

# ENVIRONMENTAL ANALYSIS ASSOCIATES, INC.

## REAL QUANTITATIVE DUST ANALYSIS

Using automated Scanning Electron Microscopy / SDD X-ray particle analysis

**APPLICATIONS: IAQ - Construction/corrosion dust – Respirable quartz – Fire residue**

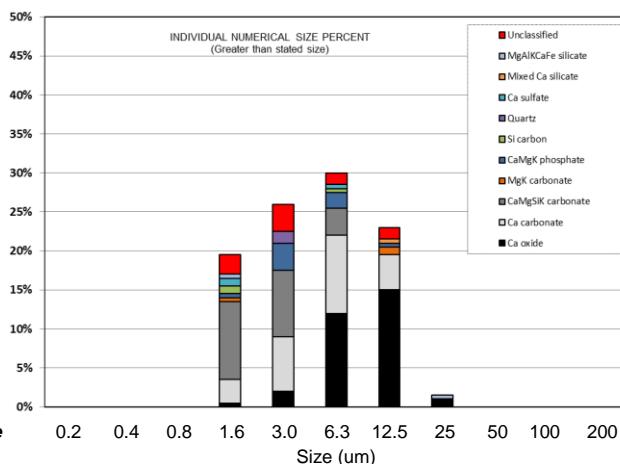
**Size & Mass Distribution → Chemical Profile → Source Identification**

The ENVIRONMENTAL ANALYSIS ASSOCIATES (EAA) dust analysis method provides the simultaneous analysis of particle size, mass, and exposure concentrations specifically designed for industrial hygiene applications. The method is made possible by integrating the use of new high speed Silicon Drift (SDD) X-ray detectors, industry recognized automated particle analysis software, and interpretation software developed directly by EAA.

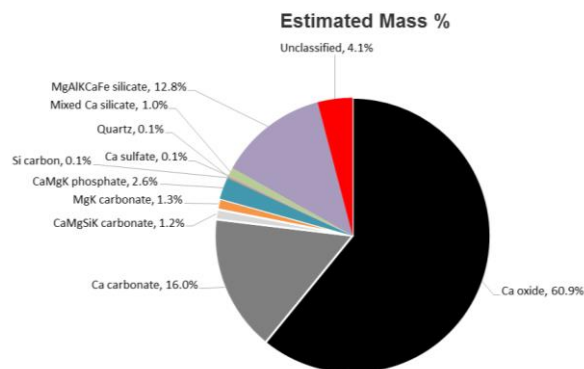
For the first time, the particle size distribution, mass distribution, and chemistry of complex air and dust samples can be simultaneously collected and classified into a profile of probable emission sources. Data collection that used to take an entire day (or more), can now be acquired economically within 20-30 minutes. This service is not available anywhere else in the industry. An example of key summary tables for the analysis of wildfire “ash” are given below. Key features of the analysis report are also described in more detail on additional spec sheets.

Particle Classification	Particles Counted	Mean size (um)	* Specific Gravity	Numerical %	* Mass Ratio %
Ca oxide	61	13.7	3.00	30.5%	60.9%
Ca carbonate	49	8.3	3.00	24.5%	16.0%
CaMgSiK carbonate	44	4.1	3.00	22.0%	1.2%
MgK carbonate	3	10.2	3.00	1.5%	1.3%
CaMgK phosphate	13	6.6	3.00	6.5%	2.6%
Si carbon	3	5.0	1.50	1.5%	0.1%
Quartz	3	5.7	2.60	1.5%	0.1%
Ca sulfate	3	3.8	3.00	1.5%	0.1%
Mixed Ca silicate	1	16.2	3.00	0.5%	1.0%
MgAlKCaFe silicate	2	20.4	3.00	1.0%	12.8%
Unclassified	18	7.1	2.00	9.0%	4.1%

Example analysis of wildfire fire ash – Particle classification summary table



Wildfire ash - Numerical particle size distribution



Wildfire ash – Mass distribution

For more information contact Daniel Baxter at Environmental Analysis Associates, Inc.

