

Health Hazard Rating Systems for Chemical Screening— Are They All Created Equal?

*A.J. Rocky Petrocchi
Washington Group International
May 2007*



EMI-SIG & SCAPA 2007 Annual Meeting

NO!

Some
APPEAR
to be!

But are they?

Let's find
out.....

A. During emergency planning...

- DOE Order 151.1C
 - Ch III, 3.b.(2)(b)3, page III-4
 - Specifies use of **NFPA 704 Health Hazard Ratings (HHRs)** for Chemical Screening
 - "Chemicals without an assigned [NFPA] Health Hazard rating require further analysis in an EPHA ..."
- Draft DOE Guide 151.1-1 (11-1-2006 RevCom)
 - Vol II, Appendix A, A.3.2, page A-11
 - "**Human Health Hazard.** Materials that have been assigned a NFPA health hazard category rating (**or a comparable locally assigned hazard rating**)..."
[emphasis added]

B. During emergency planning...

- If no NFPA HHR for a chemical exists
 - Several other HHR systems exist.....
 - Planner may be **tempted** to use other systems?
 - Current Order & Draft Guide do **NOT** allow this.
- **IF** planner decides to use them anyway...
- What **pitfalls** might be involved?
- Is the **temptation** worth the **audit risk**?
- Let's do some comparisons → → →

Purpose

- Compare HHR Systems **Health** Criteria
- Determine **Similarities** & **Differences**
- Summarize Results

Health Hazard Rating (HHR) Systems

- National Fire Protection Association (**NFPA**)
- United Nations Economic Commission for Europe (**UNECE**)
 - **Model Regulations**: “Transport of Dangerous Goods”
 - Globally Harmonized System (**GHS**)
- Hazardous Materials Identification System (**HMIS**)
 - National Paint and Coatings Association
- Sax Hazard Rating (**SAX**)
 - Part of “Sax’s Dangerous Properties of Industrial Materials” database originally published by Irving Sax
- Savannah River Site Hazard Rating System (**SRS**)
- Only **HEALTH** Hazard Rating criteria compared

