

Methamphetamine Concerns  
and Exposures Associated  
with Use and Manufacture

by  
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National Jewish Medical and Research Center

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### Red P Cook at a Home



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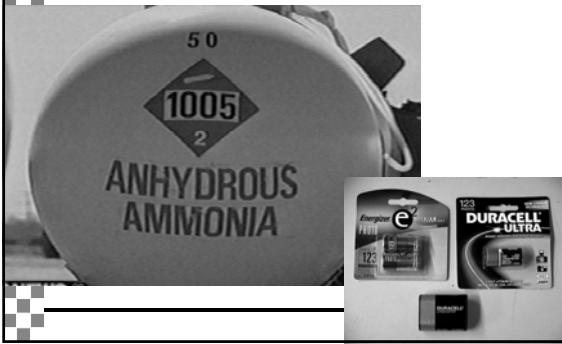
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### The "Birch" or "Nazi" Method



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**Hazards Present During the Cook**

- **Red Phosphorous Cooks**
  - Phosphine, iodine, phosphorous, strong base
- **Anhydrous Ammonia Cooks**
  - Anhydrous ammonia, reactive metals
- **All Cooks**
  - Hydrogen chloride, solvents, methamphetamine, fire hazards

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**Airborne Methamphetamine using Red P Method**



4200 ug/m<sup>3</sup>  
To  
5500 ug/m<sup>3</sup>

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**Methamphetamine**

- **Symptoms**
  - Very little known regarding low level chronic exposures.
  - Irritation of the skin, eyes, mucous membranes, and upper respiratory tract.
  - High levels may cause dizziness, headache, metallic taste, insomnia, high or low blood pressure, etc.
  - Chronic exposures may cause irritability, personality changes, anxiety, hallucinations, psychotic behavior.
  - Smaller infants, altered behavior patterns, lower IQ scores, teratogenic affects, cerebral hemorrhage.
  - Skin absorption is possible.
- **Current Standards**
  - None
  - Therapeutic dose = 5 mg (2 to 3 x per day)
  - Surface contamination = 0.1 – 0.5 ug/100 cm<sup>2</sup>

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## What About After the Cook?



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## Study Design

- Day One
  - Two controlled methamphetamine cooks
  - Red P method - 3 g each
  - Sampling time = approximately 4 hours
- Day Two
  - No Activity
  - Medium Activity
  - Heavy Activity
  - Each sampling time = 2 hours

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## Medium Activity



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### Heavy Activity



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### Cook Area Samples



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### Surface and Vacuum Samples



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## Iodine and Hydrogen Chloride

	Iodine (ppm)	Hydrogen Chloride (ppm)
Cook Area	0.07	0.34
Remote Area	0.005	0.09
No Activity	0.005	ND
Medium Activity	0.005	0.04
Heavy Activity	0.002	0.07
TLV	0.1 (c)	2 (c)
RfC (CDPHE/EPA)	0.0001	0.06

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## Exposures 24 hours After a Cook

- Airborne Methamphetamine
  - During the Cook – 520 – 780 ug/m<sup>3</sup>
  - Walking Around – 70 – 117 ug/m<sup>3</sup>
  - Mild Activity – 106 – 170 ug/m<sup>3</sup>
  - Heavy Activity – 100 – 210 ug/m<sup>3</sup>
- Meth in Carpet Dust
  - 59 ug/m<sup>2</sup> – 270 ug/m<sup>2</sup>
- Other Compounds
  - Iodine and HCl becomes airborne next day

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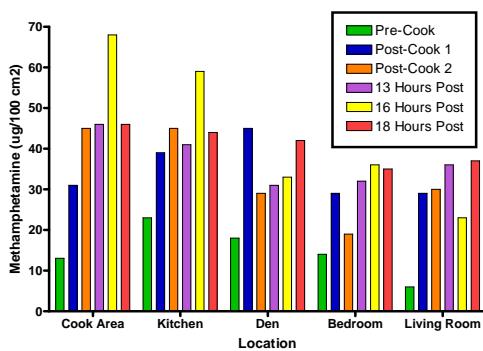
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## Surface Meth Concentrations




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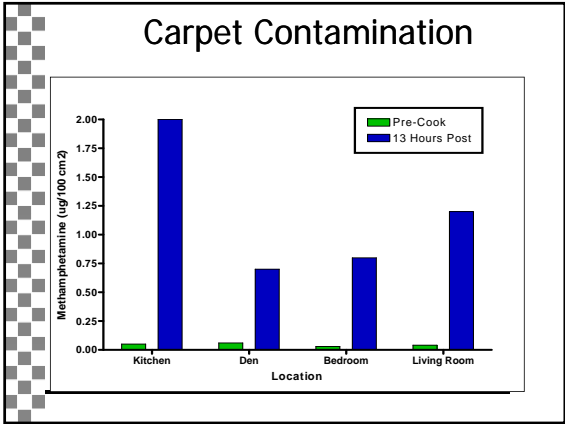
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### Study Process