San Diego, California Laboratory

5290 Soledad Road  
San Diego, CA 92109

Bay City, Michigan Laboratory

306 5<sup>th</sup> Street, Suite 400  
Bay City, MI 48708

Phone: 858-272-7747

Email: dbaxter@eaalab.com

Website: eaalab.com

# ENVIRONMENTAL ANALYSIS ASSOCIATES, INC.

## AUTOMATED SEM REPORT – KEY REPORTING FEATURES PHOTO DOCUMENTATION PAGE

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### Automated Scanning Electron Microscopy - Dust Analysis Photo Report

**Client Name :** Research

**Contact :** Daniel Baxter

**Client Project# :** Fire pit ash 4-14

**Client Sample # :** 041015-1

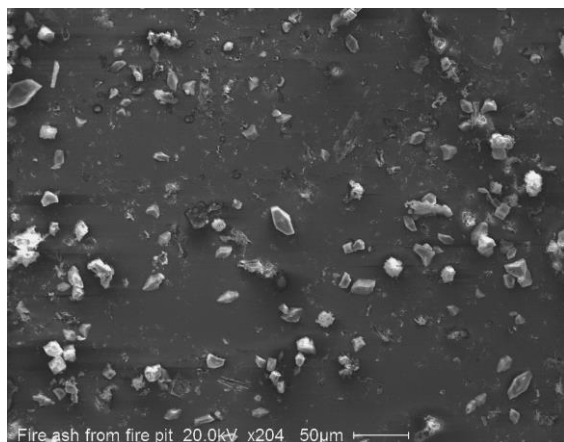
**Sample Description :** Oak ash sample from Michigan fire pit

**Analysis Method :** Automated SEMEDS

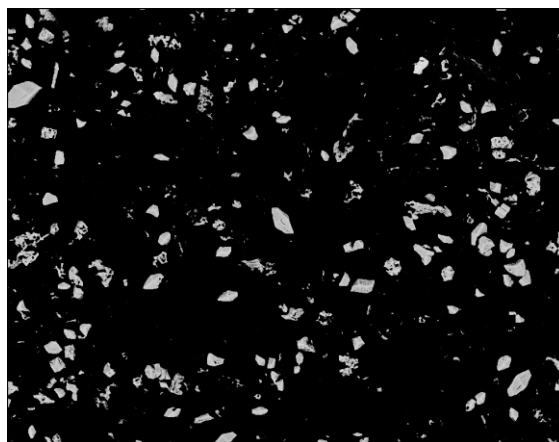
**Analysis Date :** 4/26/15

**EAA Project # :** Research

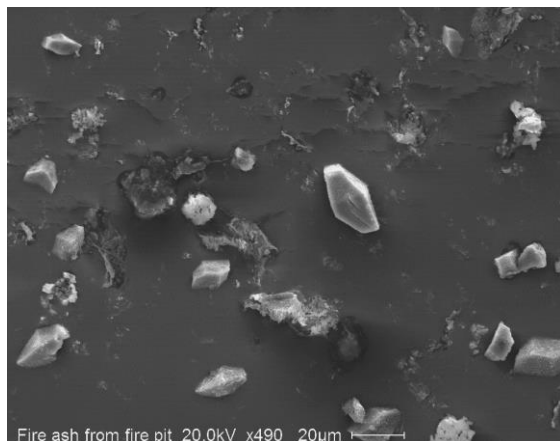
**EAA Sample # :** ash-1



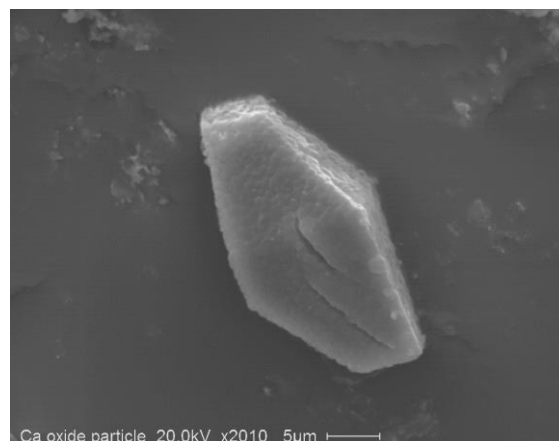
204x - Secondary electron image of analyzed field