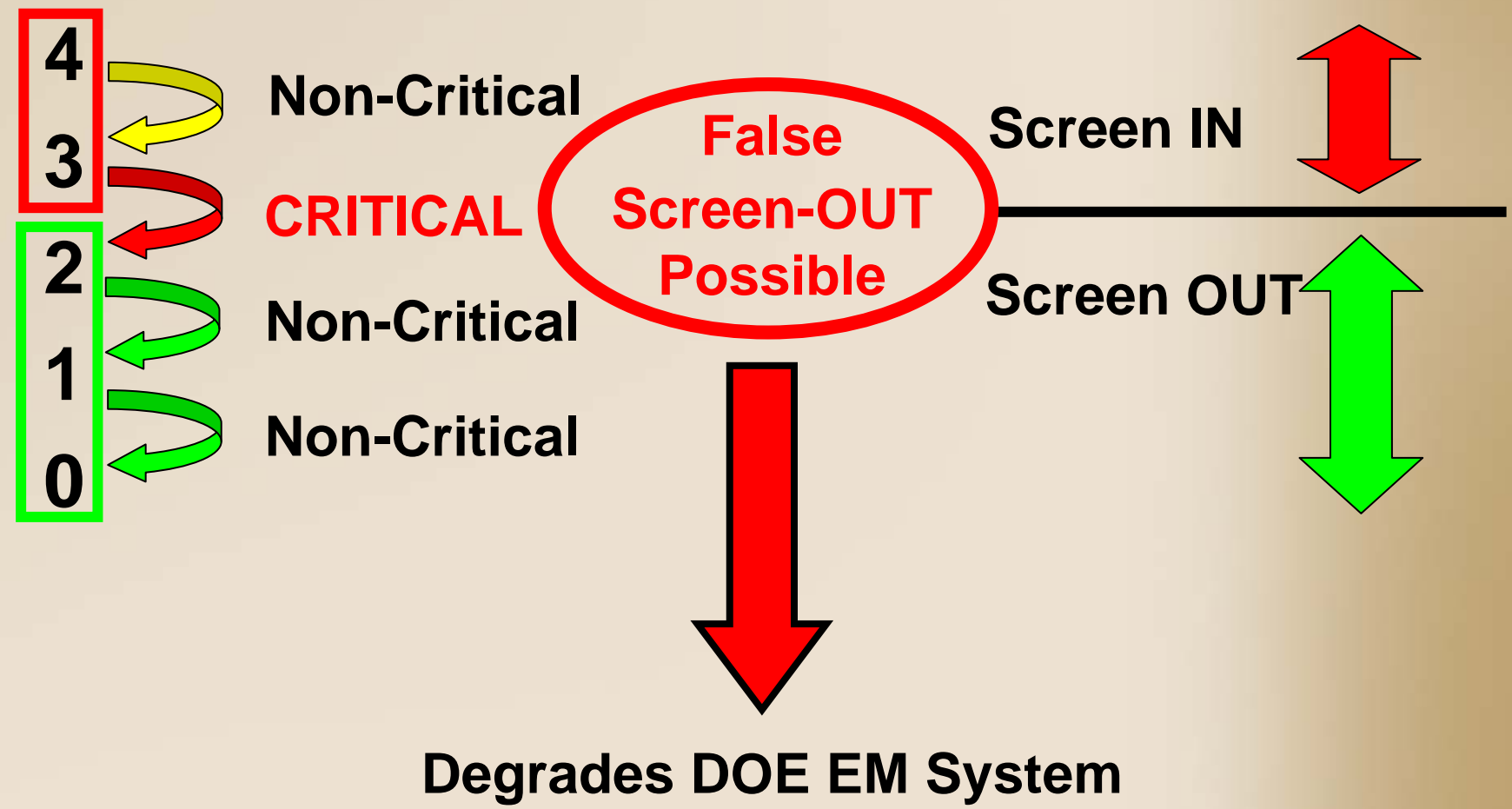
HHR Systems—Intended Use

- **NFPA**—Emergency response for chemical releases
 - Based in part on UNECE criteria
 - Includes ordinary use + emergency event issues
- **UNECE**—Safety in transport of dangerous goods
- **HMIS**—Occupational hazards
 - Ordinary use only, no emergency issues considered
- **SAX**—Health, Fire, Reactivity COMBINED
 - Single Number—May NOT be specific to Health Hazard
 - May be based on highest...
 - toxic **OR** fire **OR** explosive **OR** reactivity hazard
- **SRS**—Based on NFPA HHR criteria

NFPA HHR Criteria

- Gas or Vapor—Inhalation
 - LC50 (1-hour Rat)
- Gas or Vapor—Saturated Vapor Conc. (SVC) Index
 - SVC, ppm / LC50, ppm (Unitless index)
- Dust or Mist—Inhalation
 - 10 μm or less, LC50 (1-hour Rat)
- Oral—LD50 (Rat, 14 days or less)
- Dermal—LD50 (Rabbit, 14 days or less)
- HHR Basis—Not Published & Not Available
- Least similar criterion \rightarrow Vapor Inhalation

NFPA HHR Criteria— Critical vs. Non-Critical Overlaps



UNECE Model Regulations

- Part of basis for NFPA HHR criteria (4, 3, 2)
- Packing Groups I, II, III (High to Low)
 - Transport of Dangerous Goods
 - Notice number REVERSAL
 - I → highest hazard
 - III → lowest hazard

NFPA 704 vs. UNECE Model Regulations

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit			
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units	
		Low	High		Low	High		Low	High		Low	High		Low	High		
NFPA 704 2001	4	0	1000	ppm	10	> 10		0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg	
	3	1001	3000	ppm	1	< 10		0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg	
	2	3001	5000	ppm	0.2	< 1		2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg	
	1	5001	10000	ppm	0	< 0.2		10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg	
	0	> 10000		ppm	0	< 0.2		> 200		mg/L	> 2000		mg/kg	> 2000		mg/kg	
UNECE Model Regs (Existing) Rev 14, 2005	UN Packing Groups																
	I		≤ 1000	ppm		≥ 10			≤ 0.2	mg/L		≤ 5.0	mg/kg		≤ 50	mg/kg	
	II	> 1000	3000	ppm	1	< 10		> 0.2	2.0	mg/L	> 5.0	50	mg/kg	> 50	200	mg/kg	
	III	> 3000	5000	ppm	0.2	< 1		> 2.0	4.0	mg/L	> 50	300	mg/kg	> 200	1000	mg/kg	
	1	Not Defined															
0	Not Defined																

UN Packing Groups → I, II, III (High to Low)

- Color scheme—red to green categories
 - Colors same as DHS National Threat Advisory
 - Notes similarities & differences in criteria
- Some minor differences with NFPA

