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LLNL Standard Criticality Controls – History, Features and Advantages

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Since 1998, LLNL has utilized a system of Standard Criticality Controls Conditions (SCCC) in the Plutonium Facility

- A Brief History of the System
- Features of the System
- Current Use of Controls
- Advantages and Disadvantages

A Brief History of the SCCC System

- The concept of Standard Criticality Control Conditions (SCCCs) was developed at LLNL in 1998 to provide consistent controls across multiple work stations.
- At the time, the Plutonium Facility was in the process of resuming operations (“Resumption”) after a series of criticality safety infraction incidents.
- Management felt that increased consistency of the criticality safety controls would help reduce the number and severity of infractions.

Hence, a system of SCCCs was developed and implemented.

Features of the SCCC System

- Each SCCC is designated by a letter (e.g. A, B, C …)
- Each SCCC provides consistent controls (i.e., the wording of each SCCC is the same wherever it is used.)
- Each SCCC typically addresses mass, material form, moderation, reflection and shape controls. In some cases other parameters are controlled.
- A color-coded posting was developed for each SCCC to further aid the fissile material handlers (FMHs).

Description of SCCCs (a few examples)

SCCC	Pu Mass Limit (grams)	Moderator Limit (liter)	Reflector Limit	Shape Limit
A	65	uncontrolled	uncontrolled	uncontrolled
B	220	4.0 intermixed Uncontrolled - unmixed	reflector ≤2”, No Be	Uncontrolled
C	1200	2.5 intermixed 4.0 total	No Cladding	Uncontrolled
D	2500	1.0 intermixed 2.0 Unmixed	Cladding ≤0.25”	uncontrolled

Description of SCCCs (a few examples), cont.

SCCC	Pu Mass Limit (grams)	Moderator Limit (liter)	Reflector Limit	Shape Limit
H	1800	1.0 (not intermixed)	Graphite - 12" Thick, & 1.85 g/cc	Uncontrolled
L	4500	1-liter outside of the Approved Equipment	Approved Configuration	Approved Configuration
O	4500	No intermixed Moderator, 1-liter liquid in bottle	Approved Configuration	Approved Configuration
Ox	15000, oxide	No Liquid	Cladding ≤0.25"	Approved Equipment

A Brief History of the SCCC System (cont.)

- The original concept envisioned a relatively small set of SCCCs.
- During Resumption, criticality safety staff worked closely with Program and Facility staff to develop appropriate SCCCs as program areas resumed operation one-by-one.
- It soon became apparent that different operational areas (e.g., casting, recovery, material processing, machining, waste handling, and so forth) had specific needs.
- Hence appropriate SCCCs were developed which were tailored to needs and workstations within these areas.

This provided consistent controls, but the total number of SCCCs increased from the original concept.

A Brief History of the SCCC System (cont.)

- As the SCCC system was implemented, it also became clear that some specific workstation controls were needed which were not generic across multiple workstations.
- These often involved necessary controls on specific equipment, for example.

Hence, in addition to the SCCCs, some workstation-specific controls were also developed.

CRITICALITY SAFETY LIMITS

Workstation #####	CONDITION L
1. MATERIAL & FORM	
Pu	4500 g
Pu, total in all forms	
Pieces less than 25 g each	190 g
2. MODERATORS	
Liquids Outside approved equipment	1 liter (aqueous solution and solvents)
Graphite	Only as part of One Approved Casting Configuration
3. REFLECTORS/SHAPE	
Pu feedstock and any close-fitting materials	Only as part of ONE Approved Casting Configuration

This is an aid for Fissile Material Handlers.
Complete Controls are found in OSP 332.###

Workstation Specific Controls (*an Example for SCCC L*)

- ***4.3.2.1 Control—Transfer of Pu into Workstations 7006 and 7008***

  Only one primary fissionable material container shall be bagged into a workstation at a time. The mass of the fissionable material in each primary container shall not exceed 2500 grams.