- Standard motel room
- Did not inhale
- Total amount: 2.45 grams

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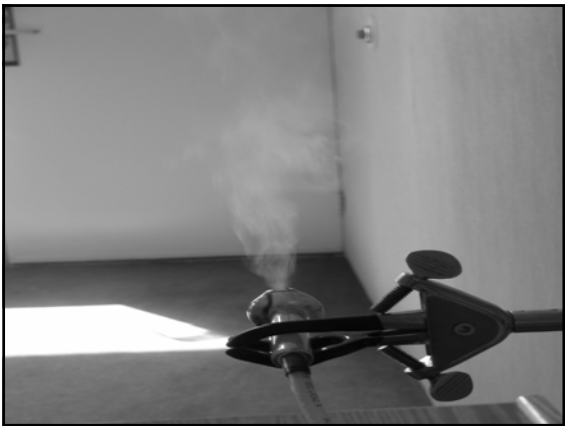
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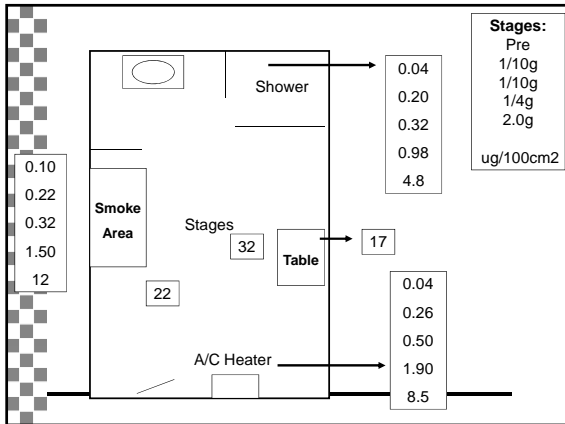
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### Controlled Smoke Findings

- Airborne meth levels ranged from 330 ug/m<sup>3</sup> to 1600 ug/m<sup>3</sup>. (Typical lab levels = 4000 – 5000 ug/m<sup>3</sup>)
- Surface areas throughout the room were contaminated with up to 35 ug/100 cm<sup>2</sup>. (Typical lab levels range up to 2800 ug/100 cm<sup>2</sup>)
- These levels may be less due to inhalation.

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### Research Findings from the Utah Methamphetamine Project at National Jewish Health

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## Goals of the Project

- Determine sampling efficiencies.
  - False positive and negative rates
  - Inter-laboratory variation
  - Interferences
    - Laboratory
    - Homes
  - Solvent usage (methanol, isopropanol, water)
  - Recovery rates from different surfaces.
- Suggest a sampling protocol
- Determine potential personnel contamination at clandestine methamphetamine laboratories

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## Goals (cont)

- Determine decontamination effectiveness
  - Decontamination of clothes.
  - Decontamination of building materials
- Determine effectiveness of different cleaners
  - Simple Green
  - Oxidizer solutions
  - Compare different surfaces (porous, smooth)
- Explore methamphetamine penetration into painted drywall
- Explore encapsulation of methamphetamine-contaminated surfaces.

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## Goals (cont)

- Provide suggestions for decontamination of individuals and materials from clandestine methamphetamine laboratories
- Help to create a website for Utah's methamphetamine project.

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## Sampling Specificity and Precision

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## Sampling Precision and Specificity

- Our Data
  - 53 blanks submitted = 53 ND (<0.05 ug)
  - 34 – 0.03 ug spikes = 31 ND and 3 at 0.37 – 0.38 ug.
  - 34 – 0.06 ug spikes
    - Range = ND – 0.10 (avg. = 0.06)
    - 2 samples at ND from 1 lab.
    - 23 samples within 10% of actual level
  - 25 – 0.3 ug spikes
    - Range = 0.3 – 0.37
    - Only 2 samples over 20% difference

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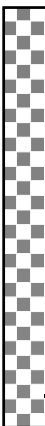
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## Sampling Specificity and Precision

- Samples using LC/MS or GC/MS are extremely precise and specific.
- A non-detect at 0.05 ug/wipe is accurate and even a spike at 0.03 ug will not be reported.
- Most samples to the lab will be within +/- 30% of the actual amount present.
- The presence of dust and latex paint will not change the results.
- The use of isopropanol or methanol will not interfere with the results.
- No difference between glass and plastic, between gauze and filter, or between cooled and uncooled shipping.

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## Methamphetamine Recovery

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### Methamphetamine Recovery Protocol

- Purpose – Determine how easily meth can be recovered from different surfaces using different solvents.
- Surfaces – unpainted drywall, painted drywall, unpainted wood, painted wood, glass, metal, floor tile, carpeting, clothing.
- Solvents – water, isopropanol, methanol

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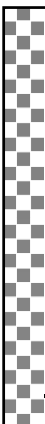
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### Protocol

- Used “street meth” spiked to surfaces in a methanol solution using a micropipette.
  - Spiked level = 27 ug/100 cm<sup>2</sup>
- Dried overnight prior to sampling.
- Sampled using a 3" x 3" gauze wipe.
  - 18 samples/surface
  - 5 samples/surface/solvent
  - 27 control samples
  - 135 spiked samples
- Analyzed using LC/MS