EXPECT THE UNEXPECTED

NFPA 704 vs. UNECE Model Regulations

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat				Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit		
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units	
		Low	High		Low	High		Low	High		Low	High		Low	High		
NFPA 704 2001	4	0	1000	ppm	10	> 10		0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg	
	3	1001	3000	ppm	1	< 10		0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg	
	2	3001	5000	ppm	0.2	< 1		2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg	
	1	5001	10000	ppm	0	< 0.2		10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg	
	0	> 10000		ppm	0	< 0.2		> 200		mg/L	> 2000		mg/kg	> 2000		mg/kg	
UNECE Model Regs (Existing) Rev 14, 2005	UN Packing Groups																
	I		≤ 1000	ppm		≥ 10			≤ 0.2	mg/L		≤ 5.0	mg/kg		≤ 50	mg/kg	
	II	> 1000	3000	ppm	1	< 10		>	0.2	5.0	mg/L	> 5.0	50	mg/kg	> 50	200	mg/kg
	III	> 3000	5000	ppm	0.2	< 1		>	2.0	4.0	mg/L	> 50	300	mg/kg	> 200	1000	mg/kg
	1	Not Defined															
0	Not Defined																

NON-CRITICAL OVERLAPS:

- UN Packing Group I & II → NFPA 4 & 3
 - Dust / Mist Inhalation
 - Dermal LD50

EXPECT THE UNEXPECTED

NFPA 704 vs. UNECE Model Regulations

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat				Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit		
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units	
		Low	High		Low	High		Low	High		Low	High		Low	High		
NFPA 704 2001	4	0	1000	ppm	10	> 10		0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg	
	3	1001	3000	ppm	1	< 10		0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg	
	2	3001	5000	ppm	0.2	< 1		2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg	
	1	5001	10000	ppm	0	< 0.2		10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg	
	0	> 10000		ppm	0	< 0.2		> 200		mg/L	> 2000		mg/kg	> 2000		mg/kg	
UNECE Model Regs (Existing) Rev 14, 2005	UN Packing Groups																
	I		≤ 1000	ppm		≥ 10			≤ 0.2	mg/L		≤ 5.0	mg/kg		≤ 50	mg/kg	
	II	> 1000	3000	ppm	1	< 10		> 0.2	2.0	mg/L	> 5.0	50	mg/kg	> 50	200	mg/kg	
	III	> 3000	5000	ppm	0.2	< 1		> 2.0	4.0	mg/L	> 50	300	mg/kg	> 200	1000	mg/kg	
	1	Not Defined															
0	Not Defined																

More NON-CRITICAL OVERLAPS:

- UN Packing Group III (lower cut-offs) → NFPA 2 & 1
 - Dust / Mist Inhalation
 - Oral LD50

EXPECT THE UNEXPECTED

NFPA 704 vs. UNECE Model Regulations

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit		
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units
		Low	High		Low	High		Low	High		Low	High		Low	High	
NFPA 704 2001	4	0	1000	ppm	10	> 10		0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg
	3	1001	3000	ppm	1	< 10		0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg
	2	3001	5000	ppm	0.2	< 1		2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg
	1	5001	10000	ppm	0	< 0.2		10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg
	0	> 10000		ppm	0	< 0.2		> 200		mg/L	> 2000		mg/kg	> 2000		mg/kg
UNECE Model Regs (Existing) Rev 14, 2005	UN Packing Groups															
	I		≤ 1000	ppm		≥ 10			≤ 0.2	mg/L		≤ 5.0	mg/kg		≤ 50	mg/kg
	II	> 1000	3000	ppm	1	< 10		> 0.2	5.0	mg/L	> 5.0	50	mg/kg	> 50	200	mg/kg
	III	> 3000	5000	ppm	0.2	< 1		> 2.0	4.0	mg/L	> 50	300	mg/kg	> 200	1000	mg/kg
	1	Not Defined														
0	Not Defined															

SUMMARY

- Non-Critical overlaps
- No Critical NFPA 3 to 2 overlaps
- No false screen-outs

UNECE

Globally Harmonized System (GHS)

- In development since 1990
 - Now in final draft stages
 - Number reversal retained
- EPA, OSHA, DOT
 - Initiated rule making to implement GHS
- DOT
 - Implementation sometime in 2008 (per UNECE)
- NFPA
 - No official statement yet on how to harmonize