- ***4.3.2.4 Control—Charging the Closed Loop Cooling System***

  The water present in the closed-loop cooling system shall not exceed 12 liters (capacity of the system).

- ***4.3.2.6 Control—Casting Feedstock***

  Casting shall be made only with plutonium alloy feedstock of a density not to exceed 16.7 g/cc.

A Brief History of the SCCC System (cont.)

- Since Resumption, criticality safety staff continued to work closely with Program and Facility staff
  - Provide appropriate SCCCs and workstation specific controls for new and changing operations in the dynamic research and development environment present in the Plutonium Facility.
- Sometimes, new SCCCs were developed to meet new needs, for which no existing SCCC applied well.
- At other times, SCCCs which no longer needed were removed from operations.

Number of SCCCs in use Varied Since Resumption

- A perception developed among some staff that there are too many SCCCs, that the original simplicity of just a few controls across the facility was not realized.
- However, most FMHs, when asked, are satisfied with the current SCCCs in their own areas.
- Periodically, criticality safety staff explore with the Program and Facility staff potential reductions in the number of controls, and these efforts have resulted in some changes.
- Typically, when SCCC changes are needed, criticality safety staff work with customers on a case-by-case basis.

Most SCCCs were developed in Resumption (1998), some were added or deleted since

Year	SCCCs Added	SCCCs Deleted	Total SCCCs
1998	17		**17**
1999	1		**18**
2000	5	2	**21**
2001	2		**23**
2002	1	1	**23**
2003	1		**24**
2004	2		**26**
2005	0	1	**25**
2006			**26**
2007			**26**
2008	1	1	**26**
2009			**26**
2010			**26**

Current Use of SCCCs

- The current number of SCCCs (26) is larger than the number at the end of Resumption (17) and much larger than originally envisioned (approximately four to six).
- A few SCCCs are widely used throughout the Plutonium Facility.
- However most SCCCs are used for a limited group of related operations.

Current Use of SCCCs (cont.)

- Five SCCCs (A, B, D, G, Z) are widely used throughout the programs.
- Ten SCCCs (C, E, V1, V2, V3, V4, V6, V7, W, Wx) are primarily used in one specific program.
- Nine SCCCs (H, Hx, I, J, K, L, M, Ox, T) are used for very specific (one or two) operations.
- Two SCCCs (O, S) are used in limited operations across several programs.

Current Distribution of SCCCs sorted by Program areas

Program	OSP	A	B	C	D	E	G	H	Hx	I	J	K	L	M	O	Ox	S	T	V1	V2	V3	V4	V6	V7	W	Wx	Z
C&MS	5	A	B	C	D																						
C&MS	17	A	B																								Z
C&MS	188	A	B																								Z
C&MS	18	A																									
C&MS	40	A	B																								
C&MS	79	A	B		D																						
C&MS	101	A																									
C&MS	103	A	B																								
C&MS	141	A																									
C&MS	171	A		C			G										S										
C&MS	175	A	B		D		G																				
C&MS	176	A		C																							
C&MS	186	A																									
C&MS	187	A			D																						
C&MS(aging)	183	A	B		D																						
DTED	2	A					G							M													
DTED	196						G							M													
DTED	4	A	B		D		G																				
DTED	37	A																T									
DTED	43	A			D		G																				
DTED	54	A	B		D		G																				
DTED	144	A			D		G																				
DTED	172	A	B		D																						
DTED	189	A																									
DTED(rad)	205	A			D		G								O												
DTED(hood)	184	A	B		D		G										S										
DTED(weld)	60	A			D		G																				
DTED(weld)	154	A			D		G																				

Current Distribution of SCCCs sorted by Program areas (contd/)

