

Investigation of Formaldehyde Levels in Occupied FEMA-Supplied Temporary Housing Units and Discussion of Associated USPHS Deployment

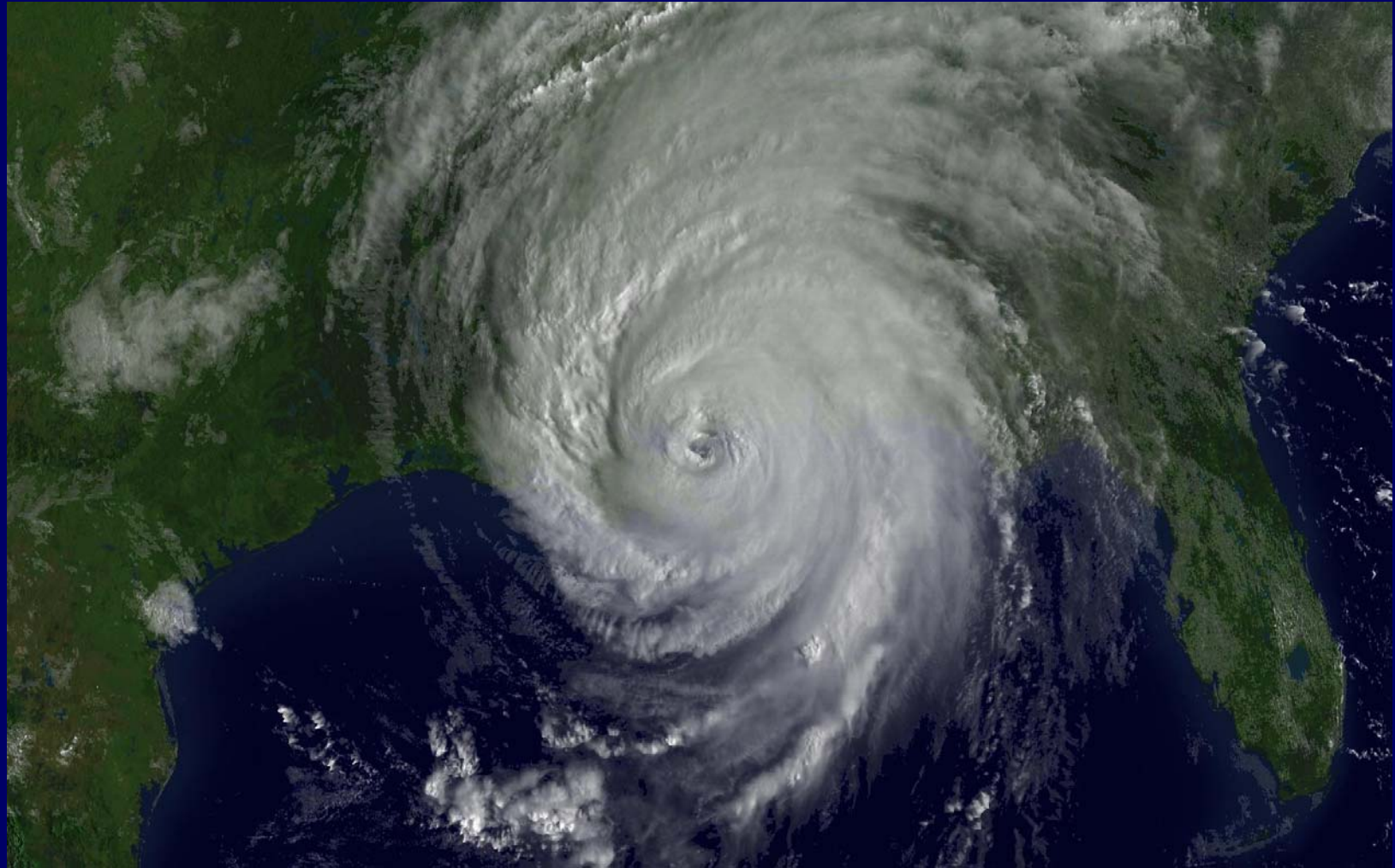


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Hurricanes Katrina and Rita 2005



Temporary Housing Units (THUs)



Travel Trailer

**October 2005: THUs
were distributed to
displaced populations**



Park Model



Mobile Home

Investigation Timeline

- July 2007: Some area physicians notice an increase in respiratory symptoms among Gulf Coast children
- November 2007: CDC initiates investigation
- December 21, 2007 to January 23, 2008: CDC conducted testing of formaldehyde levels in FEMA supplied temporary housing units (THUs)