NFPA 704 vs. UNECE GHS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit		
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units
		Low	High		Low	High		Low	High		Low	High		Low	High	
NFPA 704 2001	4	0	1000	ppm	10	> 10		0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg
	3	1001	3000	ppm	1	< 10		0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg
	2	3001	5000	ppm	0.2	< 1		2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg
	1	5001	10000	ppm	0	< 0.2		10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg
	0	> 10000		ppm	0	< 0.2		> 200		mg/L	> 2000		mg/kg	> 2000		mg/kg
UNECE GHS (Proposed) Rev 1, 2005	UN GHS Categories															
	1	0	≤ 100	ppm				0	≤ 0.05	mg/L	0	≤ 5	mg/kg	0	≤ 50	mg/kg
	2	> 100	≤ 500	ppm				> 0.05	≤ 0.5	mg/L	> 5	≤ 50	mg/kg	> 50	≤ 200	mg/kg
	3	> 500	≤ 2500	ppm				> 0.5	≤ 1.0	mg/L	> 50	≤ 300	mg/kg	> 200	≤ 1000	mg/kg
	4	> 2500	≤ 5000	ppm				> 1.0	≤ 5.0	mg/L	> 300	≤ 2000	mg/kg	> 1000	≤ 2000	mg/kg
5										> 2000	≤ 5000	mg/kg	> 2000	≤ 5000	mg/kg	

UN GHS → 1, 2, 3, 4, 5 (High to Low)

- Intended to replace UN Model Regulations
- Some significant overlaps with NFPA

NFPA 704 vs. UNECE GHS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit									
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units							
		Low	High		Low	High		Low	High		Low	High		Low	High								
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg							
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg							
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg							
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg							
	0	>	10000		ppm	0	<	0.2	>	200		mg/L	>	2000		mg/kg	>	2000		mg/kg			
UNECE GHS (Proposed) Rev 1, 2005	UN GHS Categories																						
	1	0	≤	100	ppm			0	≤	0.05	mg/L	0	≤	5	mg/kg	0	≤	50	mg/kg				
	2	>	100	≤	500	ppm			>	0.05	≤	0.5	mg/L	>	5	≤	50	mg/kg	>	50	≤	200	mg/kg
	3	>	500	≤	2500	ppm			>	0.5	≤	1.0	mg/L	>	50	≤	300	mg/kg	>	200	≤	1000	mg/kg
	4	>	2500	≤	5000	ppm			>	1.0	≤	5.0	mg/L	>	300	≤	2000	mg/kg	>	1000	≤	2000	mg/kg
5														>	2000	≤	5000	mg/kg	>	2000	≤	5000	mg/kg

Major Category OVERLAPS—Gas / Vapor & Dust / Mist Inhalation

- UN GHS 1 & 2 entirely within NFPA 4 → Non-Critical
- UN GHS 3 & 4 overlap NFPA 3 & 2 → **CRITICAL**
- Using only GHS cat. numbers → **FALSE screen-OUT possible**

NFPA 704 vs. UNECE GHS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit			
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units	
		Low	High		Low	High		Low	High		Low	High		Low	High		
NFPA 704 2001	4	0	1000	ppm	10	> 10		0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg	
	3	1001	3000	ppm	1	< 10		0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg	
	2	3001	5000	ppm	0.2	< 1		2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg	
	1	5001	10000	ppm	0	< 0.2		10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg	
	0	> 10000		ppm	0	< 0.2		> 200		mg/L	> 2000		mg/kg	> 2000		mg/kg	
UNECE GHS (Proposed) Rev 1, 2005	UN GHS Categories																
	1	0	≤ 100	ppm				0	≤ 0.05	mg/L	0	≤ 5	mg/kg	0	≤ 50	mg/kg	
	2	> 100	≤ 500	ppm				> 0.05	≤ 0.5	mg/L	> 5	≤ 50	mg/kg	> 50	≤ 200	mg/kg	
	3	> 500	≤ 2500	ppm				> 0.5	≤ 1.0	mg/L	> 50	≤ 300	mg/kg	> 200	≤ 1000	mg/kg	
	4	> 2500	≤ 5000	ppm				> 1.0	≤ 5.0	mg/L	> 300	≤ 2000	mg/kg	> 1000	≤ 2000	mg/kg	
5										> 2000	≤ 5000	mg/kg	> 2000	≤ 5000	mg/kg		