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Percent Recovery by Surface Type

Surface Type	Mean Recovery	Median Recovery
Unpainted Drywall	0.9 %	0.4 %
Painted Drywall	73.8%	70.4 %
Unpainted Wood	5.8%	5.2 %
Painted Wood	74.3 %	77.8 %
Glass	53.3 %	53.3 %
Metal	90.1%	91.9 %
Tile	11.6 %	8.9 %
Carpeting	1.3%	1.3 %
Clothing	0.4%	0.4%

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Contamination




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**Personnel Contamination Samples**

- A total of 227 total personnel contamination samples were taken during all of our projects
  - 154 were above 0.02 ug/sample
  - Mean for positive samples = 11.2 ug/sample
  - Median = 0.80 ug/sample
  - Range = 0.04 ug/sample – 580 ug/sample

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## Personnel Contamination

- Cook Personnel
  - Sample # = 46 (96% tested positive)
  - Mean = 22.1 ug/sample
  - Median = 2.22 ug/sample
  - Range = 0.04 – 580 ug/sample
- Investigation Only (Staged Cooks)
  - Sample # = 72 (87% tested positive)
  - Mean = 8.7 ug/sample
  - Median = 0.97 ug/sample
  - Range = 0.06 – 230 ug/sample

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## Personnel Contamination (cont)

- Suspect Contamination
  - 18 samples taken (94% positive)
  - Mean = 5.5 ug/sample
  - Median = 3.22 ug/sample
  - Range = 0.2 – 17.4 ug/sample

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## Lab Bust Contamination

- Suspects
  - 0.9 ug/wipe to 17.4 ug/wipe
  - Hands, clothing, etc.
- Children
  - 0.2 ug/wipe to 1.18 ug/wipe
- Pets
  - 1.89 ug/wipe (fur)
- Law Enforcement Officers
  - 0.5 – 0.93 ug/wipe

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### Entry Only Contamination: 24 hours After Cook

- All individuals that entered the home came out with measurable contamination.
  - Foot Contamination
    - 0.78 – 49 ug/wipe
  - Hand Contamination
    - 29 - 56 ug/wipe
  - Neck
    - All positive but most below 1.0 ug

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### Activity Related Exposure 24 Hours After a Staged Cook

- Heavy Activity
  - 6 samples
  - Mean = 11.1 ug/sample
  - Median = 0.7 ug/sample
  - Range = 0.59 – 49 ug/sample
- Medium Activity
  - 11 samples
  - Mean = 9.4 ug/sample
  - Median = 1.0 ug/sample
  - Range = 0.3 – 56 ug/sample
- Low Activity
  - 6 samples
  - Mean = 0.6 ug/sample
  - Median = 0.6 ug/sample
  - Range = 0.08 – 1.7 ug/sample

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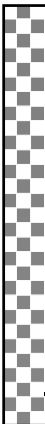
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### What Does This Mean?

- Anyone entering or taken from the lab area will be contaminated with low levels of methamphetamine.
- In many cases, these levels may not be high.
- The potential for high contamination level does exist.
  - Accidents, fires, entry during the cook, etc.
- Contamination may involve more than meth.
- There is no adequate method for direct detection at this time.

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**Clothing  
Decontamination**

- Purpose – To test the effectiveness of clothing decontamination by washing.
  - Normal washing machine
  - Warm water
  - Cold water Tide
- Clothing tested
  - Denim cloth
  - Cotton blanket material
  - Bunker Gear
- Treatments
  - 1 wash, 2 washes, 3 washes, no washes
  - "Street meth" in chamber
  - Random number grid for sampling
  - Dried overnight prior to sampling

