

EVALUATION OF THE RADIOLOGICAL IMPACT DUE TO THE OPERATION OF NUCLEAR POWER STATIONS IN ARGENTINA

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INTRODUCTION

There are at present in Argentina two commercial nuclear power stations in operation, Atucha I and Embalse, generating about 10% of the total electrical energy output. Atucha I NPP, equipped with a pressure vessel reactor, has an output capacity of 345 MW(e), while Embalse NPP is equipped with a Candu-type reactor and its output capacity is 670 MW(e). Both plants operate with natural uranium as a fuel, and heavy water as a coolant and as a moderator.

Atucha I is located at the right side of the Parana de las Palmas river, 100 km from Buenos Aires city, and Embalse is situated at the homonomous town in the province of Cordoba, 620 km from Buenos Aires, next to the Embalse del rio Tercero lake.

GASEOUS AND LIQUID EFFLUENTS

During the operation of both nuclear installations, radioactive fission and activation products are produced. These radioactive materials are for the most part retained within the fuel elements. Most of the radionuclides which diffuse into or are formed within the coolant are removed by the gaseous and liquid waste processing systems. Low-level releases which occur during normal operation are controlled and monitored. Radionuclides may reach the environment through either the gaseous or liquid effluents streams.

GENERAL PROCEDURE FOR DOSE ASSESSMENT

In this report, the terms individual dose and collective dose are used to mean individual and collective effective dose equivalent commitment respectively.

The general principles followed in assessing individual and collective doses for both nuclear plants are similar to those used by UNSCEAR (1). The type of models used are those called concentration factor or equilibrium models, where steady state among nuclide concentrations in different environmental compartments was assumed. In this approach, simple multiplicative coefficients were used to obtain the concentration of radionuclides at the point of intake by man (2). Dosimetric factors were taken from published reports (3,4).

Local data, either site specific or regional, was used when possible, such as transfer factors, ingestion rates and other habit data. Default values presented in specialized

reports were used in case of lack of site specific data (2).

As the actual dose equivalents received by members of the public vary widely depending on such factors as age, sex, dietary and other habits, as well as on variations in their environment, appropriate critical groups were identified. These groups are representative of those individuals in the population expected to receive the highest dose equivalents from the installations under consideration. The individual doses in the critical groups estimated in this report, represent the mean effective dose equivalents, assuming the most unfavourable conditions. These values are used to compare with the corresponding individual dose equivalent limits fixed by the Regulatory Authority.

The collective dose commitment represents a measure of total exposure of the population over time from a given release and it is usually considered as an indicator of the total detriment to health from the consequent irradiation. Modelling procedures were similar to those used for estimates of individual doses, and the concentrations of radionuclides in environmental compartments extending over large regions were estimated (5). Global assessments include only H-3 and C-14, because of the small contribution to these evaluations due to Kr-85 and I-129 releases from these plants (1).

Releases activity and composition were informed by the nuclear power plants operators, accordingly to the licensing requirements established by the Regulatory Authority.

RESULTS

Individual and collective doses were calculated for both nuclear installations, by using the previously described methodology. The corresponding values are presented in tables 1 and 2. The main contributors to individual doses in critical groups and regional collective doses are H-3, Kr-88, Xe-133 and Xe-135 for gaseous releases, while H-3, Co-60 and Cs-137 are the most relevant nuclides in assessing doses due to liquid discharges.

Global collective doses for H-3 and C-14 were calculated by using measured and estimated releases (6,7). These collective dose commitments, per unit electrical energy generated, are 1 man Sv/GW(e).a and 7E-02 man Sv/GW(e).a, for H-3 releases from Atucha I NPP and Embalse NPP respectively. The corresponding values for C-14 gaseous discharges were estimated to be 46 man Sv/GW(e).a and 37 man Sv/GW(e).a

CONCLUSIONS

The regulatory authority in Argentina has fixed the pair of values 0.3 mSv/a and 15 man Sv/GW(e).a as upper bounds for limiting the annual exposure of individual members of critical groups and for the collective dose commitment per unit electrical energy generated during the operation of nuclear power plants (8).

The above collective dose commitment is the incomplete quantity, integrated over the period of the practice, assumed to be several centuries (500 years). The results presented in this report are well below the limiting values for individual doses. The normalized global collective doses estimated for C-14 are lower than expected values, (1), but higher than the present upper-bound, which was not standing during Atucha I NPP and Embalse NPP designing period. Besides, much more data, particularly from continuous monitoring, are needed before a reliable assessment of the C-14 release rate and its environmental impact can be made.

On the other hand, as an application of the optimization requirement to C-14 releases, a retention system will be installed at the third Argentine nuclear power plant, Atucha II, at present under construction (9).

