GOOD SCIENCE Vs UNCERTAIN REGULATORY GUIDANCE or HOW CHI/Q AFFECTS NUCLEAR SAFETY

ABSTRACT

For many years in the nuclear industry the calculation of Chi/Q was a dry subject that was limited to meteorologists and health physics types that performed dose calculations. With the publication of NUREG/CR-5055 in 1988 the door was opened to calculating more realistic Chi/Q's. This was further developed with the introduction of ARCON-95 and then ARCON-96. Many people in the nuclear industry did not realize the impact ARCON-96 could have when it was first introduced. This was because about the same time NUREG-1465 or as it became known, "the new source term", was introduced. At Clinton Power Station a team was formed to review potential cost savings from the new source term in 1996. The team discovered that the new CHI/Q's had an even larger potential impact. This paper will summarize those results, review the regulatory uncertainties, discuss what Draft Regulatory Guide, DG-1111 covers and what it does not. The paper will also look to the future and what the new CHI/Q's could mean for nuclear safety.

INTRODUCTION

For many years the calculation of CHI/Q was a fairly straightforward task. This was because the NRC put forth fairly explicit guidance on how to calculate CHI/Q. Regulatory Guides 1.3 and 1.4 as well as Regulatory Guide 1.145 specifies the equations to be used to calculate CHI/Q. It is a well-known fact that the concentrations experienced in the vicinity of a nuclear plant are reduced by the so-called building wake. The standard building wake term is a constant that is added in to the expression for CHI/Q or CHI/Q = 1/ u{sigma y x sigma z +cA}, where c is a constant and A is the area of the building in meters. The building wake has been limited by a factor. In Regulatory Guide 1.145 there are equations specifying the limitations to be put on plume spread. Here building wake is included with plume meander. Plume meander is more evident in low wind speed and stable atmospheric conditions while building wake becomes more pronounced in unstable and high wind speed conditions. Regulatory Guide 1.145 does recognize the existence of plume meander and building wake but it puts fairly conservative limits on the amount of these effects.

In 1988 NUREG/CR-5055, "Atmospheric Diffusion for Control Room Habitability Assessments", was published. One purpose of the study was to develop a more realistic model to predict atmospheric concentrations in the vicinity of a nuclear plant. This work continued in NUREG/CR-6331 and NUREG/CR-6331, Rev. 1, "Atmospheric Relative Concentrations in Building Wakes", or as they became known ARCON 95 and ARCON 96 respectively. While ARCON 96 is now recognized as a much more realistic code to predict atmospheric concentrations than the Murphy Campe model introduced over 25 years ago, it is now as well known the differences in results the two codes predict. As stated on page 44 of NUREG/CR-6331, "…there are numerous instances where ARCON96 predicts concentrations that are more than a factor of 10 lower than the Murphy-Campe model predictions". The amazing thing about this quote is how little attention it received five years ago when published. Part of the reason for this was that the nuclear power industry was focused on benefits to be gained from the new source term.

SOURCE TERM

In 1995 NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants", was published. This document provided a more realistic estimate of the source term than what had previously been predicted in TID-14844. The main difference in the new source term was its treatment of non noble gas components. While the iodine component was smaller the new source term also considered particulates while the old one had greatly simplified its treatment of non noble gas components. The industry thought that its use would result in lower doses or consequences for safety analysis calculations. This in turn could be used to provide for some relaxation in licensing requirements such as containment leak rate testing. At Clinton Power Station a Revised Accident Source Term team was formed in 1996. Its mission was stated as follows, "Studies documented for Advance Light Water Reactors indicate that a REALISTIC ACCIDENT SOURCE TERM (RAST) may be much lower than the one used in the design basis for CPS. The mission of the team is to re-evaluate the design basis accident source used for the CPS USAR and Emergency Plan. If a backfit is appropriate, recommend specific actions to realize the maximum economic benefits over the remaining life of the plant." The team was aware of ARCON-95 and also explored what impact its use might have on lower doses.