Formaldehyde

- Formaldehyde is colorless gas used to make many wood and consumer products
- Found in nature and in the body
- Found in air along busy streets and in almost all homes throughout America



Health Messaging

1000		<p>If your reading falls into the higher range, you need to place a high priority on lowering your exposure to formaldehyde. This is especially important if residents of your trailer are elderly, young children, or have health conditions, such as asthma.</p>
100		<p>If your reading falls into the intermediate range, your risk of irritation from formaldehyde exposure is lower, but it is still important to take steps to reduce your formaldehyde exposure. This is especially important if residents of your trailer are elderly, young children, or have health conditions such as asthma.</p>
10		<p>If your reading falls into the lower range, these levels are found on the streets of many cities and in many buildings. The risk of health problems at these levels is low.</p>
1		

Note: Levels are expressed at parts per billion (ppb). To convert to parts per million (ppm), divide by 1000.

- Health effects vary among individuals
- Acute symptoms include irritation of eyes, nose, throat and upper respiratory tract
- Classified as a nasal-pharyngeal carcinogen

Study Objectives

- To determine the levels of formaldehyde in occupied temporary housing units (THUs) in LA and MS (not a health effects study)
- To provide information to assist FEMA in making decisions on relocation of residents

Methodology

- 519 THUs randomly selected from LA and MS
- 11 Strata defined by:
 - THU type (travel trailer, park model, and mobile home)
 - Most common brands in use



Methodology

- Air samples were collected from each THU
- Questionnaire and walk-through survey conducted
- Multivariate linear regression models constructed

