defined in the regulation of Taiwan Radiation Protection Act that we develop necessary radiation control procedures accordingly.
	EH	Radiation control area	Supervised area when accelerator is operating, non- radiation area when accelerator is shut down.	
PLS-II PAL-XFEL	OH	High Radiation Area	Generally-Controlled Area	The area of all hutches of PLS-II is changed to Generally-Controlled Area with closing of the shutter. But, for the PAL-XFEL, we remained the optical hutch tunnel as Radiologically-Controlled Area with consideration of accidental scenario of PAL-XFEL, such as the failure of main dump magnet.
	EH	High Radiation Area	Generally-Controlled Area	
SPring-8 NewSUBARU	OH	Radiation controlled area	Radiation controlled area	Experimental hall is always radiation controlled area.
	EH	Radiation controlled area	Radiation controlled area	

KEK-PF KEK-PFAR	OH	Radiation controlled area	Radiation controlled area	In usual accelerators, except medical accelerators and X-ray generators, the area are not radiation controlled area only if beams are off more that during 7 days
	EH	Radiation controlled area	Radiation controlled area	
SLRI	OH	Controlled area	Supervised area	Following the radiation zone classification in No.3
	EH	Controlled area	Supervised area	
SSLS	OH	Prohibited area	Supervised area	SSLS ring (Helios 2) is a soft X-ray ring and gamma-ray bremsstrahlung is very weak. There is no dose measurable of induced activity in the hutch.
	EH	Prohibited area	Supervised area	
Indus-2	OH	Inaccessible	Accessible	Safety shutter used in beam line frontend act as beam stop during sample changing. So both optics hutch and experimental hutch are accessible during safety shutter closed condition.
ESRF	OH	“prohibited access” if hutch interlocked	“public area” if hutch not interlocked	Public area when not interlocked, but access to the beamlines only authorized to people (staff, users, contractors) with a valid safety training or to visitors only when accompanied by authorised staff.
	EH	“prohibited access” if hutch interlocked	“public area” if Hutch not interlocked	
APS	OH	No Access	Controlled area (as #4)	
	EH	No Access	Controlled area (as #4)	
Australian Synchrotron	OH	Radiation Area	Controlled Area	no one can enter the hutch when the shutter is opened as the Personal Safety System (PSS) prevents entry and if entry is forced, the PSS will kill any beam from coming into that beamline down.
	EH	Radiation Area	Controlled Area	

6. SR users are classified as

Name	Classification	Base policy for classification of the SR user
MAX IV lab.	Others: Category B	Category B: - Annual dose < 6 mSv - No medical check - From the Swedish regulation: *"For workers belonging to category B, surveillance of doses shall be performed to such an extent enabling demonstration that the classification in category B is correct."* Our interpretation of this is that as long as we can demonstrate that the classification of staff and long term users as category B is correct (through personal dosimetry), then personal dosimetry for remaining users is not required.
Elettra	Others: not-classified workers	Beamlines' users are not-classified workers, therefore they are not required to submit to medical examinations nor to wear a radiation dosimeter.
ALBA	General Public	Since SR users are working in "public areas", they are classified as General Public (< 1 mSv/year)
SOLARIS	General Public	Every user is treated as a person from general population. Radiation levels on the experimental hall show, that there is no need to change this users classification policy. Users have not access to the radiation classified areas.
BESSY-II	Radiation Worker	Test operation license: it cannot be excluded that the personal dose rate is < 1 mSv/year
ANKA	General Public	
European XFEL	General Public	
PETRA III	General Public	We perform regular surveys on all synchrotron radiation beam lines assuring that the radiation level in all freely accessible areas is below 0.5µSv/h. Furthermore active sensors (acting on beam shutter or accelerator) and passive sensors (read out during the maintenance week (~every 6th week)) are installed in the experimental halls. No increased Radiation level is observed.
SOLEIL	Others: Synchrotron users are considered as workers but not exposed to ionizing radiations (almost but not really as General public in terms of the French laws), except for the radioactive materials beamline → B classified workers)	1st: depends of the employer classification of the worker with respects to exposure levels at their current working place. 2nd: Policy of SOLEIL to facilitate users' access to SOLEIL, especially for whom that are not exposed at their home lab.
iRSD (LURE)	General Public	Radiological classification of workers is based upon the radiological assessment made by the RPE. Using available data, like measurements or numerical simulations, the efficient (and equivalent dose) dose integrated by a worker is assessed. If the efficient dose is inferior to 1 mSv per year, workers do not need to be classified as radiation worker.