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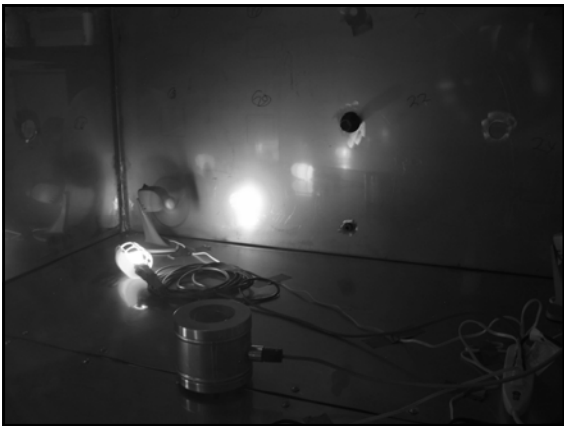
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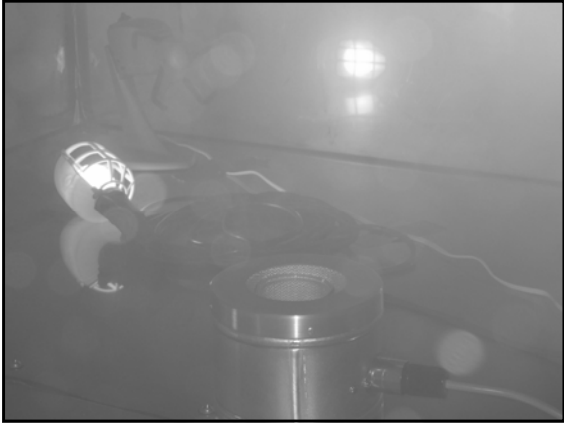
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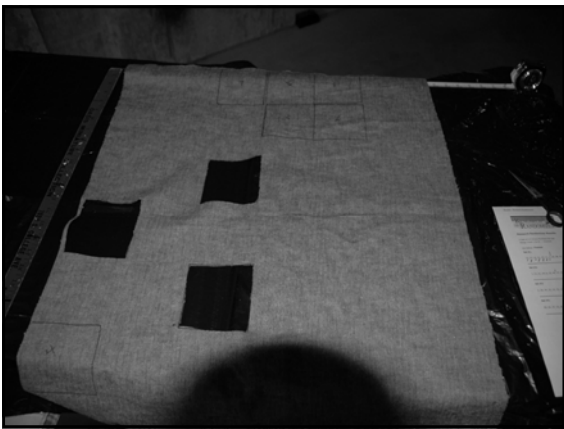
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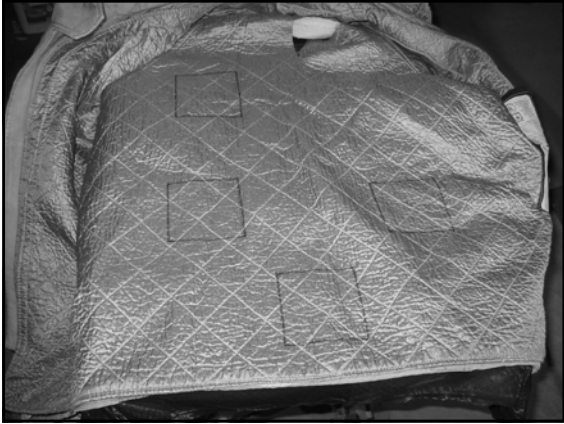
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**Denim Cloth Results**

Treatment	Start (Ug/100 cm <sup>2</sup> )	Finish (Ug/100 cm <sup>2</sup> )	% Reduction
No Wash	112.9	122.9	+ 9.0%
1 Wash	150	0.9	99.4%
2 Washes	115.4	0.3	99.7%
3 Washes	101.1	0.2	99.8%

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**Cotton Cloth Results**

Treatment	Start (Ug/100 cm <sup>2</sup> )	Finish (Ug/100 cm <sup>2</sup> )	% Reduction
No Wash	255.7	156.4	39%
1 Wash	271.4	0.5	99.8%
2 Washes	218.6	0.2	99.9%
3 Washes	125.0	0.2	99.8%

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## Bunker Gear Results

Treatment	Start (Ug/100 cm <sup>2</sup> )	Finish (Ug/100 cm <sup>2</sup> )	% Reduction
1 Wash Outside	102	4	96.1%
1 Wash Inside	64	3.4	94.6%
3 Washes Outside	109	1.3	98.8%
3 Washes Inside	19.5	1.6	91.8%

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## Conclusions

- The initial wash in a normal washing machine with no bleach resulted in a significant reduction in methamphetamine levels.
- Subsequent washes did not result in as drastic a reduction.
  - Residual meth was normally less than 0.2 ug/100 cm<sup>2</sup>
  - The last portion of meth may not be easy to remove and may not pose a significant threat.
  - Levels may dissipate over time for some clothing and not for others. We will look at this in the future.

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## Painted Construction Materials Decontamination

- Purpose – To test the effectiveness of painted construction material decontamination by washing.
  - Simple Green using spray bottle
  - Light scrubbing
  - Warm water rinse
- Treatments
  - 1 wash, 2 washes, 3 washes, no washes
  - "Street meth" in chamber
  - Random number grid for sampling
  - Dried overnight prior to sampling
  - Dried between washes
  - New washcloth