204x - Backscatter image of analyzed field



Calcium "oxide" crystals - 490x



Calcium "oxide" crystals - 2010x

#### San Diego, California Laboratory

5290 Soledad Road  
San Diego, CA 92109

#### Bay City, Michigan Laboratory

306 5<sup>th</sup> Street, Suite 400  
Bay City, MI 48708

Phone: 858-272-7747

Email: [dbaxter@eaalab.com](mailto:dbaxter@eaalab.com)

Website: [eaalab.com](http://eaalab.com)

# ENVIRONMENTAL ANALYSIS ASSOCIATES, INC.

## AUTOMATED SEM REPORT – KEY REPORTING FEATURES

### SUMMARY REPORT

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#### Automated Scanning Electron Microscopy - Dust Analysis Report

##### Summary Page

Client Name : Research	Analysis Date : 4/26/15
Contact : Daniel Baxter	EAA Project # : Research
Client Project# : Fire pit ash 4-14	EAA Sample # : ash-1
Client Sample # : 041015-1	
Sample Description : Oak ash sample from Michigan fire pit	Fields Counted : 2
Analysis Method : Automated SEMEDS	Field area cted (mm <sup>2</sup> ) : 0.095
Analysis Magnification : 204	Particles / mm <sup>2</sup> : 2103
Min. size threshold (um) : 2.0	Scale (µm/div.) : 1
Max. size threshold (um) : 100	Total particles counted : 200

#### SUMMARY CONCLUSIONS - Major Constituents

The fire ash was fully "decarbonized" at high temperature and is primarily composed of Calcium oxide / hydroxide, and Calcium carbonate and Magnesium, Potassium (K) salts.

#### Minor Constituents:

Minor amounts of Calicum/Magnesium silicates and phosphous (P) oxides are also present.

Particle Classification	Particles Counted	Mean size (um)	* Specific Gravity	Numerical %	* Mass Ratio %
Ca oxide	61	13.7	3.00	30.5%	60.9%
Ca carbonate	49	8.3	3.00	24.5%	16.0%
CaMgSiK carbonate	44	4.1	3.00	22.0%	1.2%
MgK carbonate	3	10.2	3.00	1.5%	1.3%
CaMgK phosphate	13	6.6	3.00	6.5%	2.6%
Si carbon	3	5.0	1.50	1.5%	0.1%
Quartz	3	5.7	2.60	1.5%	0.1%
Ca sulfate	3	3.8	3.00	1.5%	0.1%
Mixed Ca silicate	1	16.2	3.00	0.5%	1.0%
MgAKCaFe silicate	2	20.4	3.00	1.0%	12.8%
Unclassified	18	7.1	2.00	9.0%	4.1%

\* Mass ratios are based on the average particle size & theoretical specific gravity. If the specific gravity is unknown and not "carbonaceous", it will automatically be assigned a density value of 2.0  
"Unclassified" particles fall outside of the established chi square rule fit criteria

