

## **Nuclear Safety Information Dashboard**

The Nuclear Safety Information (NSI) Dashboard provides a new user interface to the Occurrence Reporting and Processing System (ORPS) to easily identify, organize, and analyze nuclear safety-related events reported into ORPS. The NSI Dashboard displays information developed from occurrence information reported into DOE's ORPS database. Events or conditions associated with nuclear safety are reported into ORPS, assigned unique ORPS reporting criteria and used for trending. ORPS reporting criteria are assigned a weighted value to indicate their relative importance to nuclear safety; associated ORPS reporting criteria are combined in key groups and charted over time to index trends in nuclear safety. This information can be analyzed at the contractor, site, Program Office, and DOE level to identify trends and, using insights from current events and nature of operations, enable further evaluation to prevent potential high consequence events.

Individual groups or a composite of any combination of groups can be conveniently displayed and made available for analysis using the NSI Dashboard.

## Avoid High Consequence Events (Nuclear)

DOE's mission is to ensure America's security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions. One of DOE's management principles is to pursue its mission in a manner that is safe and secure. In support of this mission, DOE strives to avoid nuclear-related high consequence events.

DOE nuclear safety subject matter experts identified 18 types of occurrences reported into ORPS that are considered nuclear-related, high consequence events. The table below describes these 18 types of events DOE strives to avoid, the associated ORPS reporting criteria, and the number of these types of occurrences since 2004. The table demonstrates that the frequency of these occurrences has been very low. DOE sites maintain these very low rates by analyzing trends, considering program/site/facility-specific information and making necessary changes.

Table 1: Frequency of High Consequence Events

Group of ORPS Reporting Criteria		Number of Occurrences 2004-2012								
ORPS Reporting Criteria	Occurrence Description	2004	2005	2006	2007	2008	2009	2010	2011	2012
<b>Operational Emergencies</b>										
1(1), 1(2), 1(3), 1(4)	An Operational Emergency not requiring classification, an Alert, a Site Area Emergency, or a General Emergency	8	12	6	6	6	7	4	3	3
<b>Fires and Explosions</b>										
2C(1)	Fire emergency/incident within primary confinement/containment boundaries of a nuclear facility, except fire that self-extinguishes < 10 minutes	1	1	0	0	0	0	0	2	0
2D(1)	Unplanned explosion within nuclear facility primary confinement/containment boundary	0	0	0	0	0	0	0	0	0

Nuclear Safety Controls										
3A(1)	Violation of nuclear facility's Technical Safety Requirement (or Operational Safety Requirement) Safety Limit	0	0	0	0	0	0	0	0	0
3C(1)	No documented controls available to prevent criticality accident	0	0	0	0	0	0	0	0	0
Loss of Control of Radiological Material										
6A(1)	Radioactive material offsite > applicable DOE limits in DOE O 458.1 due to DOE operations/activities	0	0	1	0	1	1	0	0	1
Spread of Radioactive Contamination										
6B(1)	Offsite Radioactive Contamination > applicable DOE limits in DOE O 458.1 or values in 10 CFR Part 835 Appendix D due to DOE operations/activities	3	1	3	2	1	2	2	2	1
Radiation Exposure										
6C(1)	Dose > limits in 10 CFR Part 835, Subpart C or DOE O 458.1 "Public Dose Limit"	0	0	0	1	0	0	1	0	0
Nuclear Explosive Safety										
7(1)	Damage to nuclear explosive resulting in credible threat to nuclear explosive safety	0	0	0	0	0	0	0	0	0
Occupational Injuries										
2A(1)	Fatality or terminal injury/illness due to DOE operations	2	0	1	1	1	1	0	0	1
Occupational Exposures										
2B(1)	Fatality, terminal injury/illness or in-patient hospitalization of 3 or more personnel resulting from acute exposure to a chemical, biological, or physical hazard due to DOE operations	0	0	0	0	0	0	0	0	0