CLINTON POWER STATION METHODOLOGY

The basic methodology employed by the RAST team was to compare the results achieved using ARCON 95 and Suppression Pool Scrubbing with those achieved using the new source term as listed in NUREG-1465. In the original design basis calculations credit had not been taken for suppression pool scrubbing as allowed by the Standard Review Plan, NUREG 0800. It should be pointed out that in 1996 there was not definitive guidance on how to use NUREG-1465, much less if ARCON-95 was even suitable for such calculations as Design Basis Calculations used in Chapter 15 of Safety Analysis. Calls were made to the NRC and the code developer for ARCON 95 to determine the reduction factor to use for dual control room intakes. At Clinton the intakes are separated by 180 degrees and have automatic isolation for high radiation levels. In accordance with the Standard Review Plan a factor of 4 may be incorporated into the X/Q calculations for dual control room intakes. Therefore this factor of 4 is used as well as one years worth of meteorological data. More data was not used to save time in calculations and data retrieval. It was felt that one year worth of data was representative of the site's X/Q's. With the introduction of Draft Regulatory Guide DG-1111 there is now guidance on how to calculate X/Q. For Clinton Power Station the factor of 4 reduction becomes a factor of 10 because of the design of the dual control room intakes. What follows are the Clinton calculations.

CLINTON CALCULATIONS

Abstract

Evaluate the impact of a revised Design Basis Analysis (DBA) Loss of Coolant Accident (LOCA) source term based on NUREG 1465, taking credit for current understanding of timing and duration of expected Gap Activity Release Phase. The Gap Release Phase duration is 30 minutes and begins when fuel failure commences. When Standby Gas Treatment System (SGTS) becomes operational, the current DBA is used.

Purpose

To calculate and compare the thyroid and whole body dose at the Exclusion Area Boundary (EAB), following a DBA-LOCA, assuming Revised Accident Source Term based on NUREG 1465 by taking credit for timing only, versus current DBA.

Assumptions

Two cases are analyzed, using MATHCAD.

CASE I: Based on NUREG 1465:

1. Leak rate is .05 Of .65 %/day up to 30 minutes for noble gases and halogens. Ref. (5); (Leak rate is Referenced in the Discussion Section.)
2. Leak rate is .65 % /day after 30 minutes up to 2 hours for noble gases and .05798 /day after 30 minutes up to 2 hours for iodines. The SGTS filtration is effective after 30 minutes. Ref. (5); (Leak rates are Referenced in the Discussion Section).
3. Loss of Coolant Accident Design Basis Source Term for Containment. Ref. (4)
4. General Electric (GE) Thyroid Dose Conversion Factors used in calculating Thyroid Dose Ref. (3)
5. GE Whole Body Dose Conversion Factors are used in calculating Whole Body Dose Ref. (2)
6. Design Basis assumption, X/Q, dispersion factor (0-2) hour at site boundary is (1.8 E-4). Ref. (1)
7. Adult Breathing rate is 3.47 E-4 m^3/sec. Ref. (8)
8. Isotopes Half Life are taken from Ref. (7)
9. Chemical form for Iodine remains the same as the current Design Basis.

CASE 2: Based on existing DBA:

All the assumptions are the same as in Case 1, except leak rate and timing.

1. Leak rate is .65%/day without SGTS up to 188 seconds. Ref. (6).
2. After 188 seconds, up to 2 hours, the leak rate is .05798 % per day for iodine's and .65%/day for noble gases, based on current DBA assumptions. (Referenced in the Discussion Section.)

Discussion

This calculation is performed to evaluate the impact of the revised source term based on NUREG 1465 by taking credit for timing only. In terms of timing a significant release of fission products from the fuel will not begin until 30 minutes after fuel failure commences. This time period is known as the Gap Release Phase, and during this phase the release rate of fission products released to Containment is assumed constant and the fission product inventory is 5 % of the DBA for Noble Gases and Halogens. The DBA leak rate of Containment and its penetrations is .65 % per day, (Ref (9)). Of this 92 % leaks into secondary containment and from there 99% of the organic and elemental iodine's are filtered out by SGTS leaving 1% of unfiltered iodine's released to the environment. The percentage of containment leakage that bypasses secondary containment is 8%. Therefore the Containment leak rate for iodine's is expressed by the following algorithm, .65* .92* .01 +.08* .65 =.05798 % per day with SGTS operational. The dose is calculated for EAB, as the reduction achieved would be the maximum for EAB, compared to LPZ or Main Control Room. This is due to the long duration over which the dose is calculated for MCR and LPZ (30 days).

Methodology

The methodology used to calculate the whole body and thyroid dose at the EAB is described in RTER 94-038 ED. MATHCAD was used to perform the analysis.

Results

The thyroid and whole body dose results are summarized from Attachment 1.

