



Edgewood
Chemical Biological
Center



Southwest
Research
Institute

Non-Lethal Applications of Slippery Substances

Dr. Kenneth R. Collins - U.S. Army

Ronald J. Mathis - SwRI

William A. Mallow - SwRI



Edgewood
Chemical Biological
Center

Countertraction Technologies

Screening Efforts - 1996 to 1997



Southwest
Research
Institute

Allied Colloids, Inc.

Percol 722
Percol 722F
Percol 737
Percol 757
Percol 763F
Percol 767
Percol 775
Percol 778
Percol 788N

American Cyanamid

Gelamide 250

Union Carbide

Polyox WSR 301
Polyox N-80

Dow Chemical

Methocel F4M
Methocel (?)

Cytec

Cyanmer N-300
Cyanamer N-300 LMW
Cydril 5300 (tested by SwRI, 1997)

BF Goodrich

Carbopol Ultrez 10 + 50% Triethanol/H₂O

Hercules

Retan 157
Retan 235

JRM Chemical – SoilMoist Fines & SoilMoist Hydro

CPS Chemical

Agefloc WT 603
Agefloc 603 (?)

Norell, Inc. – “Barricade Foam”

Agefloc WT 603, Percol, and
Methocel F4M judged ‘best’

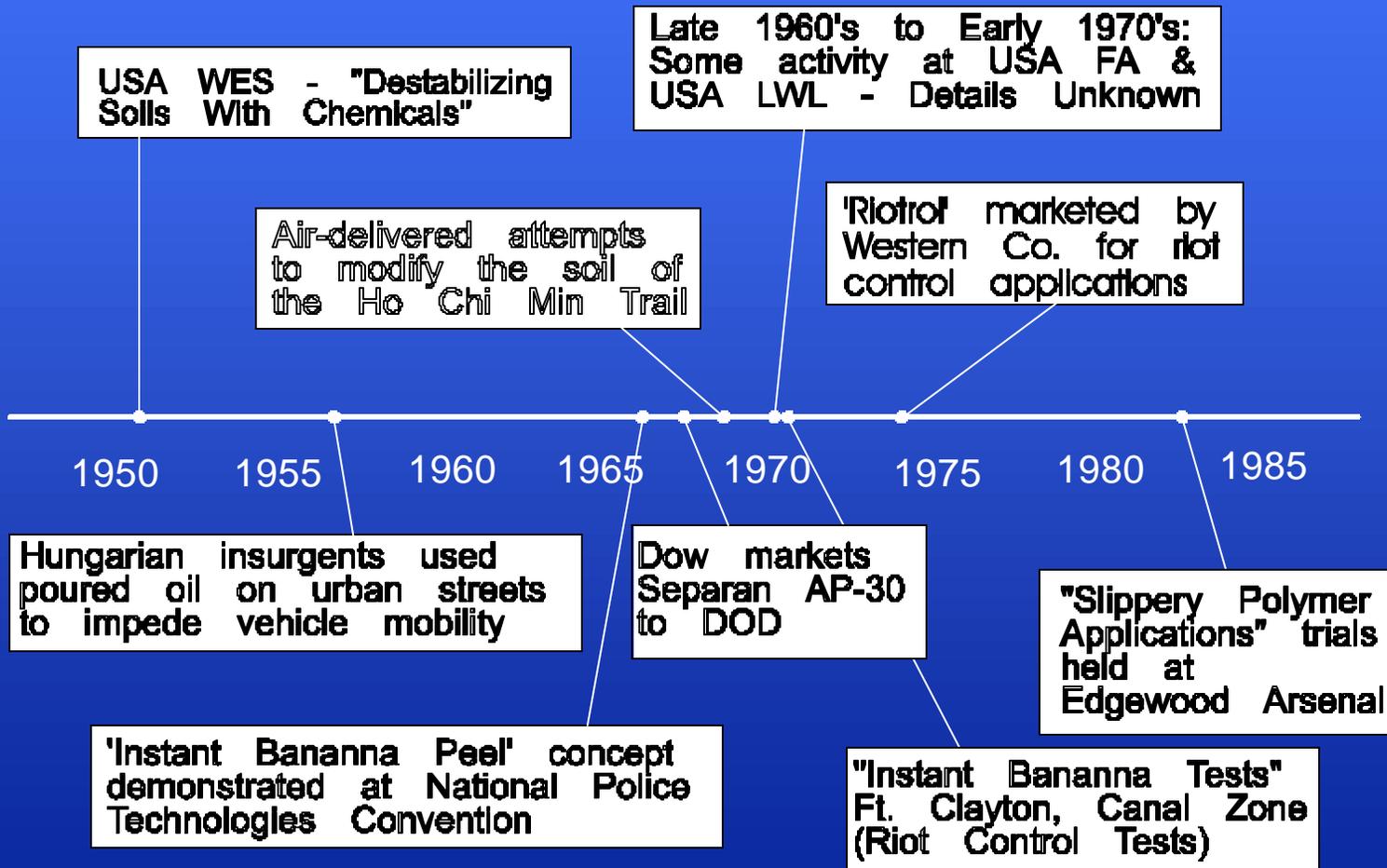


Edgewood
Chemical Biological
Center

Military Consideration of Countertraction Technologies Historical Perspective



Southwest
Research
Institute





Edgewood
Chemical Biological
Center

Mission Need Statement*



Southwest
Research
Institute

“These systems, commonly referred to as ‘Sticky or Slippery’, deny hostile elements the mobility they require to be an effective threat. Thus hindered, these threat forces are rendered incapable of resisting the will of unencumbered forces. This technology can also be applied to deny mobility to personnel, vehicles, or aircraft.”

*Assistant Commandant of the Marine Corps, 11 March 1996



Edgewood
Chemical Biological
Center

What Constitutes a Slippery Surface



Southwest
Research
Institute