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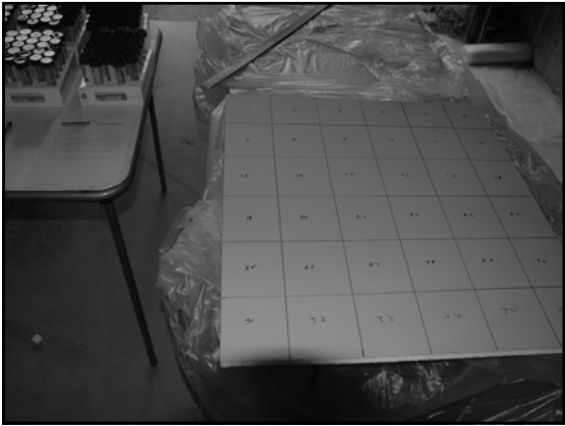
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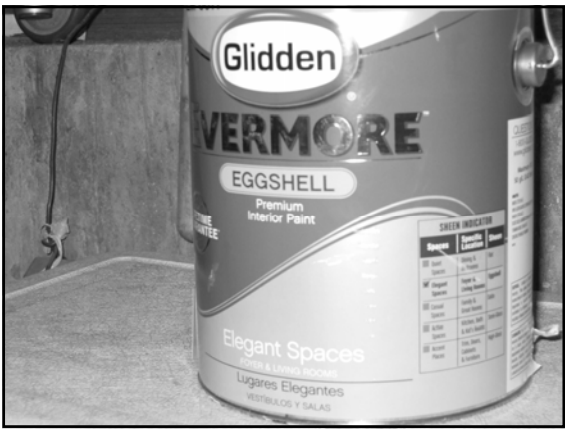
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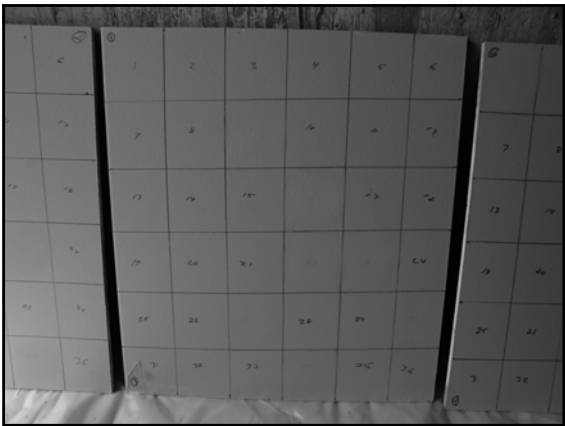
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### Painted Drywall Results

Treatment	Start (ug/100 cm <sup>2</sup> )	Finish (ug/100 cm <sup>2</sup> )	% Reduction
No Wash	12.9	14.3	-10.5%
1 Wash	36.1	8.5	76.5%
2 Washes	22.9	5.2	77.4%
3 Washes	17.0	3.2	80.9%

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### Painted Plywood Results

Treatment	Start (ug/100 cm <sup>2</sup> )	Finish (ug/100 cm <sup>2</sup> )	% Reduction
No Wash	11.3	12.5	-10.5%
1 Wash	12.1	5.7	52.9%
2 Washes	11.4	4.2	62.9%
3 Washes	17.9	3.6	79.6%

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### Sheet Metal Results

Treatment	Start (ug/100 cm <sup>2</sup> )	Finish (ug/100 cm <sup>2</sup> )	% Reduction
No Wash	3.6	3.2	12%
1 Wash	11.4	0	100%
2 Washes	1	0	100%

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### Glass Results

Treatment	Start (ug/100 cm <sup>2</sup> )	Finish (ug/100 cm <sup>2</sup> )	% Reduction
No Wash	0.1	0.2	-50%
1 Wash	0.2	0	100%
2 Washes	12.5	0	100%

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- ### Conclusions
- It is difficult to decontaminate painted surfaces.
  - The initial decontamination cleaning will remove the majority of the methamphetamine that can easily be removed.
    - 50% - 70% of the methamphetamine present is removed from the first wash.
    - Up to 80% is removed through subsequent washes
  - Smooth surfaces (metal and glass) can be cleaned with a single wash.

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### Decontamination with Oxidizers

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## Decontamination with Oxidizers

- Utilized three cleaning agents:
  - Hypochlorite-based cleaning agent
  - Quaternary ammonia cleaning agent
  - Hydrogen Peroxide – based agent
- Cleaning Process
  - Sprayed on cleaning agent and let stand for 1.5 minutes
  - Wiped cleaning agent off with tap water and cloth.
  - Hydrogen peroxide agent was just let stand.
  - Minimized potential contamination by using different cloths at each rinsing.

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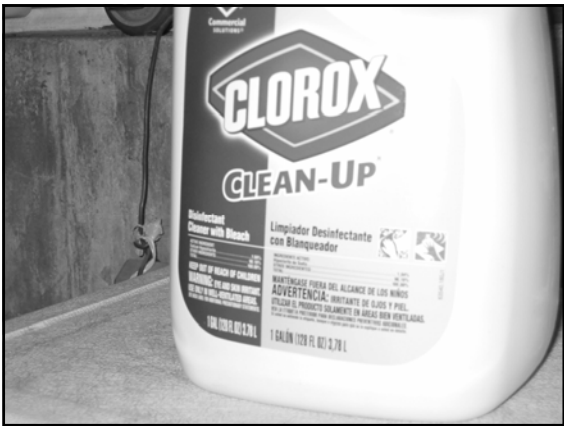
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**Results of Quaternary Ammonia Cleaner**

Treatment	Starting Conc.	Finishing Conc.	% Reduction
No Treatment	21 ug/100 cm <sup>2</sup>	21 ug/100 cm <sup>2</sup>	0%
One Wash	26 ug/100 cm <sup>2</sup>	2.7 ug/100 cm <sup>2</sup>	90%
Three Washes	18 ug/100 cm <sup>2</sup>	.96 ug/100 cm <sup>2</sup>	95%

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**Results of Hypochlorite Cleaner**