SSRL LCLS	Other: similar with non-radiological employee	The dose limit for SLAC general employee is same as the limit for general public. Users are same with general public on dose limit. But users need to take the “General Employee Radiological Training” to enter the experimental hall.
CLS	General Public	They are in the building a limited time, and are only able to perform a preset series of operations that have been tested and proven to be safe.
TLS TPS	General Public	There are two categories of radiation worker in our legal system, the radiation worker and non-radiation worker with due dose limit. Since our design dose limit for user is equivalent to the general public, e.g. the non-radiation worker, that we may relax several radiation control measures especially the health check to those users who come and go frequently.
PLS-II PAL-XFEL	General Public (until Oct. 2016, Frequent Visitor)	SR users were classified as Frequent Visitor but recently, Nuclear Safety Act about Frequent Visitor was changed. New requirements for Frequent Visitor (annual medical check, reporting the exposure record to government and extended safety training every year) are issued. So, PAL policy has been changed to assign the SR users as General Public because it is excessive to apply new requirements to the SR users and the radiation level at experimental area are sufficiently low.
SPring-8 NewSUBARU	Radiation Worker	
KEK-PF KEK-PFAR	Radiation Worker	Users are classified as radiation worker even radiation stops completely in hutch.
SLRI	Radiation Worker	Base policy for our classification is the radiation dose per year.(> 1 mSv/y)
SSLS	General Public	The floor dose at SSLS above the background is negligible. So SSLS users are classified as General public.
Indus-2	Radiation Worker	SR user has to qualify the radiation safety training prior to entering to experimental hall for experiment.
ESRF	General public	As for all people working at the ESRF, we guarantee the derived effective dose limit of 2 μSv/h.
APS	Others (Non-radiation worker)	Storage ring users are considered to be non-radiation workers. Non-radiation workers are subject to the same annual dose limit as the general public.
Australian Synchrotron	Others (occupationally exposed person)	A User may be exposed to radiation as part of the work (occupation) being undertaken, hence, occupationally exposed person. The dose limit of 'occupationally exposed person' is 20 mSv/year.

7. Requirements for the SR user

Name	(Annual) Medical Check	Training	Wearing the personal dosimeter at the experimental hall
MAX IV lab.	NO	Online safety training with test as well as practical demonstration at beamline	YES, on SPECIAL occasions at beamlines under commissioning and for long term users (>2 months/year)
Elettra	NO	Beamlines' users are required to carry out an on-line training regarding both radiological safety and general safety. The training can be performed also from remote (i.e. without being at Elettra), after registration in the Elettra Virtual Unified Office (VUO). Beamlines' users who are assigned a personal code to take the hutch keys (e.g. long-contract users) are required to carry out a frontal training held by a person of the Radiation Protection Service and focused on the beamline Personnel Safety System.	NO
ALBA	NO (see note*)	Online safety training with online quiz	NO
SOLARIS	NO	Radiation safety training, repeated every 12 months	NO
BESSY-II	NO	Online training	YES, ALWAYS
ANKA	NO	Computer based instruction	NO
European XFEL	NO	Online & onsite general safety training including radiation protection training	NO
PETRA III	NO	Web based instruction: general safety and radiation safety aspects of the facility used. On site instruction: beam line specific	NO
SOLEIL	NO	Online training	NO for general users YES, on SPECIAL occasions, and only for the ones using the dedicated radioactive material beamline
iRSD (LURE)			
SSRL LCLS	NO	General Employee Radiological Training (GERT)	NO
CLS	NO	Facility safety training, general radiation awareness, and beamline specific orientation	YES, ALWAYS
TLS TPS	NO	Safety training including radiation protection and ESH	YES, ALWAYS
PLS-II PAL-XFEL	NO	Online safety training with a test	YES, ALWAYS
SPring-8	YES	Training for radiation workers	YES, ALWAYS