CRITICAL OVERLAPS—Gas / Vapor Inhalation & Dust / Mist Inhalation

- UN GHS 3 & 4 → NFPA 3 & 2
- FALSE Screen-OUT possible

NFPA 704 vs. UNECE GHS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit										
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units								
		Low	High		Low	High		Low	High		Low	High		Low	High									
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg								
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg								
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg								
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg								
	0	>	10000		ppm	0	<	0.2	>	200		mg/L	>	2000		mg/kg	>	2000		mg/kg				
UNECE GHS (Proposed) Rev 1, 2005	UN GHS Categories																							
	1	0	≤	100	ppm					0	≤	0.05	mg/L	0	≤	5	mg/kg	0	≤	50	mg/kg			
	2	>	100	≤	500	ppm				>	0.05	≤	0.5	mg/L	>	5	≤	50	mg/kg	>	50	≤	200	mg/kg
	3	>	500	≤	2500	ppm				>	0.5	≤	1.0	mg/L	>	50	≤	300	mg/kg	>	200	≤	1000	mg/kg
	4	>	2500	≤	5000	ppm				>	1.0	≤	5.0	mg/L	>	300	≤	2000	mg/kg	>	1000	≤	2000	mg/kg
5														>	2000	≤	5000	mg/kg	>	2000	≤	5000	mg/kg	

NON-CRITICAL OVERLAPS

- UN GHS 1-2 & 3 → NFPA 4 & 3 (Gas / Vapor Inhalation)
- UN GHS 1 & 2 → NFPA 4 & 3 (Dermal LD50)

NFPA 704 vs. UNECE GHS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit			
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units	
		Low	High		Low	High		Low	High		Low	High		Low	High		
NFPA 704 2001	4	0	1000	ppm	10	> 10		0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg	
	3	1001	3000	ppm	1	< 10		0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg	
	2	3001	5000	ppm	0.2	< 1		2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg	
	1	5001	10000	ppm	0	< 0.2		10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg	
	0	> 10000		ppm	0	< 0.2		> 200		mg/L	> 2000		mg/kg	> 2000		mg/kg	
UNECE GHS (Proposed) Rev 1, 2005	UN GHS Categories																
	1	0	≤ 100	ppm				0	≤ 0.05	mg/L	0	≤ 5	mg/kg	0	≤ 50	mg/kg	
	2	> 100	≤ 500	ppm				> 0.05	≤ 0.5	mg/L	> 5	≤ 50	mg/kg	> 50	≤ 200	mg/kg	
	3	> 500	≤ 2500	ppm				> 0.5	≤ 1.0	mg/L	> 50	≤ 300	mg/kg	> 200	≤ 1000	mg/kg	
	4	> 2500	≤ 5000	ppm				> 1.0	≤ 5.0	mg/L	> 300	≤ 2000	mg/kg	> 1000	≤ 2000	mg/kg	
5										> 2000	≤ 5000	mg/kg	> 2000	≤ 5000	mg/kg		

Another NON-CRITICAL OVERLAP—Oral LD50

- UN GHS 3 & 4 → NFPA 2 & 1

NFPA 704 vs. UNECE GHS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit									
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units							
		Low	High		Low	High		Low	High		Low	High		Low	High								
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg							
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg							
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg							
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg							
	0	>	10000		ppm	0	<	0.2	>	200		mg/L	>	2000		mg/kg	>	2000		mg/kg			
UNECE GHS (Proposed) Rev 1, 2005	UN GHS Categories																						
	1	0	≤	100	ppm			0	≤	0.05	mg/L	0	≤	5	mg/kg	0	≤	50	mg/kg				
	2	>	100	≤	500	ppm			>	0.05	≤	0.5	mg/L	>	5	≤	50	mg/kg	>	50	≤	200	mg/kg
	3	>	500	≤	2500	ppm			>	0.5	≤	1.0	mg/L	>	50	≤	300	mg/kg	>	200	≤	1000	mg/kg
	4	>	2500	≤	5000	ppm			>	1.0	≤	5.0	mg/L	>	300	≤	2000	mg/kg	>	1000	≤	2000	mg/kg
5														>	2000	≤	5000	mg/kg	>	2000	≤	5000	mg/kg

SUMMARY

- Category Overlaps → FALSE Screen-OUT possible
- CRITICAL Overlaps → FALSE Screen-OUT possible
- Non-Critical overlaps

HMIS

- Occupational hazards
- Ordinary use only
- No emergency issues considered
- Same category numbers as NFPA

HMIS—Vapor Inhalation Issue

- **NFPA**: 1-hour LC50 rat vapor inhalation data
- **HMIS**: 4-hour LC50 rat vapor inhalation data
- NFPA
 - Recommends multiplication factor of 2 to convert 4-hour vapor inhalation data to 1-hour data
 - NFPA quote from UNECE guidelines
- HMIS—LC50 (4-hour) $\times 2 \approx$ LC50 (1-hour)
- Enables a better apples-to-apples comparison of the two systems.