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TABLE 1	
INDIVIDUAL DOSES IN CRITICAL GROUPS (Sv/a)	
ATUCHA I NPP	EMBALSE NPP
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
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80	80
81	81
82	82
83	83
84	84
85	85
86	86
87	87
88	88
89	89
90	90
91	91
92	92
93	93
94	94
95	95
96	96
97	97
98	98
99	99
100	100

YEAR	ATMOSPHERIC RELEASES	LIQUID RELEASES	TOTAL RELEASES	ATMOSPHERIC RELEASES	LIQUID RELEASES	TOTAL RELEASES
1974	6.0E-07	5.8E-07	1.2E-06			
1975	2.2E-07	1.6E-06	1.8E-06			
1976	2.1E-06	2.5E-06	4.6E-06			
1977	1.4E-06	1.5E-06	2.9E-06			
1978	3.4E-06	1.1E-06	4.5E-06			
1979	3.1E-06	1.6E-06	4.7E-06			
1980	2.8E-06	1.2E-06	4.0E-06			
1981	1.3E-06	1.3E-06	2.6E-06			
1982	1.4E-06	8.7E-07	2.3E-06			
1983	3.1E-06	6.4E-07	3.7E-06			
1984	9.0E-07	9.6E-07	1.9E-06	1.6E-08	1.6E-07	1.8E-07
1985	1.2E-06	8.9E-07	2.1E-06	4.8E-07	1.3E-06	1.7E-06
1986	1.5E-06	7.0E-07	2.2E-06	2.4E-07	5.6E-06	5.8E-06

TABLE 2	
COLLECTIVE DOSES (REGIONAL) (man.Sv)	
ATUCHA I NPP	EMBALSE NPP
1975-1976	1975-1976
1977-1978	1977-1978
1979-1980	1979-1980
1981-1982	1981-1982
1983-1984	1983-1984
1985-1986	1985-1986
1987-1988	1987-1988
1989-1990	1989-1990
1991-1992	1991-1992
1993-1994	1993-1994
1995-1996	1995-1996
1997-1998	1997-1998
1999-2000	1999-2000
2001-2002	2001-2002
2003-2004	2003-2004
2005-2006	2005-2006
2007-2008	2007-2008
2009-2010	2009-2010
2011-2012	2011-2012
2013-2014	2013-2014
2015-2016	2015-2016
2017-2018	2017-2018
2019-2020	2019-2020
2021-2022	2021-2022
2023-2024	2023-2024
2025-2026	2025-2026
2027-2028	2027-2028
2029-2030	2029-2030
2031-2032	2031-2032
2033-2034	2033-2034
2035-2036	2035-2036
2037-2038	2037-2038
2039-2040	2039-2040
2041-2042	2041-2042
2043-2044	2043-2044
2045-2046	2045-2046
2047-2048	2047-2048
2049-2050	2049-2050
2051-2052	2051-2052
2053-2054	2053-2054
2055-2056	2055-2056
2057-2058	2057-2058
2059-2060	2059-2060
2061-2062	2061-2062
2063-2064	2063-2064
2065-2066	2065-2066
2067-2068	2067-2068
2069-2070	2069-2070
2071-2072	2071-2072
2073-2074	2073-2074
2075-2076	2075-2076
2077-2078	2077-2078
2079-2080	2079-2080
2081-2082	2081-2082
2083-2084	2083-2084
2085-2086	2085-2086
2087-2088	2087-2088
2089-2090	2089-2090
2091-2092	2091-2092
2093-2094	2093-2094
2095-2096	2095-2096
2097-2098	2097-2098
2099-2100	2099-2100
2101-2102	2101-2102
2103-2104	2103-2104
2105-2106	2105-2106
2107-2108	2107-2108
2109-2110	2109-2110
2111-2112	2111-2112
2113-2114	2113-2114
2115-2116	2115-2116
2117-2118	2117-2118
2119-2120	2119-2120
2121-2122	2121-2122
2123-2124	2123-2124
2125-2126	2125-2126
2127-2128	2127-2128
2129-2130	2129-2130
2131-2132	2131-2132
2133-2134	2133-2134
2135-2136	2135-2136
2137-2138	2137-2138
2139-2140	2139-2140
2141-2142	2141-2142
2143-2144	2143-2144
2145-2146	2145-2146
2147-2148	2147-2148
2149-2150	2149-2150
2151-2152	2151-2152
2153-2154	2153-2154
2155-2156	2155-2156
2157-2158	2157-2158
2159-2160	2159-2160
2161-2162	2161-2162
2163-2164	2163-2164
2165-2166	2165-2166
2167-2168	2167-2168
2169-2170	2169-2170
2171-2172	2171-2172
2173-2174	2173-2174
2175-2176	2175-2176
2177-2178	2177-2178
2179-2180	2179-2180
2181-2182	2181-2182
2183-2184	2183-2184
2185-2186	2185-2186
2187-2188	2187-2188
2189-2190	2189-2190
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YEAR	ATMOSPHERIC RELEASES	LIQUID RELEASES	TOTAL RELEASES	ATMOSPHERIC RELEASES	LIQUID RELEASES	TOTAL RELEASES
1974	1.7E-02	1.8E-02	3.5E-02			
1975	2.5E-04	7.3E-02	7.3E-02			
1976	6.8E-02	1.4E-01	2.1E-01			
1977	4.7E-02	2.4E-01	2.9E-01			
1978	1.0E-01	2.4E-01	3.4E-01			
1979	9.2E-02	2.8E-01	3.7E-01			
1980	9.2E-02	3.0E-01	3.9E-01			
1981	4.0E-02	4.1E-01	4.5E-01			
1982	4.8E-02	3.0E-01	3.5E-01			
1983	1.0E-01	2.4E-01	3.4E-01			
1984	3.0E-02	4.0E-01	4.3E-01	1.2E-04	5.6E-03	5.7E-03
1985	3.7E-02	3.7E-01	4.1E-01	4.7E-03	1.5E-02	2.0E-02
1986	4.2E-02	2.6E-01	3.0E-01	1.1E-02	8.9E-02	1.0E-01