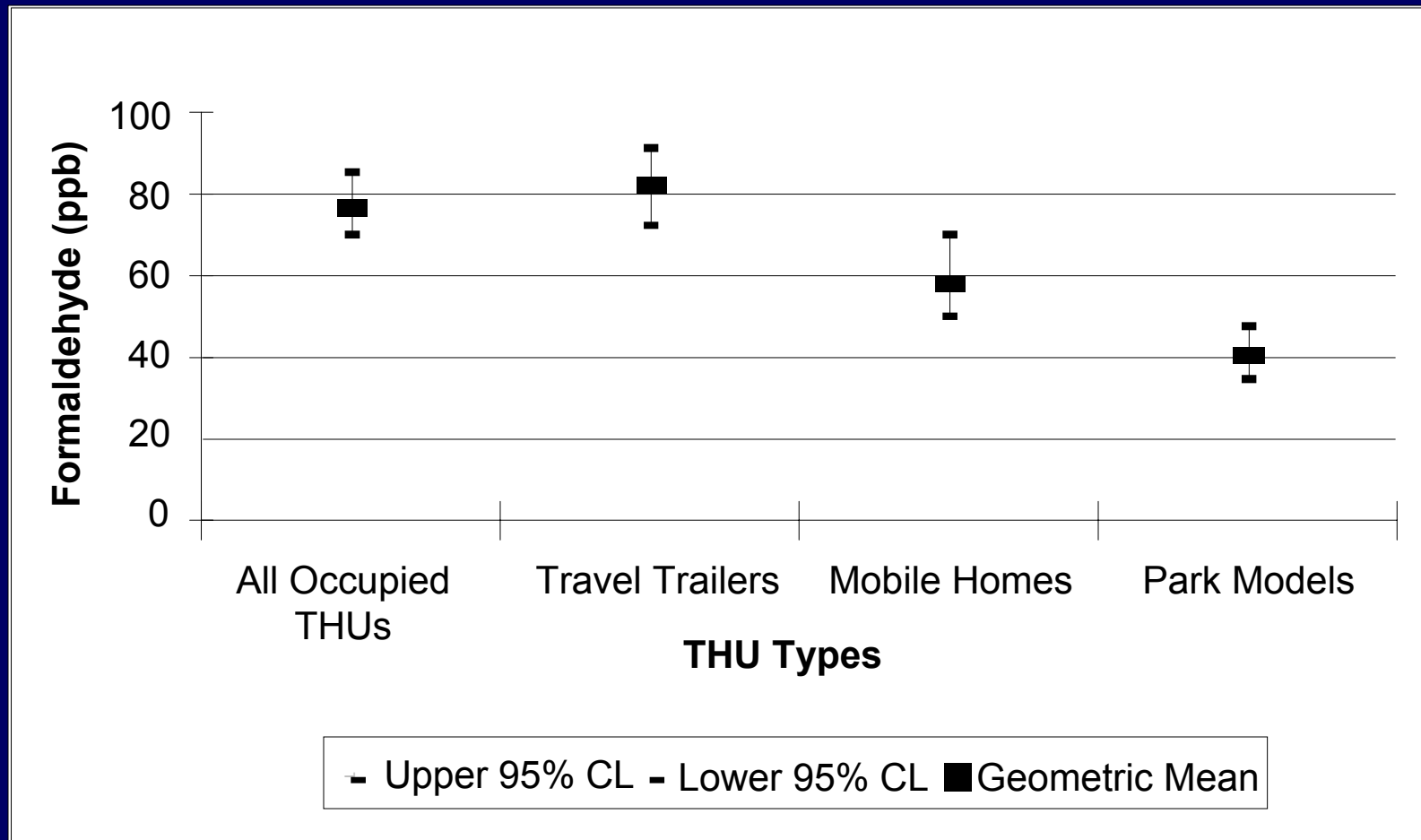


Formaldehyde Sampling

- NIOSH Method 2016
- Flow Rate: 500 mL/hr
- Height: 4 feet
- Central location
- 1 hour period
- Samples analyzed at Bureau Veritas Laboratory
- QC/QA conducted



Mean Formaldehyde Level by Temporary Housing Unit (THU) Type



Range: 3 – 590 ppb

Formaldehyde Levels by Brand (ppb)

Unit Type	Brand	Formaldehyde GM (95% C.I.)	Range
Travel Trailer	A	103 (87-121)	3 – 580
	B	85 (65-110)	17 – 510
	C	108 (85-136)	25 – 520
	D	102 (79-131)	23 – 480
	E	39 (31-48)	3 – 140
	F	42 (33-53)	7 – 300
	Other	73 (56-95)	11 – 590
Park Model	G	33 (27-39)	3 – 100
	Other	42 (35-51)	11 – 170
Mobile Home	H	78 (64-96)	14 – 320
	Other	56 (47-68)	11 – 260

Formaldehyde Levels by Brand (ppb)

Unit Type	Brand	Formaldehyde GM (95% C.I.)	Levels \geq 100 ppb	Levels \geq 300 ppb
Travel Trailer	A*	103 (87-121)	56%	8%
	B**	85 (65-110)	44%	5%
	C*	108 (85-136)	51%	3%
	D*	102 (79-131)	53%	11%
	E	39 (31-48)	7%	0%
	F	42 (33-53)	11%	3%
	Other	73 (56-95)	33%	5%
Park Model	G	33 (27-39)	3%	0%
	Other	42 (35-51)	11%	0%
Mobile Home	H	78 (64-96)	38%	1%
	Other	56 (47-68)	13%	0%

* $p < 0.01$ ** $p < 0.05$

Key Findings

- GM formaldehyde levels 4 to 10 times that of traditional homes; 2 to 5 times that of previous mobile home studies
- Formaldehyde levels varied by type (mobile homes, park models, and travel trailers) and brand
- Travel trailers had significantly higher mean formaldehyde levels and also the highest percentage of units with formaldehyde levels above 100 and 300 parts per billion

Key Findings (cont)

- Higher indoor temperatures associated with higher formaldehyde levels
- Levels likely under-represent long-term exposure
 - Sampling was conducted in cooler winter months
 - THUs sampled averaged 2 years of age

Recommendations

- Relocate residents in travel trailers before warmer weather according to following priority:
 - Symptomatic residents
 - Vulnerable populations
 - Living in brands with higher levels
- Follow-up will require multi-agency collaboration involving HUD, CDC and others, to assess the potential for formaldehyde exposure in travel trailer and mobile homes used in other places and contexts including units that are used for temporary housing, permanent housing and schools