NFPA 704 vs. HMIS

EXPECT THE UNEXPECTED

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit				
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units		
		Low	High		Low	High		Low	High		Low	High		Low	High			
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg		
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg		
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg		
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg		
	0	>	10000		ppm	0	<	0.2	>	200	mg/L	>	2000		mg/kg	>	2000	mg/kg
HMIS 3rd ed., 2001		4-hour Rat (adj to 1-hr)									Rat		Rabbit or Rat					
	4	≤	50		ppm (1)						≤	1		mg/kg	≤	20		mg/kg
	3	>	50	500	ppm (1)						>	1	50	mg/kg	>	20	200	mg/kg
	2	>	500	2000	ppm (1)						>	50	500	mg/kg	>	200	1000	mg/kg
	1	>	2000	20000	ppm (1)						>	500	5000	mg/kg	>	1000	2000	mg/kg
0	>	20000		ppm (1)						>	5000		mg/kg	>	2000		mg/kg	

HMIS → 4, 3, 2, 1, 0 (High to Low)

➤ Also some significant overlaps with NFPA

NFPA 704 vs. HMIS

EXPECT THE UNEXPECTED

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit				
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units		
		Low	High		Low	High		Low	High		Low	High		Low	High			
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg		
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg		
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg		
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg		
	0	>	10000		ppm	0	<	0.2	>	200	mg/L	>	2000		mg/kg	>	2000	
HMIS 3rd ed., 2001		4-hour Rat (adj to 1-hr)									Rat		Rabbit or Rat					
	4	≤	50	ppm (1)							≤	1	mg/kg	≤	20	mg/kg		
	3	>	50	500 ppm (1)							>	1	50 mg/kg	>	20	200 mg/kg		
	2	>	500	2000 ppm (1)							>	50	500 mg/kg	>	200	1000 mg/kg		
	1	>	2000	20000 ppm (1)							>	500	5000 mg/kg	>	1000	2000 mg/kg		
0	>	20000		ppm (1)						>	5000		mg/kg	>	2000		mg/kg	

Category OVERLAPS—Gas / Vapor Inhalation

- HMIS 4 & 3 entirely within NFPA 4 → Non-Critical
- HMIS 2 somewhat similar to NFPA 3 → **CRITICAL**
- Using only HMIS 2 cat. number → **FALSE screen-OUT possible**

NFPA 704 vs. HMIS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit				
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units		
		Low	High		Low	High		Low	High		Low	High		Low	High			
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg		
	3	100	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg		
	2	300	3000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg		
	1	500	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg		
	0	>	10000		ppm	0	<	0.2	>	200	mg/L	>	2000		mg/kg	>	2000	
HMIS 3rd ed., 2001		4-hour Rat (adj to 1-hr)									Rat		Rabbit or Rat					
	4	≤	50	ppm (1)							≤	1	mg/kg	≤	20	mg/kg		
	3	>	50	500 ppm (1)							>	1	50 mg/kg	>	20	200 mg/kg		
	2	>	500	2000 ppm (1)							>	50	500 mg/kg	>	200	1000 mg/kg		
	1	>	2000	20000 ppm (1)							>	500	5000 mg/kg	>	1000	2000 mg/kg		
0	>	20000		ppm (1)							>	5000		mg/kg	>	2000		mg/kg

CRITICAL OVERLAPS—Gas / Vapor Inhalation

- HMIS 2 & 1 → NFPA 3 & 2
- FALSE Screen-OUT possible

NFPA 704 vs. HMIS

EXPECT THE UNEXPECTED

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit				
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units		
		Low	High		Low	High		Low	High		Low	High		Low	High			
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg		
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg		
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg		
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg		
	0	>	10000		ppm	0	<	0.2	>	200	mg/L	>	2000		mg/kg	>	2000	
HMIS 3rd ed., 2001		4-hour Rat (adj to 1-hr)									Rat		Rabbit or Rat					
	4	≤	50	ppm (1)							≤	1	mg/kg	≤	20	mg/kg		
	3	>	50	500 ppm (1)							>	1	50 mg/kg	>	20	200 mg/kg		
	2	>	500	2000 ppm (1)							>	50	500 mg/kg	>	200	1000 mg/kg		
	1	>	2000	20000 ppm (1)							>	500	5000 mg/kg	>	1000	2000 mg/kg		
0	>	20000		ppm (1)						>	5000		mg/kg	>	2000		mg/kg	

NON-CRITICAL OVERLAPS

- HMIS 3 & 2 → NFPA 4 & 3
 - Gas / Vapor Inhalation
- HMIS 4 & 3 → NFPA 4 & 3
 - Oral LD50, Dermal LD50

