EUROPEAN SPALLATION SOURCE

Archive number	2011-08-09 ID24 RadRelease v01.docx
Date	2011-03-30
Rev. Nr.	01 draft
Rev. Date	2011-08-09
Author	Mathias Brandin
Reviewer	Wolfgang Hees
Approver	Mats Lindroos

Interface
LINAC
ID 24 – Radioactive Releases

DRAFT

European Spallation Source ESS AB
Visiting address: Stora Algatan 4
P.O. Box 176
SE-221 00 Lund
SWEDEN

www.esss.se

Archive number	2011-08-09 ID24 RadRelease v01.docx
Date	2011-03-30
Rev. Nr.	01 draft
Rev. Date	2011-08-09
Author	Mathias Brandin
Reviewer	Wolfgang Hees
Approver	Mats Lindroos

TABLE OF CONTENTS

1. RADIOACTIVE RELEASES

There are two conceivable types of radioactive releases from the ESS accelerator. One is from an accidental leak of cooling media, mainly water from the closed cooling circuits. Another fluid present in sufficiently large quantities is helium, which is not activated and therefore not a radiological issue. The other type of release is that of activated air from the tunnel, which cannot be completely avoided.

These releases must be controlled to the degree required by the Swedish Radiation Safety Authority, SSM [1,2,3]. The annual effective dose limit to public individuals, from all sources, totals 1 mSv/y, of which a small share, 0.1 mSv/y, could be accepted to come from ESS.

1.1 Air releases

A preliminary study on the radioprotection of the accelerator was conducted [4], in which a rough estimate of the releases due to air activation was performed. The air exchange rate in the tunnel is the only parameter investigated. Releases of different nuclides for three different air exchange rates are given in Table 1. The air exchange rate is $r = Q/V$, where Q is the ventilation rate, and V is the total air volume. The approximations made in this study are conservative and make it less accurate but erring on the side of caution. While the irradiation time used is infinite, giving all the nuclides time to reach saturation activity, the release time is instantaneous, giving no time for decay. In reality, there will be interruptions in the production that might prevent the long-lived nuclides to reach saturation, as well as a significant transportation distance to the stacks where the air will be released, giving a transit time in which most of the short lived nuclides will decay to insignificant levels.

Table 1: Equilibrium activity of the air released from the linac tunnel as a function of the air exchange rate (r)

nuclide	**$T_{1/2}$ (s)**	Saturated activity **(Bq cm^{-3})**	Annual release (Bq)		
			r = 0.1	r = 1	r = 10
^{12}B	2.020E-02	3.6203E-01	1.097E+10	1.097E+11	1.097E+12
^{13}B	1.740E-02	8.8180E-02	2.302E+09	2.302E+10	2.302E+11
^{12}N	4.400E-02	1.1841E-01	1.954E+09	1.954E+10	1.954E+11
^{8}Be	6.700E-17	2.9108E-01	2.926E-05	2.926E-04	2.926E-03
^{6}He	8.081E-01	2.0655E-01	2.504E+11	2.504E+12	2.496E+13
^{8}Li	8.400E-01	1.4995E-01	1.885E+11	1.885E+12	1.879E+13
^{10}C	1.926E+01	1.9598E-01	5.658E+12	5.619E+13	5.256E+14
^{16}N	7.130E+00	2.7227E-01	2.908E+12	2.900E+13	2.828E+14
^{14}O	7.060E+01	*6.8806E-01*	*7.270E+13*	*7.090E+14*	*5.683E+15*
^{15}O	1.222E+02	*1.0657E+00*	*1.945E+14*	*1.863E+15*	*1.312E+16*
^{11}C	1.218E+03	**1.9309E+00**	**3.379E+15**	**2.382E+16**	**6.026E+16**
^{13}N	5.982E+02	**1.9043E+00**	**1.668E+15**	**1.378E+16**	**5.028E+16**
^{41}Ar	6.5770E+03	*3.2748E-02*	*2.557E+14*	*8.887E+14*	*1.181E+15*
^{7}Be	4.6040E+06	1.1376E+00	4.236E+16	4.256E+16	4.258E+16
^{3}H	3.89E+008	3.5295E-01	1.585E+17	1.585E+17	1.585E+17

Another approximation used is that the activation level in the entire accelerator tunnel is the same as at the high-energy end. Since activation may depend on proton energy, this result might not be entirely correct. With its approximations and limited set of parameters this study may serve primarily as a basis for further, more detailed, work.

1.2 Liquid and gaseous releases

There could be consequential liquid or gaseous releases due to accidental leaks in the closed cooling water circuits, but no studies have yet been conducted on that matter.

Future studies should investigate what activation levels could be expected, the probabilities of leak occurrences and their consequences, how well leaks could be contained and how much radioactivity would be released.

2. REFERENCES

[1] Strandman, *Strålsäkerhetsmyndighetens författningssamling 2008:27,* ISSN 2000-0987, 2009

[2] Strandman, *Strålsäkerhetsmyndighetens författningssamling 2008:50,* ISSN 2000-0987, 2009

[3] Strandman, *Strålsäkerhetsmyndighetens författningssamling 2008:51,* ISSN 2000-0987, 2009

[4] Ene, *Radioprotection studies for the ESS superconducting linear accelerator Preliminary estimates,* 2010