#### San Diego, California Laboratory

5290 Soledad Road  
San Diego, CA 92109

#### Bay City, Michigan Laboratory

306 5<sup>th</sup> Street, Suite 400  
Bay City, MI 48708

Phone: 858-272-7747

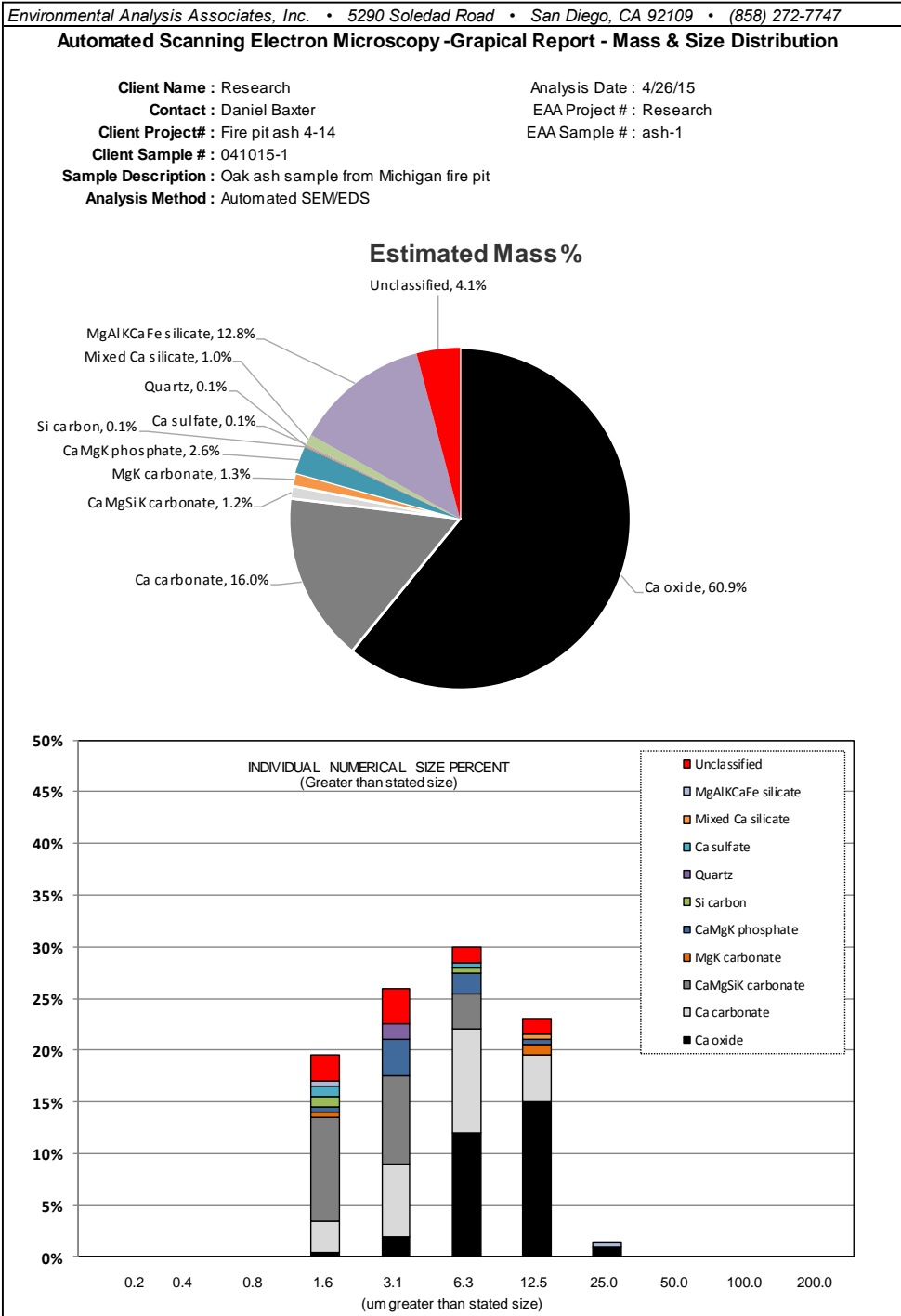
Email: dbaxter@eaalab.com

Website: eaalab.com

# ENVIRONMENTAL ANALYSIS ASSOCIATES, INC.

## AUTOMATED SEM ANALYSIS KEY REPORTING FEATURES –

### GRAPHICAL REPORT



**San Diego, California Laboratory**

5290 Soledad Road  
San Diego, CA 92109

**Bay City, Michigan Laboratory**

306 5<sup>th</sup> Street, Suite 400  
Bay City, MI 48708

Phone: 858-272-7747

Email: [dbaxter@eaalab.com](mailto:dbaxter@eaalab.com)

Website: [eaalab.com](http://eaalab.com)

# ENVIRONMENTAL ANALYSIS ASSOCIATES, INC.

## AUTOMATED SEM ANALYSIS - KEY REPORTING FEATURES

### PARTICLE SIZE AND DISTRIBUTION INFORMATION BY PARTICLE CLASSIFICATION

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#### COMPOSITION SIZE & MASS DISTRIBUTION ANALYSIS (Particle Classification Detail)