USPHS Deployment

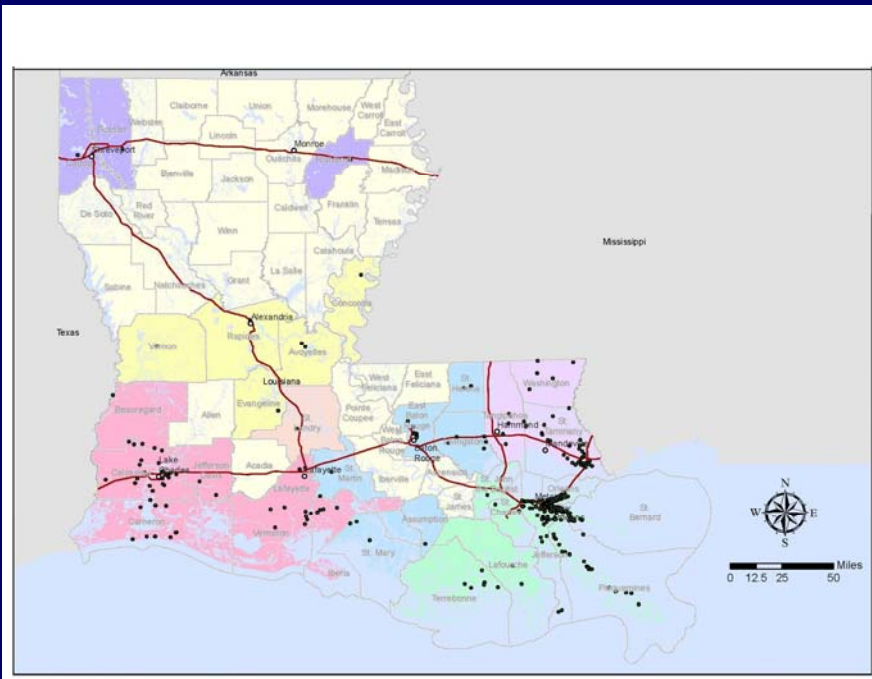


25 USPHS Officers
Louisiana and Mississippi
Feb. 18th – March 2nd

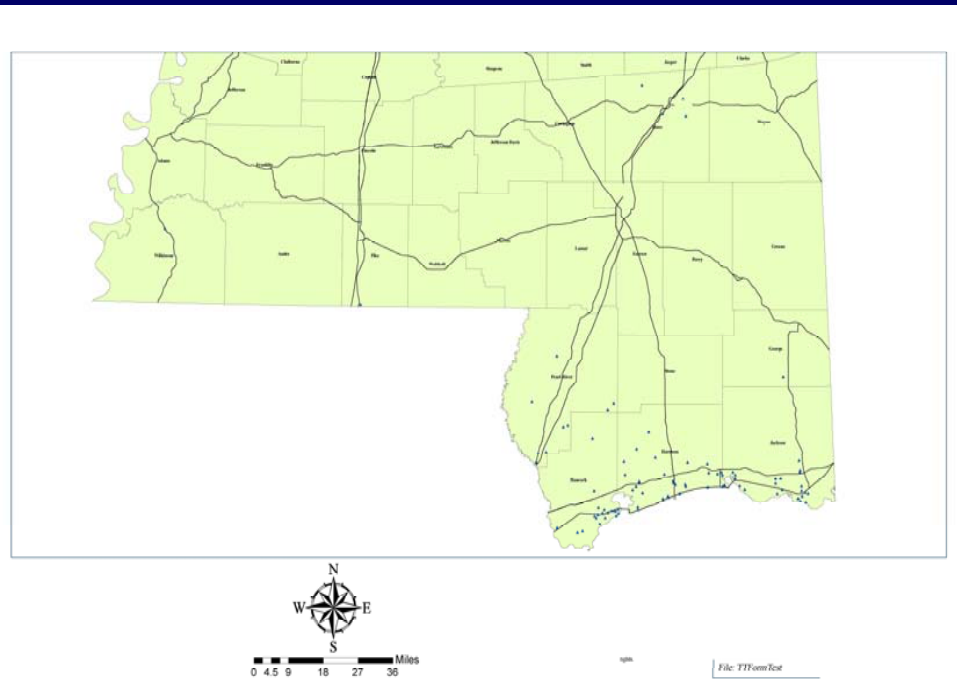
Mission Objectives

- Notify study participants of their formaldehyde test results to explain formaldehyde health issues to the occupants
- Explain formaldehyde health issue to concerned communities

THU Locations



Louisiana



Mississippi

Deployment Challenges

- Logistics of transporting and assigning officers to regional teams
- Coordinating appointments with FEMA
 - FEMA workers accompanied USPHS officers
- Developing a comprehensive training program for deployed officers

Training

- Cultural Competency
- Formaldehyde Overview
- CDC Study Design
- Risk Communication
- Health Messaging Scripts
- Educational Handouts
- Media



Field Activities



Community Meetings

- Ventilate
- Temperature at lowest comfortable level
- Do not smoke
- Increase time spent outside of trailer



Project and Mission Impact

- FEMA relocated approximately 40,000 residents living in FEMA-supplied travel trailers
- FEMA has new standards for use of travel trailers in emergency housing
- Over 470 occupants received in-home consultations from USPHS officers
- Over 1,500 residents attended the 14 community meetings held throughout LA and MS
- High visibility for USPHS promoting public health

Acknowledgements

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"The findings and conclusions in this presentation have not been formally disseminated by the Centers for Disease Control and prevention (CDC) and should not be construed to represent any CDC determination or policy."