MPL	72	A	B			E												O												Z
MPL	75	A				E	G											O												
MPL	190	A					G											O												
MPL	194	A				E																								
MPL	199	A				E													Ox											
MPL	200	A				E																								
MPL	201	A				E																								
MPL	202	A				E													Ox											
Casting	20	A						H			J	K	L																	Z
DOE Class	211	A								I																				
NAI	156	A																O												
NAI	191	A			D		G		Hx									O												
Forensics	174	A	B	C	D	E	G													S										Z
Forensics	212	A	B	C	D	E	G													S										Z
MMS	32	A																			V1	V2	V3		V6					
MMS	84																				V1	V2	V3	V4	V6	V7				
MMS	168	A																			V1	V2	V3				W			
MMS	169	A																			V1	V2	V3		V6					
MMS	179	A																			V1	V2	V3							
RHWM	136	A																									W	Wx		
RHWM	173																										W	Wx		
RHWM	208	A					G																				W	Wx		

Advantages of the SCCC System

- The original concept of the SCCCs was to provide simplicity and consistency throughout the facility.
- The controls of each SCCC are the same in each operation where it is used.
- SCCC postings are uniquely color-coded, which makes it easy for FMHs to recognize which SCCC is authorized (posted) for each workstation.
- As the system was implemented, SCCCs were developed for groups of operations and customers. Hence, these SCCCs fit those operations very well.

Disadvantages of the SCCC System

- The method of implementation led to a larger total number of SCCCs within the facility.
  - This led to a persistent perception that there are too many SCCCs and hence the system is not as simple as originally conceived.

- During implementation, it was recognized that some additional criticality safety controls are needed to address very specific requirements of individual workstations.
  - This led to the need for “workstation specific controls” which further reduces the intended simplicity.

However, looking at the broad picture

- The low number and severity levels of criticality safety infractions since Resumption tends to confirm the over-all success of the system.

SCCC – Examples

- **Several widely used SCCCs are shown in Color Coded Postings**

CRITICALITY SAFETY LIMITS

Workstation XXXX	CONDITION A

1. MATERIAL & FORM

Pu ..... 65 g

or

^{235}U ..... 110 g

or

Combination of Pu and ^{235}U ... 65 g

Form ..... Uncontrolled

2. MODERATORS Uncontrolled

3. REFLECTORS Uncontrolled

4. SHAPE Uncontrolled

This is an aid for Fissile Material Handlers.
Complete controls are defined in B332 FSP

CRITICALITY SAFETY LIMITS

Workstation XXXX	CONDITION B

1. MATERIAL & FORM

Pu ..... **220 g**

or

^{235}U ..... **350 g**

or

Combination of Pu and ^{235}U ..... **220 g**

Form ..... **Uncontrolled**

2. MODERATORS

Maximum 4 liters when mixed with fissile material. **Volume uncontrolled** when not mixed with fissile material.

Aqueous (water-based) mixtures allowed.

Trace quantities are allowed. Contact Criticality Safety for guidance.

NO Beryllium, Graphite, Deuterium, Plastics, Oils, or other hydrogenous materials, except as specifically approved.

3. REFLECTORS

Maximum 5 cm thickness for close-fitting materials.

NO Beryllium. Trace quantities are allowed. Contact Criticality Safety for guidance.

4. SHAPE

Uncontrolled

This is an aid for Fissile Material Handlers.
Complete controls are defining defined in the B332 FSP.

CRITICALITY SAFETY LIMITS

WS # XXXX	CONDITION C
1. MATERIAL & FORM	
Pu, any form (except hydrides)	**1200 g**
or	
U-235, any form (except hydrides)	**2000 g**
2. MODERATORS	
Liquids and solids intermixed with fissionable material	**2.5 liters**
Total solids and liquids	**4 liters**
3. REFLECTORS	
Cladding	**Not Allowed**
4. SHAPE	**Not Controlled**

Complete controls are defined in OSP332.XXX

CRITICALITY SAFETY LIMITS

Workstation XXXX	CONDITION D
1. MATERIAL & FORM	
Pu any form	**2500 g**
or	
^{235}U any form	**3600 g**
2. MODERATORS	
Liquids and solids intermixed with fissionable material	**1 liter**
Liquids and solids not mixed with fissionable material	**2 liters**
3. REFLECTORS	
Cladding	**≤ 0.25 inches**
4. SHAPE	**Uncontrolled**