Environmental										
5A(1)	Release (onsite/offsite) of hazardous or extremely hazardous substance, including radionuclides from a DOE facility above federally permitted releases in a quantity equal to or exceeding the federal reportable quantities	5	2	4	2	3	2	1	2	0
5B(1)	Occurrence causing significant impact to ecological or cultural resource for which DOE has responsibility	0	0	1	0	1	0	0	0	0
Packaging and Transportation										
8(1)	Offsite transportation incident involving HazMat that requires immediate 49 CFR Section 171.15(b) notice	1	0	0	1	0	0	0	0	0
Management Concerns										
10(1)	Any event resulting in the initiation of a Federal Accident Investigation Board, as categorized by DOE O 225.1B, Accident Investigation.	6	2	7	2	1	6	2	3	0

## **ORPS Reporting Criteria/Groups of ORPS Reporting Criteria**

Precursor events and conditions associated with high consequence events can be identified and analyzed in order to implement appropriate actions. These actions enable sites to successfully manage nuclear safety at DOE.

Occurrences assigned any one of sixty-five types of ORPS reporting criteria were identified as potential precursor events/conditions. Approximately one-half of the ORPS reporting criteria are directly associated with nuclear safety and the other half are indirectly related. There have been a sufficient number of these sixty-five types of occurrences over time to establish meaningful rates. It is also important to track occurrences that are reported less frequently since they provide point data that may require immediate attention. Trended occurrence information related directly to nuclear safety is not normalized since it does not correlate well with factors such as work-hours, facility size and number of facilities. As a result, trends are only relevant for individual contractors, sites or programs.

The sixty-five ORPS reporting criteria were divided into 17 groups. Table 2 below shows the ORPS reporting criteria that were assigned to each group and the weighted factor assigned to each ORPS reporting criterion. Weighted factors are discussed in the next section.

Table 2: Groups of ORPS Reporting Criteria /ORPS Reporting Criteria/Weighted Factors

Groups of ORPS Reporting Criteria /ORPS Reporting Criteria/Weighted Factors	
GROUP	
Reporting Criteria Weighted Factor	Description of ORPS Reporting Criteria
<b>Fires and Explosions</b>	
2C(2) 6.9	Fire in a nuclear facility that: activates a fixed automatic fire suppression system, is extinguished by emergency response organization, disrupts normal operations, or is within primary confinement/containment that self-extinguishes < 10 minutes
2C(4) 2.4	Fire in a nuclear facility
2D(2) 15.4	Unplanned explosion in a nuclear facility that disrupts normal operations
<b>Nuclear Safety Controls</b>	
3A(2) 2.6	Violation of Hazard Category 1, 2, or 3 nuclear facility's Technical Safety Requirement, Operational Safety Requirement, Limiting Control Setting, Limiting Condition for Operation, Specific Administrative Control, or Surveillance Requirement
3A(3) 1.5	Violation of credited hazard control specified in Hazard Category 1, 2, or 3 nuclear facility's Documented Safety Analysis
3A(4) 1	Surveillance test performed late in which the structure, system, or component was capable of performing its safety function
3B(1) 0.8	Positive Unreviewed Safety Question (USQ) reveals inadequacy in documented safety analysis
3C(2) 6.9	No documented controls available to prevent a criticality accident. An accident has not occurred due to other, non-documented barriers or controls
3C(3) 3.8	Loss of one or more nuclear criticality documented controls such that an accidental criticality is possible from the loss of one additional documented control
3C(4) 2.5	Deficiency in criticality safety analysis or degradation of a documented criticality control such that adequate controls were not in place for a credible criticality accident scenario
<b>Safety Structure/System/Component</b>	
4A(1) 0.6	Degradation of required SC or SSC
4A(2) 0.2	Degradation of required SC or SSC when not required to be operable
4B(1) 0.6	DOE Office Stop Work Order
4B(2) 0.7	Actuation of a Safety Class SSC or its alarms as a result of unsafe condition.
4B(3) 0.3	Actuation of a Safety Significant SSC or its alarms as a result of unsafe condition.
4B(4) 0.2	Facility evacuation
4B(5) 1	Facility operational event which results in adverse effect on safety
4B(6) 0.8	Facility shutdown requiring a corrective actions prior to continuing operations
4B(7) 0.2	Condition that prevents immediate facility or offsite emergency response capabilities
<b>Loss of Control of Radioactive Material</b>	
6A(2) 3.5	Loss or unexpected discovery of radioactive material > 100 times the values in 10 CFR Part 835, Appendix E or loss of accountability > 24 hours
6A(3)	Loss or unexpected discovery of radioactive material > 1 times and < 100 times the values in 10 CFR Part 835, Appendix E or loss