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USPHS Deployment

CAPT Jose Belardo

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CDR Theresa Harrington

CDR Elijah Martin

CDR Michael Swann

CDR Teran-Maciver

CDR Thomas Weiser

LCDR Alicia Anderson

LCDR Michael Bartholomew

LCDR James Blankenship

LCDR Shari Campbell

LCDR Bernadette Gonzalez

LCDR Lynda Lee-Bishop

LCDR Angela Robinson

LCDR Vladimir Tirado

LT Samantha Fontenelle

LT Doan Nguyen

LT Tajah Blackburn

OFRD

CDR Shawn Waterman

Questions?

Formaldehyde Levels by Brand

Unit Type	Brand	N in stratum	n in sample	Formaldehyde GM (ppb)*	Range (ppb)	95 % CI for GM (ppb)	Percent of the sample with levels ≥	
							100 ppb	300 ppb
Travel Trailer	Gulfstream	14,624	121	103	3–580	87, 121	56%	8%
	Forest River	3,220	39	85	17–510	65, 110	44%	5%
	Fleetwood	2,371	44	39	3–140	31, 48	7%	0%
	Fleetwood CA	1,699	38	42	7–300	33, 53	11%	3%
	Pilgrim	1,584	39	108	25–520	85, 136	51%	3%
	Keystone	1,395	38	102	23–480	79, 131	53%	11%
	Other TTs	15,637	39	73	11–590	56, 95	33%	5%
Park Model	Silver Creek	224	38	33	3–100	27, 39	3%	0%
	Other PMs	809	44	42	11–170	35, 51	11%	0%
Mobile Home	Cavalier	921	40	78	14–320	64, 96	38%	3%
	Other MHs	4,486	39	56	11–260	46, 68	13%	0%
	Total	46,970	519	77	3–590	69, 85		

***GM = Geometric Mean; ppb = Parts Per Billion (divide by 1000 to get ppm)**

THU Types



Travel Trailer

< 320 sq. ft.

Temporary

**Regulated by
state transportation
authorities**



Park Model

< 400 sq. ft.

Temporary

**Exempt from
HUD**



Mobile Home

> 320 sq. ft.