CASE 1

Time	**Thyroid Dose**	**Whole Body Dose**
	Rem	**Rem**
0-30 min	17.918	0.157
30 min.-2 hr.	94.068	0.601
TOTAL 0-2 hr	111.987	2.758

CASE 2

Time	**Thyroid Dose**	**Whole Body Dose**
	Rem	**Rem**
1-188 sec	37.605	0.449
188 sec-2 hr	122.678	4.048
TOTAL 0-2 hr	160.283	4.497

Conclusions

The results show that the revised timeline of the DBA scenario, the thyroid dose at the EAB is 30.1 % lower and the whole body dose is 38.7 %. lower than the scenario corresponding to the current DBA based on Reg Guide 1.3 and TID 14844 assumptions. The purpose of the calculation was to show the impact on dose using revised release assumptions from NUREG 1465, and keeping all other parameters the same between the two cases as described in the Design Basis.

References

1.0 CPS USAR, Table 15.6.5-1
2.0 RTER 94-038 ED, Attachment 7
3.0 RTER 94-038 ED, Attachment 6
4.0 CPS USAF, Table 15.6.5-2
5.0 NUREG 1465 Table 3.12
6.0 CPS USAR, Section 6.5.1.1
7.0 Radiological Health Handbook Bureau of Radiological Health (1972).
8.0 USNRC Regulatory Guide 1.3 Rev 2, June 1974
9.0 CPS USAR, 15.6.5.5.1.2

Abstract

Off site and Main control Room doses are evaluated following of a Design Basis Loss of Coolant Accident, assuming scrubbing of suppression pool and using revised X/Q values. The X/Q values used are calculated using one year worth of data and using ARCON 95, which is a computer code written by Pacific Northwest Laboratory for NRC and published in NUREG/CR-6331, PNL-10521. The suppression pool scrubbing reduces the inventory of iodine's available for release by 6.7(Standard Review Plan, NUREG 0800). A factor of 4 reduction in X/Q is taken based on dual intake in Main Control Room design. The thyroid and whole body doses are calculated at the EAB, LPZ and the Main Control room. The calculated doses are a factor of 10 lower than the existing design Basis values. This shows that leakage restraints can be relaxed by a factor of 10 and the doses can be still maintained below existing values, even without assuming revised accident source term as recommended in NUREG 1465.

Purpose

Off site and Main Control room doses were calculated following a DBA-LOCA using the new X/Q values and taking credit for suppression pool scrubbing to evaluate if leakage testing criteria can be relaxed.

Bases

10 CFR 100, Reactor siting criteria (Ref. 1).
Standard Review Plan, NUREG 0800 (Ref. 2).

Assumptions

1. The source term is based on Reg. Guide 1.3 (Ref. 3).
2. All the information and input are taken from RTE. 95-006-ED, Rev 0 (Ref. 4) unless otherwise noted.
3. The X/Q for EAB, LPZ and Main Control Room are taken from attachment 1, computer runs of ARCON 95, using approximately one year worth of data.
4. The decontamination factor, or the scrubbing effect of suppression pool is taken to be 0.15, based on the calculation by Sargent and Lundy (Ref. 5).
5. MSIV leakage (0.15 %/day per Ref. 4), is excluded from the credit for suppression pool scrubbing, as it is a leakage directly from the drywell to the environment, via SGTS. This leakage starts 2 hours post accident.
6. The reduction factor of 0.15 due to suppression pool scrubbing is not applicable to noble gases, as they do not dissolve in water.
7. The credit for dual intake is taken as outlined in USAR, chapter 15.6.5, and as given in the paper by Murphy and Campe(Ref. 7). This factor reduces the X/Q by four for X/Q for MCR. In previous calculations(Ref. 4 and Ref. 6), this is contained in the design basis X/Q values used.

Discussion

The Revised Accident Source Team was formulated to realize if benefits could be derived assuming lower source term, which would result in lower doses following a DBA-LOCA. The team realized that same benefit can be realized by taking credit for suppression pool scrubbing for iodines and using new X/Q's calculated per NRC methodology.

Analysis

Since MSIV leakage does not start until 2 hours post LOCA, the dose calculation consists of two runs for LPZ and MCR for dose calculation. Dose is calculated for the regular leakage for 0-720 hours and for MSIV leakage bypassing the suppression pool scrubbing effect for 2-720 hours. The MSIV leakage case is run for 0-720 hours, with the leakage for 0-2 hours is set to zero, to simulate no MSIV leakage until after 2 hours. These two cases are added to get the resultant dose.