NFPA 704 vs. HMIS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit				
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units		
		Low	High		Low	High		Low	High		Low	High		Low	High			
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg		
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg		
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg		
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg		
	0	>	10000	ppm	0	<	0.2	>	200	mg/L	>	2000	mg/kg	>	2000	mg/kg		
HMIS 3rd ed., 2001	4-hour Rat (adj to 1-hr)								Rat			Rabbit or Rat						
	4	≤	50	ppm (1)							≤	1	mg/kg	≤	20	mg/kg		
	3	>	50	ppm (1)							>	1	50	mg/kg	>	20	200	mg/kg
	2	>	500	ppm (1)							>	50	500	mg/kg	>	200	1000	mg/kg
	1	>	2000	ppm (1)							>	500	5000	mg/kg	>	1000	2000	mg/kg
0		20000	ppm (1)								5000	mg/kg	>	2000	mg/kg			

More NON-CRITICAL OVERLAPS—Gas / Vapor Inhalation, Oral LD50
 ➤ HMIS 1 & 0 → NFPA 1 & 0

NFPA 704 vs. HMIS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit		
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units
		Low	High		Low	High		Low	High		Low	High		Low	High	
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg
	0	>	10000	ppm	0	<	0.2	>	200	mg/L	>	2000	mg/kg	>	2000	mg/kg
HMIS 3rd ed., 2001		4-hour Rat (adj to 1-hr)									Rat		Rabbit or Rat			
	4	≤	50	ppm (1)							≤	1	mg/kg	≤	20	mg/kg
	3	>	50	500 ppm (1)							>	1	50 mg/kg	>	20	200 mg/kg
	2	>	500	2000 ppm (1)							>	50	500 mg/kg	>	200	1000 mg/kg
	1	>	2000	20000 ppm (1)							>	500	5000 mg/kg	>	1000	2000 mg/kg
0	>	20000	ppm (1)							>	5000	mg/kg	>	2000	mg/kg	

SUMMARY

- Category Overlaps → FALSE Screen-OUT possible
- CRITICAL Overlaps → FALSE Screen-OUT possible
- Non-Critical overlaps

SAX

- Broad Overview of Chemical Hazard
- Only 3 hazard category numbers: 3, 2, 1
- Only **ONE** number assigned for all hazards
- Highest Hazard
 - toxic **OR** fire **OR** explosive **OR** reactivity
- SAX HR may **NOT** be based on Health

NFPA 704 vs. SAX

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit								
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units						
		Low	High		Low	High		Low	High		Low	High		Low	High							
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg						
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg						
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg						
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg						
	0	>	10000	ppm	0	<	0.2	>	200	mg/L	>	2000	mg/kg	>	2000	mg/kg						
SAX 11 ed., 2004	ONE Rating: HIGHEST of HEALTH or FIRE or REACTIVITY																					
	4	Not Defined																				
	3	<	100	ppm												<	400	ppm				
	2		100	500	ppm													400	4000	ppm		
	1		500	5000	ppm													4000	40000	ppm		
0	Not Defined																					

SAX → 3, 2, 1 (High to Low)

➤ **Least similar to NFPA of all systems compared**

NFPA 704 vs. SAX

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit							
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units					
		Low	High		Low	High		Low	High		Low	High		Low	High						
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg					
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg					
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg					
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg					
	0	>	10000	ppm	0	<	0.2	>	200	mg/L	>	2000	mg/kg	>	2000	mg/kg					
SAX 11 ed., 2004	ONE Rating: HIGHEST of HEALTH or FIRE or REACTIVITY																				
	4	Not Defined																			
	3	<	100	ppm													<	400			
	2	100	500	ppm													400	4000			
	1	500	5000	ppm													4000	40000			
0	Not Defined																				

Category OVERLAPS—Gas / Vapor Inhalation

- SAX 3 entirely within NFPA 4 → Non-Critical
- SAX 2 entirely within NFPA 4 → **CRITICAL**
 - Using only SAX 2 number → **FALSE screen-OUT possible**

NFPA 704 vs. SAX

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit			
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units	
		Low	High		Low	High		Low	High		Low	High		Low	High		
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg	
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg	
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg	
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg	
	0	> 10000		ppm	0	<	0.2	> 200		mg/L	> 2000		mg/kg	> 2000		mg/kg	
SAX 11 ed., 2004	ONE Rating: HIGHEST of HEALTH or FIRE or REACTIVITY																
	4	Not Defined															
	3	<	100		ppm												
	2		100	500	ppm												
	1		500	5000	ppm												
0	Not Defined																