Treatment	Starting Conc.	Finishing Conc.	% Reduction
No Treatment	20 ug/100 cm <sup>2</sup>	21 ug/100 cm <sup>2</sup>	-6%
One Wash	20 ug/100 cm <sup>2</sup>	8.9 ug/100 cm <sup>2</sup>	56%
Three Washes	23.6 ug/100 cm <sup>2</sup>	8.4 ug/100 cm <sup>2</sup>	64%

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## Results of Hydrogen Peroxide Agent

Treatment	Starting Conc.	Finishing Conc.	% Reduction
No Treatment	15.3 ug/100 cm <sup>2</sup>	14.6 ug/100 cm <sup>2</sup>	4.3%
One Wash	14.8 ug/100 cm <sup>2</sup>	<0.05 ug/100 cm <sup>2</sup>	100%
Three Washes	14 ug/100 cm <sup>2</sup>	<0.05 ug/100 cm <sup>2</sup>	100%

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## Conclusions

- The hydrogen peroxide agent was the most effective with no detectable methamphetamine present after its use.
- The quaternary ammonia cleaner was more effective than the hypochlorite cleaner.
  - 1<sup>st</sup> wash = 90% vs. 50%
  - 3<sup>rd</sup> wash = 95% vs 64%
- All of these chemicals are very irritating and may be associated with pulmonary problems.
- Oxidation by-products are unknown at this time.

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## Methamphetamine Persistence in Paint

- Exposed drywall painted with latex paint to methamphetamine in a chamber
  - Sampled the drywall with methanol wipe.
  - Sampled the remaining paint by cutting out a 100 cm<sup>2</sup> section of paint and paper.
  - Sampled an un-sampled area by cutting out a 100 cm<sup>2</sup> section of paint and paper.

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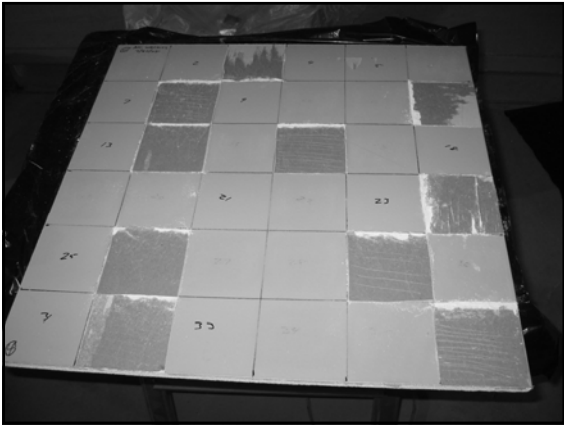
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**Methamphetamine penetration  
into painted drywall**

Sample Type	Mean Meth Level	Median Meth Level	Mean % of Total Meth	Median % of Total Meth
Wipe Only	5.5	4.8	36.9	34.3
Cut Out After Wipe	8.6	8.6	57.8	61.4
Cut Out	14.8	14.0		
Cut Out After Wipe + Wipe	14.0	13.4		

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**Methamphetamine Reduction  
Over Time**

Treatment	Date Sampled	Mean Meth Conc.	% Reduction
No Treatment	7/24/2008	14.3 ug/100 cm <sup>2</sup>	
No Treatment	1/19/2008	3.2 ug/100 cm <sup>2</sup>	77.6%
Three Washes	7/24/2008	3.3 ug/100 cm <sup>2</sup>	
Three Washes	1/19/2009	0.62 ug/100 cm <sup>2</sup>	81.3%

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## Conclusions

- Wipe samples only remove approximately 30% of the total meth on a painted drywall surface.
- 50% - 60% of the meth present is contained within the paint.
  - Used latex enamel paint
  - Surface was painted recently (2 days)
- Over a period of 6 months, the amount of meth present (via wipe only) on painted drywall was reduced by as much as 81%

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## Encapsulation of Methamphetamine on Drywall

- Contaminated drywall in a chamber using street methamphetamine
  - Painted with latex paint
  - Painted with Kilts paint
  - Painted with oil based paint
- Used a roller for the latex paint and sprayed on the other paints.
- Sampled using a methanol wetted wipe.
- Re-sampled 4 months later to determine break-through

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Treatment	Mean Conc.	% Reduction
Untreated Pretest	29.7	
Untreated Post test	27.2	8.3
Latex Pretest	29.8	
Latex Post test	5.0	83.4
Latex 4 month	2.4	91.8
Kills Pretest	28.4	
Kills Post Test	0	100
Kills 4 month	0	100
Oil Pretest	34.6	
Oil Post Test	0	100
Oil 4 month	0	100

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### Conclusions

- Latex applied with a roller will only encapsulate approximately 83% of the meth present.
- Oil based paints will encapsulate 100% of the meth present.
  - No meth broke through for as long as 4 months.

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**Health Hazards Associated with Marijuana Grow Operations**

Tri-County Health Department  
Commerce City, CO

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**Types of Marijuana Operations**

- **Small Home Operations**
  - Few plants for recreational use.
  - Similar to any plant growing.
- **Large Outdoor Operations**
  - May have acres of plants.
  - Water pollution, criminal behavior.
- **Large Indoor Operations**
  - Called MGO's

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**Indoor MGO's**

- **Numbers have increased dramatically.**
  - Ontario police executed 160 warrants in 2000 and 650 in 2001.
  - Ontario believes they have 15,000 in Province.
  - Calgary raids 100 MGO's per year
  - Increasing in the US.
- **Who are they?**
  - Growers hire family to grow.
  - Many have children.