<b>Client Name :</b> Research	<b>Analysis Date :</b> 04/26/15
<b>Contact :</b> Daniel Baxter	<b>EAA Project # :</b> Research
<b>Client Project# :</b> Fire pit ash 4-14	<b>EAA Sample # :</b> ash-1
<b>Client Sample # :</b> Research	<b>Scale (µm/div.) :</b> 1.00
<b>Sample Description :</b> 041015-1	<b>Total particles counted :</b> 200
<b>Analysis Method :</b> Automated SEM/EDS	

**Analysis Magnification :** 204

Particle Classification	Numerical Count	Individual Count % >= stated aerodynamic size(µm)										
		>=0.2	>=0.4	>=0.8	>=1.6	>=3.1	>=6	>=13	>=25	>=50	>=100	>=200
Ca oxide	61				0.5%	2.0%	12.0%	15.0%	1.0%			
Ca carbonate	49				3.0%	7.0%	10.0%	4.5%				
CaMgSiK carbonate	44				10.0%	8.5%	3.5%					
MgK carbonate	3				0.5%			1.0%				
CaMgK phosphate	13				0.5%	3.5%	2.0%	0.5%				
Si carbon	3				1.0%		0.5%					
Quartz	3					1.5%						
Ca sulfate	3				1.0%		0.5%					
Mixed Ca silicate	1							0.5%				
MgAlKCaFe silicate	2				0.5%				0.5%			
Unclassified	18				2.5%	3.5%	1.5%	1.5%				

Particle Classification	Count %	* Estimated Mass %	Mean Size (µm)	Aspect Ratio	Roundness		
					Mean	>3.13	<3.13
Ca oxide	30.5%	60.9%	13.7	1.44	2.18	2.19	1.36
Ca carbonate	24.5%	16.0%	8.3	1.44	2.34	2.51	1.14
CaMgSiK carbonate	22.0%	1.2%	4.1	1.45	1.81	2.26	1.27
MgK carbonate	1.5%	1.3%	10.2	1.98	3.29	4.01	1.85
CaMgK phosphate	6.5%	2.6%	6.6	1.52	2.18	2.27	1.15
Si carbon	1.5%	0.1%	5.0	2.89	2.52	4.58	1.50
Quartz	1.5%	0.1%	5.7	1.95	1.43	1.43	
Ca sulfate	1.5%	0.1%	3.8	2.25	1.69	2.84	1.12
Mixed Ca silicate	0.5%	1.0%	16.2	3.43	1.79	1.79	
MgAlKCaFe silicate	1.0%	12.8%	20.4	1.41	4.92	8.84	1.00
Unclassified	9.0%	4.1%	7.1	1.41	1.90	2.19	1.14

#### San Diego, California Laboratory

5290 Soledad Road  
San Diego, CA 92109

#### Bay City, Michigan Laboratory

306 5<sup>th</sup> Street, Suite 400  
Bay City, MI 48708

Phone: 858-272-7747

Email: dbaxter@eaalab.com

Website: eaalab.com

# ENVIRONMENTAL ANALYSIS ASSOCIATES, INC.

## AUTOMATED SEM ANALYSIS - KEY REPORTING FEATURES -

### INDIVIDUAL PARTICLE CHEMISTRY DETAIL

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#### PARTICLE CHEMISTRY TABLE

(Elemental Composition - ZAF Weight %)

Page 1

Client Name: Research

Contact : Daniel Baxter

Client Project#: Fire pit ash 4-14

EAA Project #: Research

Client Sample # : 041015-1

EAA Sample # : ash-1

Sample Description : Oak ash sample from Michigan fire pit

Note: The elemental wt% primarily uses the "K" shell X-ray peak for quantification