Values for Leakage rates, the fraction by passing SGTS and start time of SGTS are the same as outlined in the calculation RTE. 95-006. Individual dose calculations are summarized below.

Revised X/Q is taken from Ref. 8 for all the cases. (As in Ref. 4, Noble Gases are not removed by SGTS.)

Off site Dose Calculation: EAB Time: 0-2 hours

No MSIV leakage (Ref. 4; also contained in USAR 15.6.5)

Thyroid Dose: Suppression pool scrubbing factor of 0.15 applied to the iodine inventory

Whole Body Dose: No suppression Pool scrubbing factor; contribution from iodines to whole body dose is added (although not significant).

Off site Dose Calculation: LPZ Time: 0-720 hours

Two cases are:

1. MSIV leakage (0.15 % per day via SGTS) Thyroid Dose: NO suppression pool scrubbing factor Time: 2-720 hours

   Leak rate from 0-2 hours is set to zero to simulate no leak due to MSIV.
   Whole body dose: NO suppression pool scrubbing factor. The Contribution from iodines to whole body dose added (although not significant) for the period.

2. Remainder of the leakage from containment and drywell bypass (see Ref. 4 and 6). Time: 0-188 seconds: 0.65 % per day bypass SGTS up to 188 seconds. 188 seconds -720 hours: 92 % of 0.65 % /day filtered via SGTS. 8 % of 0.65 % /day bypasses SGTS. Total leakage is.05798 % per day.

   Thyroid Dose: Suppression pool scrubbing factor of 0.15 applied to the iodine inventory.

   Whole Body Dose: No suppression Pool scrubbing factors.

   Total dose is obtained by adding the results from the two cases.

3. Off site Dose Calculation: MCR

   Note: X/Q from Attachment 1 multiplied by .0.25 to consider dual intake reduction factor. Time: 0-720 hours

Two cases are:

1. MSIV leakage (0.15 % per day via SGTS). Time: 2-720 hours

   Leak rate from 0-2 hours is set to zero to simulate no MSIV leakage during this period.
   Thyroid Dose: NO suppression pool scrubbing factor. Whole body dose: NO suppression pool scrubbing factor.
2. Remainder of the leakage from containment and drywell bypass (see Ref. 4 and 6). Time: 0-188 seconds: 0.65 % per day bypass SGTS up to 188 seconds. 188 seconds -720 hours: 92 % of 0.65 % /day filtered via SGTS. 8 % of 0.65 % /day bypasses SGTS. Total leakage is .05798 % per day.

   Thyroid Dose: Suppression pool scrubbing factor of.0.15 applied to the iodine inventory.

   Whole Body Dose: No suppression school scrubbing factor.

   Total dose is obtained by adding the results from the two cases.

   Note: The whole body dose contribution from noble gases is taken as a single run by having 0.65% /day leak rate up to 2 hours and (0.65+0.15)% per day after two hours and run as a single run for both LPZ and MCR to account for both leakages.

<u>Methodology</u>

Equations written in MATHCAD as described in RTE 95-006-ED (Ref. 4) are used to calculate the of site and Main Control Room Doses. Detailed explanation is also found in RTE 94-037-ED (Ref. 6).

The suppression pool scrubbing is taken into consideration as described in Ref. 5. Radioiodine inventory is decreased by 0.15. Noble gases are not impacted by scrubbing. The dual intake reduction factor decreases the X/Q by 4 for Main Control Room. The X/Q values taken from ARCON 95 runs are multiplied by 0.25 to account for reduction. Other factors such as occupancy and wind direction factors given in Ref. 7 are not applied, even though this further decreases the effective X/Q. These are built into the X/Q in the existing calculation (Ref 4 and 7). The ICRP 30 dose conversion factors are not used, even though they result in lower off site doses.

Results

The results obtained in this evaluation and the existing Design Basis Dose values along with the new and the current values for X/Q, and the resulting reduction achieved is summarized below.