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## Why Have Indoor MGO's

- Better growing conditions
  - Plants grow and mature faster.
  - Growing conditions can be controlled.
  - THC content can be doubled.
- Security
  - May be harder to detect.
  - Law enforcement is using thermography and utility usage.
- Continuous crop rotations

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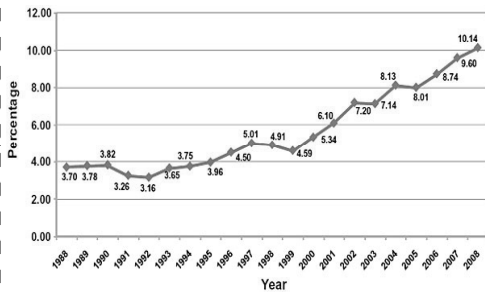
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### Average THC Content of Marijuana



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## Environmental Conditions in MGO's

- Hydroponic and "Natural" grow conditions.
- High humidity present in both types of operations.
- High carbon dioxide increases THC content.
- Electricity demands are high and often jury-rigged.
- Temperatures are normally high.
- Pesticides and fertilizers are utilized.
- Solvents may be utilized for extractions.

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**Dangers Associated with MGO's**

- **Environmental Conditions**
  - Elevated CO2, Mold, Nitrogen Oxides, pesticides, fertilizers,.
- **Structural and electric Problems**
  - Damage to foundations, cuts in floors, mold, fires.
- **Utility Theft**
  - Use of high intensity lights need high electricity flow.
  - Single utility in Ontario estimated loss at \$1 million at 191 MGO's
- **Criminal Activity**
  - Booby traps, firearms, etc
- **Hashish Production**

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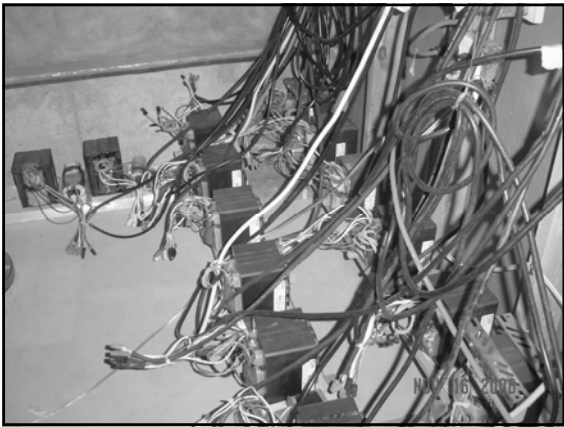
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**Reports of Health Complaints**

- **Denver Area Law Enforcement**
  - Reports of rashes, difficulty breathing, increased asthma symptoms.
- **Other Law Enforcement Complaints**
  - Upper respiratory irritation, runny nose, cough, rash, eye irritation.

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**Exposure Concerns**

- High Humidity and warm temperatures.
  - Fungal growth
  - Endotoxin
- Elevated carbon dioxide
  - Carbon monoxide exposures
  - Oxides of nitrogen exposures
- Fertilizers and pesticides
- Solvents

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**Health Hazards Associated with Fungal Exposure**

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**Exposures to Fungal Contamination**

- Canada Mortgage and Housing Corp.
  - Looked at 12 MGO's
  - 7 had extensive mold contamination
  - 2 moderate mold contamination
  - Musty smell in most houses
- Jennifer Mustard et al. looked at 68 homes and found no significant difference in total spore counts
  - Asp/pen increased in unknown history homes.
- McLaren et al. found 13/14 samples contaminated with *Aspergillus*.
  - Majority of pot smokers have antibodies to *Aspergillus* sp.

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**Health Effects of Fungi**

- Allergic Reactions
  - Hay fever, allergic rhinitis, hypersensitivity pneumonitis, asthma
- Infections
  - Aspergillosis
- Irritation and Toxic Reactions
  - Mycotoxins, endotoxins, MVOC's
  - Stachybotris

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### Health Concerns During Investigation

- Dust exposure for sensitive individuals.
- Allergic response from sensitized individuals.
  - Asthma
  - Atopic
  - Hypersensitivity Pneumonitis
- Aspergillus sp infections in individuals with a lowered immune system.
- Organic Dust Toxic Syndrome (ODTS)
  - Fever, flu-like symptoms, respiratory affects.