More Category OVERLAPS—Gas / Vapor Inhalation

- SAX 1 overlaps NFPA 4, 3, 2 → **CRITICAL**
 - Using only SAX 1 number → **FALSE screen-OUT possible**

NFPA 704 vs. SAX

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit					
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units			
		Low	High		Low	High		Low	High		Low	High		Low	High				
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg			
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg			
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg			
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg			
	0	>	10000	ppm	0	<	0.2	>	200	mg/L	2000	mg/kg	2000	mg/kg	mg/kg				
SAX 11 ed., 2004	ONE Rating: HIGHEST of HEALTH or FIRE or REACTIVITY																		
	4	Not Defined																	
	3	<	100	ppm													<	400	
	2	100	500	ppm													400	4000	
	1	500	5000	ppm													4000	40000	
0	Not Defined																		

Category OVERLAPS—Oral LD50

- SAX 3 overlaps NFPA 4, 3, 2 → Non-Critical
 - Using only SAX 3 number → FALSE screen-IN possible
- SAX 2 overlaps NFPA 2, 1, 0 → Non-Critical
- SAX 1 entirely within NFPA 0 → Non-Critical

EXPECT THE UNEXPECTED

NFPA 704 vs. SAX

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit			
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units	
		Low	High		Low	High		Low	High		Low	High		Low	High		
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg	
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg	
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg	
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg	
	0	> 10000		ppm	0	<	0.2	> 200		mg/L	2000		mg/kg	2000		mg/kg	
SAX 11 ed., 2004	ONE Rating: HIGHEST of HEALTH or FIRE or REACTIVITY																
	4	Not Defined															
	3	<	100		ppm												
	2		100		500	ppm											
	1		500		5000	ppm											
0	Not Defined																

SUMMARY

- **ANY** SAX HR → could screen IN
 - If based on inhalation criteria but basis is never known
- **Category Overlaps → FALSE Screen-OUT possible**
 - Based on HR Category numbers ONLY → SAX 2, 1
- **Non-Critical overlaps**

EXPECT THE UNEXPECTED

NFPA vs. SRS

Hazard Rating System	HHR	Gas / Vapor Inhalation LC50 1-hour Rat			Gas / Vapor Saturated Vapor Conc. (SVC, ppm / LC50, ppm)			Dust / Mist Inhalation 10 microns or less LC50			Oral LD50 Rat			Dermal LD50 Rabbit		
		Range		Units	Range		Unit-less	Range		Units	Range		Units	Range		Units
		Low	High		Low	High		Low	High		Low	High		Low	High	
NFPA 704 2001	4	0	1000	ppm	10	>	10	0	0.5	mg/L	0	5	mg/kg	0	40	mg/kg
	3	1001	3000	ppm	1	<	10	0.51	2	mg/L	5.01	50	mg/kg	40.1	200	mg/kg
	2	3001	5000	ppm	0.2	<	1	2.01	10	mg/L	50.1	500	mg/kg	201	1000	mg/kg
	1	5001	10000	ppm	0	<	0.2	10.1	200	mg/L	501	2000	mg/kg	1001	2000	mg/kg
	0	> 10000		ppm	0	<	0.2	> 200		mg/L	> 2000		mg/kg	> 2000		mg/kg
SRS DRAFT 9/11/2006	"Consistent with NFPA 704"															
	4															
	3															
	2															
	1															
0																

“Consistent with NFPA 704” per SRS Draft 9/11/2006

SUMMARY

- SRS HHR system uses identical NFPA HHR criteria
- “Comparable” to NFPA

Conclusions

- UNECE Model Regulations
 - Very similar to NFPA 4, 3, 2—no false screen-outs
- UNECE GHS
 - Several differences with NFPA—**some false screen-outs**
- HMIS
 - Several differences with NFPA—**some false screen-outs**
- SAX
 - Least similar to NFPA—**several false screen-outs**
- SRS
 - “Comparable” to NFPA—no false screen-outs

Comparison Summary

	NFPA 704, 2001				
	4	3	2	1	0
UNECE Packing Groups 14th rev ed, 2005	I	II	III		
UNECE GHS 1st rev ed, 2005	1, 2	3	4		5
HMIS 3rd ed, 2001	4, 3	2		1	0
SAX 11th ed, 2004	3, 2	1			
SRS Draft, 9/11/2006	4	3	2	1	0

 = **Possible FALSE Screen-OUT**
 = **Non-critical Overlap**

BOTTOM LINE:

- Except for NFPA and SRS
- None of these other systems are either approved or recommended for use in chemical screening at this time.