0.6	of accountability > 24 hours
<b>Spread of Radioactive Contamination</b>	
6B(2) 4.3	Onsite radioactive contamination > 100 times the total contamination values in 10 CFR Part 835 Appendix D
6B(3) 1.1	Onsite radioactive contamination > 10 times and < 100 times the total contamination values in 10 CFR Part 835, Appendix D
<b>Radiation Exposure</b>	
6C(2) 4.6	Failure to monitor for an exposure estimated > values for providing personnel dosimeters and bioassays IAW 10 CFR 835.402(a) or 10 CFR 835.402(c)
6C(3) 2.4	Single occupational dose attributed to an event that exceeds an expected dose by: (1) 500 mrem Committed Effective Dose (CED), or (2) the greater of 10 percent or 100-mrem effective dose due to external exposure.
6C(4) 1.1	Radiological release > any limit in DOE O 458.1 or 40 CFR 61.92
<b>Personnel Contamination</b>	
6D(1) 5.9	Offsite medical assistance for contaminated personnel due to contamination > 1 times the total contamination values in 10 CFR 835, Appendix D
6D(2) 2.2	Offsite personnel or clothing contamination > 1 times the total contamination values in 10 CFR Part 835, Appendix D
6D(3) 0.8	Onsite personnel or clothing contamination > 10 times the total contamination values identified in 10 CFR Part 835, Appendix D
<b>Nuclear Explosive Safety</b>	
7(2) 7.6	Near miss during nuclear explosive operations
7(3) 2.6	Adverse effect on safety during nuclear explosive operations
<b>Occupational Injuries</b>	
2A(2) 0.4	Injury: in-patient hospitalization of three or more personnel
2A(3) 0.3	Injury: in-patient hospitalization for 5 days or more, commencing within 7 days of injury
2A(4) 0.1	Injury: 3 or more personnel having Days Away, Restricted or Transferred (DART) cases
2A(5) 0.2	Serious injury: in-patient hospitalization for more than 48 hours; fracture of any bone; severe hemorrhages or severe damage to nerves, muscles, tendons, or ligaments; damage to any internal organ; concussion/loss of consciousness due to an impact to the head, 2nd/3rd-degree burns > 5% of body
<b>Occupational Exposure</b>	
2B(2) 0.4	Acute exposure: in-patient hospitalization >5 days or 3 or more personnel having Days Away, Restricted or Transferred (DART) cases
2B(3) 0.2	Exposure: > 10 times OSHA PEL or ACGIH TLV, or deemed immediately dangerous to life and health (IDLH)
2B(4) 0.1	Exposure: > OSHA PEL or ACGIH TLV and requires medical treatment > first aid on same day
2B(5) 0.2	Exposure: results in serious occupational injury - in-patient hospitalization > 48 hours, commencing within 7 days of exposure; damage to internal organ; diagnosis of a debilitating disease; or causes 2nd/3rd-degree burns > 5% of body
2B(6) 0.1	Exposure: > OSHA PEL or ACGIH TLV