This is an aid for Fissile Material Handlers.
Complete controls are found in OSP 332.XXX

CRITICALITY SAFETY LIMITS

Workstation XXXX	CONDITION E
1. MATERIAL & FORM	
Pu and/or ^{235}U	**4000 g**
Metal Oxide Nitride Hydride Non-Hydrogenous Compounds	Any combination allowed provided metal is restricted outside approved equipment to: **ONE** Approved Item **or** **one or more BARE metal items with no single item or container to exceed 2500g.**
2. MODERATORS.....	No liquids allowed
3. REFLECTORS	
Cladding Containers	**Approved items only** Wall thickness **≤ 0.25 inches**
4. SHAPE	**Use only Approved equipment or items**

This is an aid for Fissile Material Handlers.
Complete controls are found in OSP 332.XXX

CRITICALITY SAFETY LIMITS

Workstation ###	CONDITION G

1. MATERIAL & FORM

Pu and/or ^{235}U	**ONE Approved Item**

May be single item or multiple subcomponent parts. Pieces removed from Approved Item shall be limited to **220 g**

2. MODERATORS

Liquids and solids intermixed with fissionable material	**In approved equipment only**
Bottles of cleaning Solvents or other liquids	**Not Controlled**

3. REFLECTORS

Cladding	**Per approved item**

4. SHAPE

Subcomponent parts	**Re-assembly allowed only if pre-approved**

This is an aid for Fissile Material Handlers
Complete controls are found in OSP 332.###

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CRITICALITY SAFETY LIMIT

Workstation ##### **CONDITION V1**

1. MATERIAL & FORM

Pu **2500 g**
Metal or Dry Non-Hydrogenous Compounds

or

^{235}U **3500 g**
Metal or Dry Non-Hydrogenous Compounds

or

^{233}U **2000 g**
Metal or Dry Non-Hydrogenous Compounds

2. MODERATORS/REFLECTORS

Liquids **Not Allowed**

Hydrogenous **Not Allowed Materials**

Total Net Weight 3500 g

Complete controls are found in OSP 332.###

This is an aid for Fissile Material Handlers

CRITICALITY SAFETY LIMITS

Workstation XXXX — **CONDITION O**

1. MATERIAL & FORM

Pu ..... **4500 g**

any combination of Pu and ^{235}U

Fissionable Material shall be in the form of metal, oxide, or non-hydrogenous materials excluding beryllium and graphite

2. MODERATORS

Liquids and solids **intermixed with** fissionable material — **Not Allowed**

Liquids in bottles not mixed with fissionable material — **1 liter**

3. REFLECTORS

Cladding is limited to approved configurations specified in OSP

4. SHAPE

Material shall be configured as defined in OSP

CRITICALITY SAFETY LIMITS

Workstation XXXX — CONDITION Ox

1. MATERIAL & FORM

Combination of Pu and 235 ..... 15000 g Total

Form ..... Oxide

2. MODERATORS

No liquids allowed*

*Liquids in limited volume cooling systems (shown as installed equipment in OSP 332.199 Section 3.2, Table 2) are allowed as part of the approved equipment

3. REFLECTION

Containers — Wall thickness ≤ 0.25 inches or Approved Equipment

4. SHAPE

Changes to Approved Equipment shall be approved by Criticality Safety Section

This is an aid for Fissile Material Handlers.
Complete controls are defined in OSP 332.XXX

Summary

- The current system of criticality safety controls in the Plutonium Facility, utilizing SCCCs augmented by workstation-specific controls as needed, has generally worked quite well.
- Although most FMHs seem satisfied with the criticality safety controls applicable to their own workstations, there has persisted a perception that the number of SCCCs is large.
- The on-going reduction in inventory will reduce/eliminate the need for many current higher mass controls.
- The LLNL criticality safety staff continue to work with the Program and Facility staff to identify ways to simplify the controls while ensuring safety and meeting customer needs.