- OSHA, UL, NBS, and ASTM recommend a COF of 0.5 as the threshold of safety for normal ambulation of dry walking surfaces.
- People can walk on surfaces with a COF < 0.4 and surfaces more slippery than ice, ***if they know of the hazard***. It is the unexpected slippery spot that produces a COF < 0.2 that causes slips and falls.
- It is not the COF that determines the difficulty of crossing a slippery surface, it is the localized spots that are more slippery than the rest of the surface.



Edgewood
Chemical Biological
Center

Anti-Traction Application Requirements



Southwest
Research
Institute

Material Classification	Target Sets / Surface Type	Dispensing System	Environment	Area Coverage	
Mandatory	Foot Traffic	Manual (man portable)	40° to 100°F	800 sq. ft.	
					Level Surface
					Sloping Surface
					Concrete Walkways & Roads
Preferred	Wheel Vehicles	Mechanical (vehicle mount)	32° to 120°F	1,200 sq. ft.	
					Vegetated and Loose Soil
					Non-Porous
Preferred Plus	Track Vehicles Aircraft	Aircraft	<32° to 120°F	1,500 sq. ft.	



Edgewood
Chemical Biological
Center

Anti-Traction Material Requirements



Southwest
Research
Institute

Material Classification	Form	Activation	Deactivation	Application Time	Availability	Durability
Mandatory	As Available	As Required	Removable	1-hour	COTS	2 hours
Preferred	Single Component	Ready-to-Use	Biodegradable	10 – 30 minutes	COTS / MOTS	24 hours
Preferred Plus	Multiple Component or Single Sheet	Water Humidity Chemically	Reversible	5–minutes or less	Formulation	Several days



Edgewood
Chemical Biological
Center

Potential Applications for Anti-Traction Materials



Southwest
Research
Institute

MITROVICA, Kosovo, Feb. 22 -- Serbs living on the northern side of this city were edgy today after a show of force by ***tens of thousands of Albanian protesters*** on Monday.