Hazardous Electrical Energy Control	
2E(1) 2	Unexpected/unintended personal contact with an electrical hazardous energy source
2E(2) 0.4	Unexpected discovery of uncontrolled electrical hazardous energy source (not zero-energy checks)
2E(3) 0.4	Failure to follow a hazardous energy control process
Non Electrical Hazardous Energy Control	
2F(1) 2	Unexpected/unintended personal contact with non-electrical hazardous energy source
2F(2) 0.4	Unexpected discovery of uncontrolled non-electrical hazardous energy source (not zero-energy checks)
2F(3) 0.4	Failure to follow a non-electrical hazardous energy control process
Suspect/Counterfeit and Defective	
4C(1) 0.6	S/CI in Safety Class or Safety Significant SSC
4C(2) 0.2	S/CI not in Safety Class or Safety Significant SSC, but could result in a loss of safety function or present a hazard
4C(3) 0.2	Defective item other than S/CI, but could result in a loss of safety function or present a hazard
Environmental	
5A(2) 0.3	Onsite or offsite release above limits
5B(2) 1	Occurrence resulting in extensive environmental degradation
Packaging and Transportation	
8(2) 0.5	Deviation that requires report to NRC/DOE HCO/NNSA CO (per DOE O 460.1C or DOE O 461.1B): significant reduction of approved fissile or Type B packaging during use; defect with safety significance in fissile/Type B packaging after first use; conditions of approval in Certificate of Compliance not performed in making shipment
8(3) 0.2	Offsite 49 CFR Section 390.5 accident of motor vehicle carrying DOE hazardous materials operating on highway-interstate/intrastate commerce
8(4) 0.3	Offsite transportation incident involving DOE hazardous materials requiring HazMat Incident Report pursuant to 49 CFR Section 171.16
8(5) 0.6	Offsite transportation of hazardous material, including radioactive material that it is noncompliant with the receiving facilities Waste Acceptance Criteria (WAC)
8(6) 0.9	Transportation activity for onsite transfer resulting in onsite release of radioactive materials, hazardous materials, hazardous substances, hazardous waste, or marine pollutants that is above permitted levels and exceeds RQ specified in 40 CFR Section 302 or 40 CFR Section 355
8(7) 0.3	Violation of HazMat regulations for 49 CFR Section 171.1(b) activities while preparing offsite hazardous material shipments and discovered during shipment in commerce or at receiving site
8(8) 0.6	Onsite transfer of HazMat, including radioactive material that it is noncompliant with the receiving facility's Waste Acceptance Criteria (WAC)
8(9) 0.2	Unauthorized deviation from DOE instructions to commercial motor carriers for DOE HazMat shipments
Noncompliance Notifications	
9(1) 0.5	Written noncompliance notification from outside regulatory agency
9(2) 0.5	Packaging/transportation DOT violations resulting in fines > \$5,000 or Unsat/Conditional ratings



Management Concerns	
10(2) 0	Doesn't meet ORPS criteria, but is safety significant or of concern
10(3) 0.4	Near miss to an otherwise ORPS reportable event
10(4) 0	May result in significant concern by state/tribal/local officials; damage DOE credibility
10(5) 0	Results in significant immediate interest to offsite personnel that it warrants prompt notification to the DOE HQ OC

See Appendix A for definitions and references

### Weighted Factors

A working group with nuclear safety expertise used paired pairing computer software to develop first, a severity-weighted factor for the 17 Groups of ORPS Reporting Criteria and then, a severity-weighted factor for the sixty-five ORPS reporting criteria. The sum of the severity-weighted factors for the sixty-five ORPS Reporting Criteria equals 100%.

Paired pairing is an analytical tool used to determine weighted factors. A team evaluated pairs of ORPS reporting criteria and concurred on the relative importance of each pair. Each ORPS reporting criterion in a group was compared with one other ORPS reporting criterion in the group until each unique combination of pairs was evaluated. A computer program was used to combine the results for each “paired pair” in the group and calculate the weighted factor for each ORPS reporting criterion.