Permanent

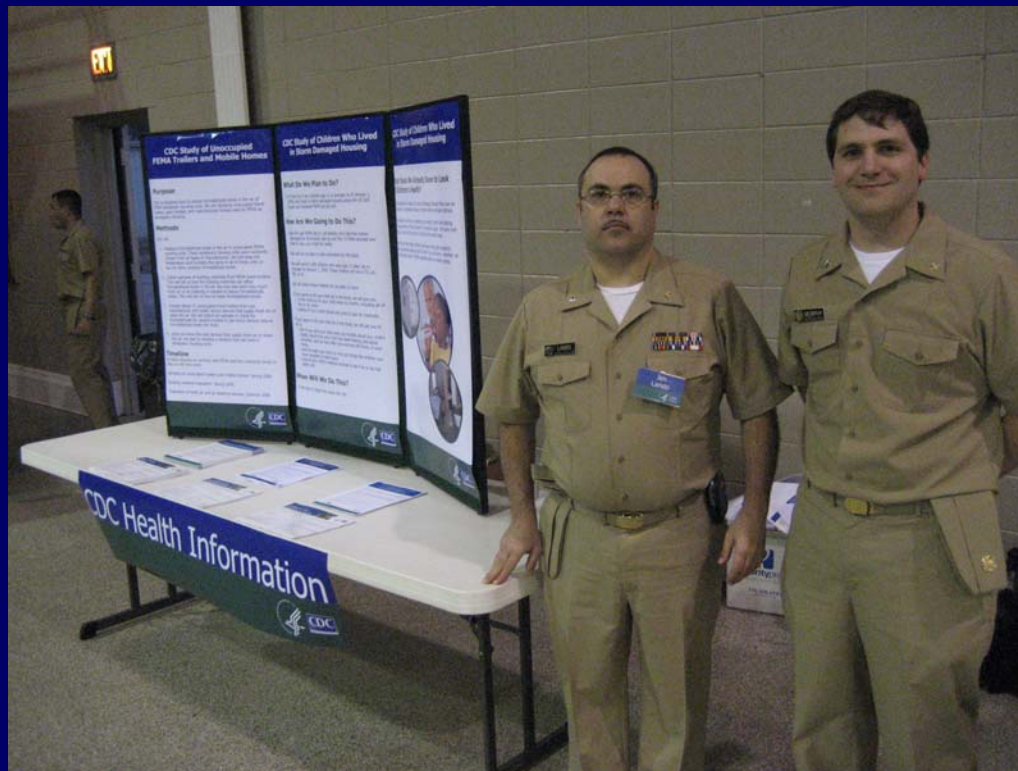
**Regulated by
HUD**

In the Field



Recommendations

- CDC recommended that FEMA relocate travel trailer occupants prioritizing vulnerable populations
- Assess the potential for formaldehyde exposure in travel trailer and mobile homes used in other places and contexts
- FEMA and CDC will establish a registry of people residing in THUs



Health Effects

- No “safe level”
- Acute health effects vary by individual
- Typical threshold for development of symptoms is 800 – 1000 ppb
- Sensitive individuals: 100 ppb
- Other suggested symptoms:
 - Chronic runny nose
 - Chronic bronchitis
 - Obstructive lung disease
- Nasal-pharyngeal carcinogen
- Limited studies in residential environments

Recommendations for Residents

- Increase time spent outdoors in fresh air
- Open windows to let in fresh air
- Maintain indoor temperature at lowest comfortable level
- Do not smoke, especially not inside.
- If you have health concerns, see a doctor or another medical professional.

Eligibility Criteria

- Adult resident \geq 18 years of age
- Adult resides in a FEMA-supplied THU in MS or LA at time of phone recruitment
- Adult respondent spends at least 6 hours each day in the THU
- Assent:
 - Obtained first through scripted recruitment call
 - Signature obtained at time of sampling

Limitations

- Results likely under-estimate risk of occupant long-term exposure
- Sampling was conducted in cooler winter months
- THUs sampled averaged 2 years of age

Key Findings (cont)

- Higher indoor temperatures associated with higher formaldehyde levels
- Formaldehyde levels varied by type (mobile homes, park models, and travel trailers) and brand but
- Travel trailers had significantly higher average formaldehyde levels than mobile homes and park models in this study
- Travel trailers also the highest percentage of units with formaldehyde levels above 100 and 300 parts per billion compared with mobile homes or park models

Recommendations for Partners

- Relocate residents before warmer weather according to following priority:
 - Symptomatic residents
 - Vulnerable populations
 - Living in brands with higher levels
- Multi-agency collaboration to:
 - achieve safe, healthy housing
 - assess the potential for formaldehyde exposure in other places and contexts
 - consider how best to provide necessary assistance to ensure adequate follow-up for residents
 - consider supporting the establishment of a health registry of residents

Follow-up

- Results hand delivered to residents
- Public availability sessions
- Information to health care providers
- Results presented to industry groups
- Continued collaboration with partners
- Final report expected before summer

Recommendations for Residents

- Increase time spent outdoors in fresh air
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- If you have health concerns, see a doctor or another medical professional.

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Government Standards in Occupational Settings

- No residential indoor regulations exist
- OSHA Guidelines:
 - 8-hour time weighted average (TWA): 750 ppb
 - Short term exposure limit (STEL): 2000 ppb
- NIOSH Guidelines:
 - 8-hour time weighted average (TWA): 16 ppb
- HUD Guidelines:
 - 300 ppb (in wood components)

Data Analysis

- SAS version 9.1
- To account for stratified sampling:
 - SURVEYREG
 - SURVEYMEANS
 - SURVEYFREQ
- Measures of central tendency expressed as geometric means
- Multivariate linear regression models

Sampling Strata

Unit Type	Brand	Units Sampled	Units in Population	% of Population
Travel Trailer	A	121	14,624	31.1
	B	39	3,220	6.9
	C	44	2,371	5.0
	D	38	1,699	3.6
	E	39	1,584	3.4
	F	38	1,395	3.0
	Other	39	15,637	33.2
Park Model	G	38	224	0.5
	Other	44	809	1.7
Mobile Home	H	40	921	2.0
	Other	39	4,486	9.6
All Types		519	46,970	

Sample Size

- 95% Confidence and 80% Power
- Minimum sample size of 38 THUs in each strata

Assumptions:

Equal variance among strata

Strata variances less than overall variance

Multiple comparisons of group means requires

Bonferroni correction for each group against the mean

Summary

- Travel trailers had significantly higher levels than other THU types