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### Hypersensitivity Pneumonitis

- Caused by repeated or continuous exposure to antigenic substances.
- Flu symptoms - chills, fever, malaise, cough, difficulty breathing.
- Granulomatous lesions within the lung.
- Easily misdiagnosed.
  - Sarcoidosis

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### Pesticide Exposures

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## Hazards of Concern

- Insecticides
  - Organophosphates
  - Carbamates
  - Biologicals
- Herbicides
  - Chlorophenoxy Herbicides
- Other Pesticides

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## Route of Entry

- Ingestion
  - Chlorophenoxy herbicides
- Skin Absorption
  - Organophosphates
- Respiratory
  - Pyrethrins

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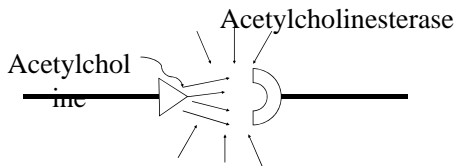
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## Organophosphates

- Causes phosphorylation of the acetylcholinesterase enzyme at the nerve endings.



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**Organophosphates (Cont)**

- Symptoms
  - Headache, hypersecretion, muscle twitching, nausea, diarrhea, respiratory depression, seizures, loss of consciousness, miosis, depressed plasma and red cell cholinesterase.
- Cause of death
  - Pulmonary edema
  - Respiratory failure
- Treatment
  - Establish airway, atropine sulfate, pralidoxime (2-PAM), decontaminate

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**Organophosphates (cont)**

- Route of Entry
  - Inhalation
  - Ingestion
  - Skin Absorption
- Toxicity
  - Parathion – LD50 = 3 – 8 mg/kg
  - Phosalone – LD50 = 1500 mg/kg
- OPIDN

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**Carbamates**

- Cause carbamylation of the acetylcholinesterase enzyme.
- It dissociates more easily than does the organophosphate bond.
  - Limits duration of effect.
  - Larger difference between initial symptoms and lethality.

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## Carbamates (cont)

- **Symptoms**
  - Fatigue, muscle weakness, dizziness, sweating, headache, salivation, sweating. Cholinesterase levels may not be significantly depressed.
- **Cause of Death**
  - Pulmonary edema
  - Respiratory failure
- **Treatment**
  - Establish airway, atropine sulfate, pralidoxime (2-PAM), decontaminate

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## Carbamates (cont)

- **Route of Exposure**
  - Primarily by inhalation or ingestion.
  - Some skin absorption may occur.
- **Toxicity**
  - Most have LD50's between 50 mg/kg and 500 mg/kg.

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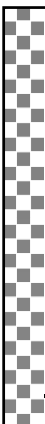
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## Pyrethrums

- Oleoresin extract from dried chrysanthemum flowers.
- Penetrate insects and cause nervous system paralysis.
- Human toxicity is usually as a dermal and respiratory allergen.
- Pyrethroids may cause some neurotoxicity and skin effects.

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### Biological Agents

- **Bacillus Thuringiensis**
  - Pathogenic to some insects.
- **No to low toxicity for humans.**
  - Fever and GI symptoms have been reported.

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### Chlorophenoxy Herbicides

- **Symptoms**
  - Not highly toxic to humans but may cause irritation to skin and mucous membranes.
  - Has caused vomiting, diarrhea, headache, confusion, cardiac changes, renal failure, metabolic changes, etc. in high ingested doses.
- **Dioxin and furan contamination may be linked to teratogenic and mutagenic properties.**

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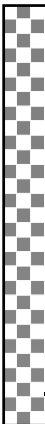
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### Un-Vented Fossil Fuel Combustion

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**Hazards Associated with Un-Vented Combustion**

- Carbon Dioxide
  - Toxic reactions are only at very high exposure levels.
  - Oxygen Displacement
- Carbon Monoxide
  - Binds to hemoglobin with stronger forces than will oxygen (210 – 250 x).
  - One of the most common causes of death in the U.S.
  - Can cause permanent nerve damage.
  - No odor or taste.

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**Carbon Monoxide Health Effects**

- Carboxyhemoglobin
  - Non-Smokers – 1 – 2%
  - 1 – 10% may result in many symptoms or very few.
  - >50% may be fatal.
- Carbon Monoxide
  - NIOSH REL = 35 ppm
    - Ceiling = 200 ppm
    - IDLH = 1,200 ppm
  - ACGIH – TLV = 25 ppm
  - OSHA – PEL = 50 ppm

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### Carbon Monoxide (cont)

- Carboxyhemoglobin half-life
  - Normal ½ life in blood = 2 to 6.5 Hrs
  - With Oxygen = 40 min
  - With hyperbaric oxygen = 20 min

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### Hazards (cont)

- Oxides of nitrogen
  - Present even if CO is absent or low.
  - Very irritating (asthmatics)
- Nitrogen dioxide
  - 0.1 ppm may result in increased lung irritation
  - Asthmatics may have symptoms.
  - >3 ppm may result in a drop in lung function

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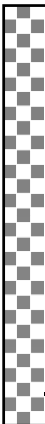
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### Contact Information

- Email – [Martynyj@njhealth.org](mailto:Martynyj@njhealth.org)
- Phone – 303-398-1520
- National Alliance for Drug Endangered Children – [www.nationaldec.org](http://www.nationaldec.org)
- California Documents -  
• [http://www.oehha.ca.gov/public\\_info/public/meth120507.html](http://www.oehha.ca.gov/public_info/public/meth120507.html)

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