For example, a group of four choices (A, B, C, and D) would be evaluated against each other as follows. Using letters to represent the choices, the unique pairs are:

A vs. B	A vs. C	A vs. D
B vs. C	B vs. D	
C vs. D		

The weighted factors determined for the sixty-five ORPS reporting criteria using this “paired pairing” process are shown in Table 2, above.

### Calculating Trends for Groups of ORPS Reporting Criteria /Nuclear Safety Indices

Each ORPS occurrence is assigned at least one ORPS reporting criterion. If an occurrence is associated with a DOE nuclear facility and assigned a reporting criterion that is associated with the NSI Dashboard, then the event is counted for the identified ORPS reporting criterion and used to calculate the value for a particular Group of ORPS reporting criteria.

The value for a Group of ORPS reporting criteria for a given period of time is calculated by adding the relative contribution of each ORPS reporting criterion. The number of events associated with an ORPS reporting criterion is multiplied by its severity-weighted factor; this is calculated for each ORPS reporting criterion associated with a Group of ORPS reporting criteria and added together to provide a value for each Group. The value for each Group can be determined and displayed for all of DOE, a Program Office or for a particular site or contractor.

The nuclear safety index is a composite of the selected Group(s) of ORPS reporting criteria. The nuclear safety index is the top of the family of area curves representing the Groups of ORPS reporting criteria. The results can be displayed for all of DOE, a Program Office or for a specific site or contractor.

Figure 2: DOE Total

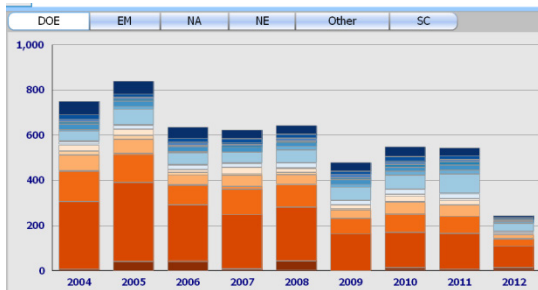


Figure 3: NNSA

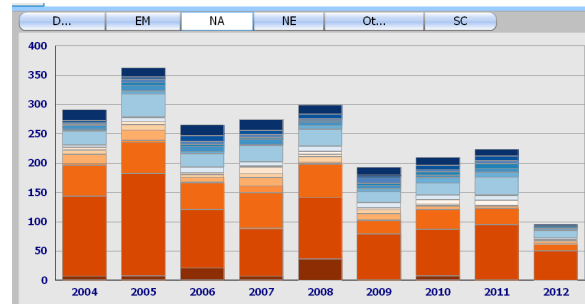
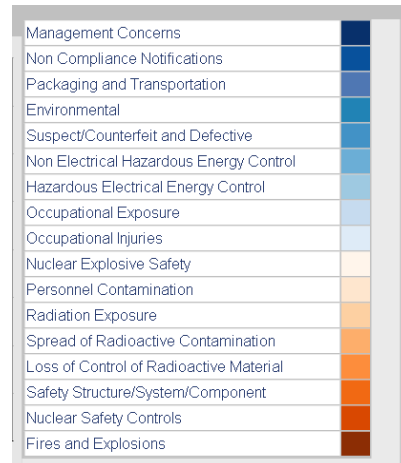
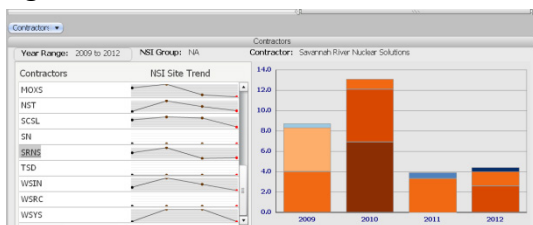


Figure 4: Savannah River Nuclear Solutions



The following table shows how the value for the Groups of ORPS reporting criteria and the nuclear safety index are calculated. The number of events associated with each ORPS reporting criterion in a Group is multiplied by its corresponding severity-weighted factor; the products, added together, are the value for the Group of ORPS reporting criteria. The values for the Groups are added together to calculate the nuclear safety index. A plot of the value of the Groups over time is used to generate a corresponding graph.