NewSUBARU			
KEK-PF KEK-PFAR	YES	Radiation Education	YES, ALWAYS
SLRI	NO	Radiation and industrial hygiene training	YES, ALWAYS (electronic dosimeter)
SSLS	NO	Brief of general safety and radiation training is given.	YES, on SPECIAL occasions (e.g., school student, experimental work)
Indus-2	NO	Radiation safety training	YES, ALWAYS
ESRF	No medical follow-up for users done by ESRF, but we ask for medical fitness certificate from home institute	Online safety training, with online test	NO
APS	NO	Laboratory (Argonne) orientation; facility (APS) orientation; beamline orientation; computer security; General Employee Radiological Training	NO
Australian Synchrotron	NO	Safety induction before entry to the Experimental Hall is allowed • Work, Health and Safety; Radiation Safety; and Personnel Safety System	NO. Exemption from personal radiation monitoring for users by radiation regulator(ARPANSA) in 2014

*In ALBA, Safety Declaration is requested to the SR users. It's like occupational medical examination done at the user home institute.

8. Extra operation permit from governmental authority to install or use new SR beamline?

Name	Answer
MAX IV lab.	**No extra permit needed**. However, risk assessment, commissioning plan and description of the personnel safety system should be submitted to the authority before start of commissioning.
Elettra	When we install a new SR beamline we **have to notify the installation** to the National Authority and to send them the technical documentation concerning the radiological risk assessment, the description of the Personnel Safety System (PSS) and the checklist that will be used for the PSS commissioning. **If no request** of additional documentation is received from the Authority, **after 90 days we can start** the beamline commissioning.
ALBA	**Yes**, new beamlines need an authorization from the governmental authority to operate. To obtain such authorization, a report including shielding studies must be sent to the regulator (Nuclear Safety Council). A tax must be payed and an inspection is done by the regulator at the end of the commissioning period.
SOLARIS	**No.**
BESSY-II	**Only if a hutch is needed** then we need extra operation permit from governmental authority (interlock saved exclusion area)
ANKA	We are **permitted** to install new beamlines and **notify** the governmental authority.
European XFEL	**No.**
PETRA III	**Yes**: Inspection by an external authorized expert followed by permission of the authority.
SOLEIL	**Generally No**. But could be necessary for specific purpose. Before opening a new beamline to users and even for the BL team, a formal intern authorization to operate a new beamline is mandatory, based on radiation protection tests and surveys, delivered by SOLEIL's Radiation Protection Group. This authorization and all reports connected to it are able to be controlled by French Regulation Authority.
iRSD (LURE)	
SSRL LCLS	**No**.
CLS	**No**, a license amendment is not required for a new beamline specifically. However, up to date procedures for the commissioning and operating of beamlines is required in general.
TLS TPS	Our **supervising authority acknowledges** the NSRRC beamline safety review system when we only need to submit the document of beamline safety report, interlock check list, radiation survey results and readiness review report when the beamline is ready to open for users.
PLS-II PAL-XFEL	**Yes**, we submit all safety documents to get a permit (Change of Permitted Condition) But the next step, field inspection is exempted.
Spring-8 NewSUBARU	**Yes**.
KEK-PF KEK-PFAR	**Yes**.

SLRI	**No**, SLRI needs to have only the license for the possession and utilization of radiation machine.
SSLS	**Yes**, we need to make a safety assessment to university authority, including a dose report.
Indus-2	**Yes**, Installation and commissioning of new SR beam line require approval from national regulatory body.
ESRF	**No**, an update is sent to the authorities at least once every 5 years.
APS	**No**
Australian Synchrotron	**Yes**, Once approved, ARPANSA will then issue us a new facility licence to cover the additional beamline but no separate licence.