"It was a clear intention to show us they have a big number of people and that they will one day come ***over the bridge***. It was also a message for us that we are not welcome here.

" ***With 10,000 Serbs on the northern side and 90,000 Albanians south of the river, the sheer demographics explain their fears.***



Edgewood
Chemical Biological
Center

Surface Conditions Include Paved Roads & Grassy Terrain



Southwest
Research
Institute



Thousands of Albanians from throughout Kosovo demonstrated in Mitrovica, clashing with British, Canadian and French forces.



Edgewood
Chemical Biological
Center

Terrain & Environmental Conditions for Anti-Traction



Southwest
Research
Institute



**Americans tried to protect themselves from stones
thrown by Serbs in Mitrovica, Kosovo Feb. 21, 2000**



Edgewood
Chemical Biological
Center

Scenario for Rapid Dispensing of Anti-Traction Material



Southwest
Research
Institute



The Americans, along with German troops, had to leave the area, where they had been searching for weapons.



Edgewood
Chemical Biological
Center

Area Coverage & Stand-off Distance Requirements



Southwest
Research
Institute



**Serbs throwing stones at G.I.'s
Mitrovica, Kosovo Feb. 21, 2000**



Edgewood
Chemical Biological
Center

Footwear & Conditions Vary with Location and Populace



Southwest
Research
Institute

**Poso, Central Sulawesi
December 28, 1998**



Mobs ready to go into action



Edgewood
Chemical Biological
Center

Target Sets Include Foot and Wheel Vehicles



Southwest
Research
Institute

**Rioters arrive by foot
and wheeled vehicles
in Poso, Central
Sulawesi**



**Footwear varies from no
shoes, sandals, shoes or
boots**



Edgewood
Chemical Biological
Center

Criteria for Selection of Anti-Traction Agents



Southwest
Research
Institute

- Effective at low and high velocities
- Effective at low and high loads (foot, tank, aircraft)
- Low slump on graded surfaces
- Non-displaceable by traffic
 - fixed and constant thickness under compressive loads
- Non-toxic
- One single part, storable, dispersible system (sprayable or flockable)



Edgewood
Chemical Biological
Center



Southwest
Research
Institute

Properties of An Anti-Traction Agent

- Low Coefficient of Friction (COF)
- Thixotropic or rheopectic liquid
- Film thickness of $\approx 1/8$ inch, non-displaceable under load
- Optional mechanical or chemical propping agents*

*Swollen particles, glass, plastic or metal beads



Edgewood
Chemical Biological
Center

Classes of Agents Meeting the Criteria



Southwest
Research
Institute

- Aqueous polymer solutions and dispersions
- Polysaccharides, acrylates, acrylamids partially dissolved with/without propants*
- Liquid soaps, detergents, surfactants of controllable viscosity and rheology
- Non-aqueous oils, greases, fats containing particles of non-displaceable and minimum compressible properties (propants*)
- Flakes or fibers of polyethylene, polypropylene, Teflon and other plastics in an aqueous or non-aqueous, viscous fluid

*Propants -- smaller polymers (semi-solid, non-displaceable) or microspheres (glass beads, bb's)



Edgewood
Chemical Biological
Center

Recommendations & Conclusions



Southwest
Research
Institute

- A thixotropic or rheopectic liquid or grease-like film containing semi-solid granules of swollen polymers, or such agents such as glass or metal beads, sparsely dispersed, i.e., approximately 1-2 per square inch throughout the liquid surface film; sprayable, pumpable and dispersible
- A typical option is a liquid detergent, thickened with a colloid or polymer to give a thixotrope of low slump on graded surfaces, and containing dispersed granules of swollen hydroxy ethylcellulose or acrylamid or polyacrylic acid.
- An optimal and effective film of approximately 1/8-inch thickness or more, distributed over all types of terrain, i.e., grass, gravel, asphalt, concrete, dirt.