Table 3: Calculating the Value for the Groups of ORPS Reporting Criteria and Overall Nuclear Safety Index

Groups of ORPS Reporting Criteria	ORPS Reporting Criteria	# of events	Severity-Weighted Factor	Product	Value of Groups of ORPS Reporting Criteria
Fires and Explosions	Fire in a nuclear facility that: activates a fixed automatic fire suppression system, is extinguished by emergency response organization, disrupts normal operations, or is within primary confinement/containment that self-extinguishes < 10 minutes	W	6.9	$W*6.9=A$	$A+B+C = M$
	Fire in a nuclear facility	X	2.4	$X*2.4=B$	
	Unplanned explosion in a nuclear facility that disrupts normal operations	Y	15.4	$Y*15.4=C$	
Nuclear Safety Controls	-	-	-	-	N
Safety Structure/System /Component	-	-	-	-	O
Loss of Control of Radioactive Material	-	-	-	-	P
XXX	-	-	-	-	Q
YYY	-	-	-	-	R

Nuclear Safety Index	$M+N+O+P+Q+R = \text{Total \#}$
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## Using the Nuclear Safety Information Dashboard

The Nuclear Safety Information (NSI) Dashboard compiles and displays nuclear safety information from data reported into ORPS. Since nuclear safety information is not normalized, trends should not be used to compare one site to another. Instead, trends and related information should be used to evaluate individual trends over time. Trending should not be performed for periods less than a quarter since individual sites report a relatively small number of ORPS reports in a given month. Trending over longer periods of time is more reliable since more data is collected. The NSI Dashboard can display trends for contractors, individual sites, for all sites reporting to a Program Office, or for all DOE sites.

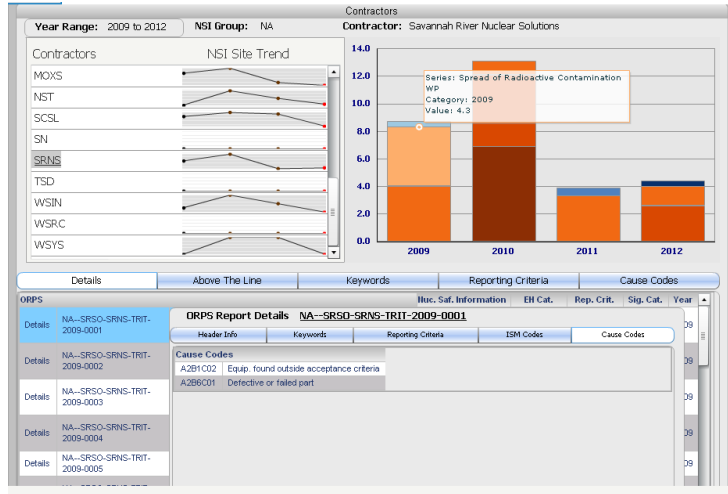
An increasing trend does not always indicate a problem. Since trends are based on precursor events/conditions, further analysis is required to determine the reasons for observed changes. The Dashboard enables users to view trends for individual Groups of ORPS reporting criteria and view related, individual ORPS reports in order to understand underlying causes. Additional analytical features available through the dashboard include the ability to search cause codes assigned by the field and keywords assigned by headquarters.

Other sources of information (e.g., contractor operating experience information, investigation reports, oversight reviews, external reviews, discussions with facility representatives and internal contractor issues tracking systems) should be explored to understand possible reasons for trends.

The many useful features of the NSI Dashboard prove it to be one of many valuable tools for analyzing nuclear safety information.

Figure 5 shows a sample of cause codes identified for a Group of occurrences that are available on the NSI Dashboard.