Particle	Dia. (um)	Aspect Ratio	ELEMENTAL COMPOSITION (Estimated ZAF weight %)														Class
			CK	OK	NaK	MgK	AlK	SiK	PK	SK	ClK	KK	CaK	TiK	FeK	ZnK	
1	11.9	2.4	38.5	28.6	1.0	1.3	0.7	0.7	0.9	0.6	0.5	1.1	21.8	0.2	0.6	1.02	Ca carbonate
2	3.1	1.7	50.2	18.4	0.2	3.6	0.6	0.7	7.3	0.6	0.5	4.1	9.8	0.5	0.7	0.84	CaMgK phosphate
3	3.8	2.4	44.1	25.7	0.9	2.8	0.6	0.7	7.0	0.8	0.3	3.0	10.0	0.4	0.6	1.12	CaMgK phosphate
4	4.5	2.0	19.2	32.1	1.0	1.2	1.0	0.9	1.0	0.9	0.6	0.9	35.7	0.5	0.7	1.47	Ca oxide
5	4.7	3.4	18.1	35.6	0.3	1.5	0.9	0.8	1.1	0.8	0.6	0.8	34.1	0.5	0.9	1.02	Ca oxide
6	1.8	2.7	54.3	21.7	0.3	3.5	0.7	3.3	0.8	1.0	0.4	1.2	9.1	0.1	0.7	0.73	CaMgSiK carbonate
7	15.8	2.7	21.7	37.8	0.9	1.3	0.8	0.8	0.9	0.6	0.6	0.5	29.3	0.5	0.6	1.38	Ca oxide
8	4.3	2.4	27.5	38.3	0.5	1.1	0.7	24.5	0.7	0.6	0.4	0.5	1.8	0.3	0.6	0.79	Quartz
9	10.1	1.9	23.2	42.7	0.9	1.1	0.8	0.6	0.8	0.6	0.4	0.6	24.5	0.3	0.6	0.94	Ca carbonate
10	4.6	2.4	36.0	24.7	0.5	0.8	0.7	29.2	0.9	0.7	0.5	0.7	1.3	0.4	0.7	0.88	Quartz

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#### PARTICLE CHEMISTRY - GRAPHICAL REPORT

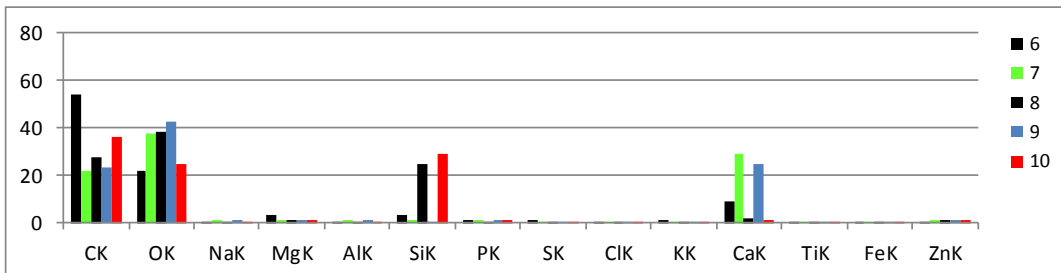
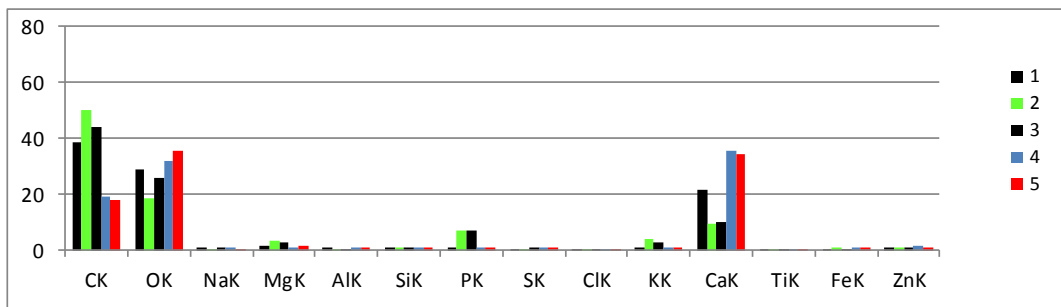
(Elemental Composition - Weight %)

Page 1a

Client Name: Research

Client Sample # : 041015-1

EAA Project #: Research



San Diego, California Laboratory

5290 Soledad Road  
San Diego, CA 92109

Bay City, Michigan Laboratory  
306 5<sup>th</sup> Street, Suite 400  
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