Results Dose Summary

Present Rem	**EAB**	**LPZ**	**MCR**	**New Rem**	**EAB**	**LPZ**	**MCR**
Thyroid	164.80	169.03	26.32		2.102	5.609	0.823
Whole Body	4.37	1.73	1.62		0.328	0.162	0.171

Offsite and Main Control Room Doses following a DBA-LOGA MSIV LEAKAGE AND NEW X/Q VALUES *INCLUDES DUAL LEAKAGE						
Thyroid Dose (REM)				X/Q Values		
Time (hours)	EAB	MCR*	LPZ	EAB	MCR	LPZ
0-2	0	0	0	1.53E-05	2.11E-04	3.06E-06
2-8		0.006	0.055		8.54E-05	1.06E-06
8-24		0.016	0.075		9.61E-05	1.21E-06
24-96		0.036	0.211		6.54E-05	7.78E-07
96-720		0.058	0.425		3.76E-05	5.56E-07
0-30 days	0	0.116	0.766			

Whole Body Dose (REM)				X/Q Values		
Time (hours)	EAB	MCR*	LPZ	EAB	MCR	LPZ
0-2	0	0	0	1.53E-05	2.11E-04	3.06E-06
2-8		0.005	0.005		8.54E-05	1.06E-06
8-24		0.004	0.004		9.61E-05	1.21E-06
24-96		0.005	0.004		6.54E-05	7.78E-07
96-720		0.006	0.006		3.76E-05	5.56E-07
0-30 days	0	0.02	0.019			

SUPPRESSION POOL SCRUB AND NEW X/Q VALUES
*INCLUDES DUAL LEAKAGE

Thyroid Dose (REM)				X/Q Values		
Time (hours)	EAB	MCR*	LPZ	EAB	MCR	LPZ
0-2	2.102	0.039	0.421	1.53E-05	2.11E-04	3.06E-06
2-8		0.035	0.322		8.54E-05	1.06E-06
8-24		0.092	0.432		9.61E-05	1.21E-06
24-96		0.207	1.221		6.54E-05	7.78E-07
96-720		0.334	2.447		3.76E-05	5.56E-07
0-30 days	2.102	0.707	4.843			
Whole Body Dose (REM)				X/Q Values		
Time (hours)	EAB	MCR	LPZ	EAB	MCR	LPZ
0-2	0.328	0.65	0.066	1.53E-05	2.11E-04	3.06E-06
2-8		0.03	0.025		8.54E-05	1.06E-06
8-24		0.021	0.019		9.61E-05	1.21E-06
24-96		0.027	0.023		6.54E-05	7.78E-07
96-720		0.028	0.029		3.76E-05	5.56E-07
0-30 days	0.328	0.171	0.162			

Offsite and Main Control Room Doses following a DBA-LOGA
SUPP POOL + MSIV LEAKAGE AND NEW X/Q VALUES
*INCLUDES DUAL LEAKAGE

New - Thyroid Dose (REM) SUM				**Present - Thyroid Dose (REM) SUM**		
Time (hours)	EAB	MCR*	LPZ	EAB	MCR	LPZ
0-2	2.102	0.039	0.421	164.80	2.28	38.47
2-8		0.041	0.377		5.16	26.97
8-24		0.108	0.507		7.14	20.03
24-96		0.243	1.432		7.83	35.42
96-720		0.392	2.872		3.91	48.14
0-30 days	2.102	0.823	5.609	164.80	26.32	169.03

New - Whole Body Dose (REM) SUM				**Present-Whole Body Dose (REM) SUM**		
Time (hours)	EAB	MCR	LPZ	EAB	MCR	LPZ
0-2	0.328	0.065	0.066	4.37	0.55	1.02
2-8		0.03	0.025		0.63	0.35
8-24		0.021	0.019		0.24	0.15
24-96		0.027	0.023		0.15	0.11
96-720		0.028	0.029		0.05	0.10
0-30 days	0.328	0.171	0.162	4.37	1.62	1.73

Whole Body Dose RATIO				**Thyroid Dose RATIO**		
Time (hours)	EAB	MCR	LPZ	EAB	MCR	LPZ
		Present/New			Present/New	
0-2	13.31	8.46	15.45	78.40	58.46	91.38
2-8		21	14.00		125.85	71.54
8-24		11.43	7.89		66.11	39.51
24-96		5.56	4.78		32.22	24.73
96-720		1.79	3.45		9.97	16.76
0-30 days		9.47	10.68		31.98	30.14

Time (hours)	EAB	MCR	LPZ	EAB	MCR	LPZ	EAB	MCR	LPZ
		Present X/Q			New X/Q			Present/New	
0-2	1.80E-04	4.61E-04	4.20E-05	1.53E-05	5.28E-05	3.06E-06	11.76	8.73	13.73
2-8		4.61E-04	1.31E-05		2.14E-05	1.06E-06		21.54	12.36
8-24		2.73E-04	8.20E-06		2.40E-05			11.38	6.78
24-96		9.03E-05	3.30E-06		1.64E-05	7.78E-05		5.51	4.24
96-720		1.61E-05	1.60E-06		9.40E-06	5.56E-07		1.71	2.88

Conclusions

The results show the new doses are lower by more than a factor of 10. There are conservatism's such as the wind direction and occupancy factors not applied for the calculation of X/Q's for Main Control Room. The most recent Dose Conversion Factors as given in ICRP 30 are not considered. The ICRP dose conversion factors are lower than the Reg. Guide 1.109 conversion factors used in the present analysis and would result in lower dose.

These calculations show that X/Q has more of an impact than the new source term on dose. What is not obvious is why the new X/Qs calculated by ARCON95 and ARCON96 were not used more by the nuclear industry to seek relaxation in dose calculations.

REGULATORY UNCERTAINTY

The title of this paper was chosen to emphasize a point that sometimes is not fully appreciated. That point could also be expressed, as regulations are not always based on the best science. It should be recognized that scientists and regulators are not mutually exclusive entities. In the case of the Nuclear Regulatory Commission it is made up of both scientists and regulators. In the case of ARCON 96 it was a code developed for the NRC for use in control room habitability assessments. It has had extensive peer review and meets the definition of good science. What many people do not realize is that the NRC was using the code before guidance was put out on its use.

This author discovered in early 1996 that the current version of RASCAL, the NCR's own dose assessment code used during radiological emergencies, had incorporated algorithms from ARCON 96 in its calculation of dispersion coefficients. The discovery resulted from a comparison of the MESOREM dose code with RASCAL. This was also when it was discovered that the new X/Qs were much lower even at several miles from the release point. Draft Regulatory Guide 1111 only addresses control room habitability assessments using ARCON-96. This is emphasized on page 3 where it states, "Analyst should not assume that the use of the ARCON96 code is acceptable for purposes other than control room radiological habitability assessments". This can be the cause of some rather inconsistent X/Qs. To take an example look at the X/Qs calculated for Clinton for the 0-2 hour period. The new X/Q for the control room is 5.28E-5, which is less than the old X/Q at the Exclusion Area Boundary. Furthermore if the X/Qs had been calculated with a factor of 10 reduction instead of the four assumed at the time the control room X/Q would have been 2.11E-5 which is less than the old X/Q at the Low Population Zone. The point of this is good science or X/Qs do not stop at the control room. The Regulatory Uncertainty here becomes how one is supposed to apply the new X/Qs and under what conditions they are acceptable.

NUCLEAR SAFETY

In the Nuclear Industry we are committed to nuclear safety. Some of us have the concept of nuclear safety at the center of what we do while others have it as part of our core values. The reason the guidance on use of ARCON96 is not clear is that the X/Qs it calculates are used to calculate dose which is used to determine margin of safety. A relaxation in a licensee's containment leak rate can be achieved if it can be shown that the resultant dose is within the present margin of safety. With a lower X/Q the leak rate can be greater and still result in a lower dose or no higher. The problem with design basis calculations used in safety analysis is that most are based on very simplistic deterministic assumptions. Conservatism is used to counter not including other complicating factors, which may increase consequences. An example of this is the Regulatory Guide 1.3 and 1.4 source term with its high percentage of radioiodine designed to be a surrogate for other particulates not included. Many licensees found this out when using the NUREG-1465 Source Term and the dramatic reductions in dose that had been expected did not materialize because of the dose due to the particulate component of the source term was now included. In this paper the discussion of the Source Term has been included because the use of ARCON96 can not be viewed in a vacuum.

In conclusion the future use of ARCON96 is dependent on resolution of how the source term is addressed. Dose is the quantity that ultimately affects margin of safety. Dose is also the product of a X/Q and concentration that is a function of the source term. The X/Q is a relatively straightforward quantity and with ARCON96 based on fairly good science. Source Term quantity and timing is a more complex process. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents At Nuclear Power Reactors", has been out about a year. This Regulatory Guide is an important step in providing guidance on the use of the new source term or alternate source term as named here. ARCON 96 is referenced here but only that its use is acceptable for determining control room X/Q. It does not say the methodology is unacceptable for other distances. What it does say is that other changes in determining X/Q should be reviewed by the staff. When the guidance for using NUREG-1465 becomes as well established as Regulatory Guide 1.3 and 1.4 have become, the use of ARCON96 or refinements to it should be well accepted. Until that time there will probably be uncertainty as to how and when ARCON96 can be used.

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