Figure 5: Nuclear Safety Trend



As indicated before, it is important to discuss trends with people who have knowledge of the site and gather additional information that may corroborate conclusions drawn from the NSI Dashboard.

## Appendix A:

### Definitions and References:

- Hazard Category 1, 2, and 3 nuclear facilities – Classification given to nuclear activities, processes, operations, or activities based on a hazard analysis. On the basis of that analysis, the consequences of unmitigated releases of hazardous radioactive and chemical material are evaluated and classified in the following categories:
  - Category 1 Hazard: The Hazard Analysis shows the potential for significant off-site consequences.
  - Category 2 Hazard: The Hazard Analysis shows the potential for significant on-site consequences.
  - Category 3 Hazard: The Hazard Analysis shows the potential for only significant localized consequences.

The hazard categorization process provides a method for assessing potential hazards. Section 3 and Attachment 1 provide detailed guidance on a consistent methodology which should be used for hazard categorization.

- mrem - Units for dose equivalent are the roentgen equivalent man (rem) and sievert (Sv), and biological dose equivalents are commonly measured in 1/1000th of a rem (known as a millirem or mrem). For practical purposes, 1 R (exposure) = 1 rad (absorbed dose) = 1 rem or 1000 mrem (dose equivalent).
- PEL – Permissible Exposure Limit, as covered by 29 CFR 1910.1000
- SC - SAFETY CLASS STRUCTURES, SYSTEMS, OR COMPONENTS (SAFETY CLASS SSCs). The structures, systems, or components, including portions of process systems, whose preventive or mitigative function is necessary to limit radioactive hazardous material exposure to the public, as determined from safety analyses. (10 CFR Section 830.3)
- SSC - SAFETY SIGNIFICANT STRUCTURES, SYSTEMS, OR COMPONENTS (SAFETY SIGNIFICANT SSCs). The structures, systems, or components that are not designated as safety class structures, systems, or components, but whose preventive or mitigative function is a major contributor to defense in depth and/or worker safety as determined from safety analyses. (10 CFR Section 830.3)
- TED - Total effective dose (TED) means the sum of the effective dose (for external exposures) and the committed effective dose.

Effective dose (E) means the summation of the products of the equivalent dose received by specified tissues or organs of the body (HT) and the appropriate tissue weighting factor (wT)--that is,  $E = \sum wT \cdot HT$ . It includes the dose from radiation sources internal and/or external to the body. For purposes of compliance with this part, equivalent dose to the whole body may be used as effective dose for external exposures. The effective dose is expressed in units of rems (or Sv).

Committed effective dose (E50) means the sum of the committed equivalent doses to various tissues or organs in the body (HT,50), each multiplied by the appropriate tissue weighting factor (wT)--that is,  $E50 = \sum wTHT,50 + w_{\text{Remainder}}H_{\text{Remainder},50}$ . Where  $w_{\text{Remainder}}$  is the tissue weighting factor assigned to the remainder organs and tissues and  $H_{\text{Remainder},50}$  is the committed equivalent dose to the remainder organs and tissues. Committed effective dose is expressed in units of rems (or Sv) .

- ACGIH TLV – American Council of Governmental Industrial Hygienists Threshold Limit Values published in the Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs) handbook
  
- 10 CFR Part 830, *Nuclear Safety Management*
- 10 CFR Part 835, *Occupational Radiation Protection*
- 40 CFR 61.92, *National Emission Standards for Hazardous Air Pollutants*
- 40 CFR 302, *Designation, Reportable Quantities, and Notification*
- 40 CFR 355, *Emergency Planning and Notification*
- 49 CFR 171.16, *Detailed Hazardous Materials Incident Reports*
- 49 CFR 390, *Federal Motor Carrier Safety Regulations; General*
- DOE O 458.1, *Radiation Protection of the Public and the Environment*
- DOE O 460.1C, *Packaging and Transportation Safety*
- DOE O 461.1B, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest*