

## **APPENDIX**

### **OBSERVATION DATA FROM SELECTED PAST EARTHQUAKES**

**Table A.1. Observation Data from Past Earthquakes**

Building Name	Hollywood Storage Building		Hollywood Storage Building	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. frame 14/149.5'	R.C. frame 14/149.5'	R.C. frame 14/149.5'	R.C. frame 14/149.5'
Period (sec.)	1.86	0.64	1.86	0.64
Soil Conditions	Pile Foundation	Pile Foundation	Pile Foundation	Pile Foundation
Earthquake	Kern County July 21, 1952	Kern County July 21, 1952	Whitter Narrows October1, 1987	Whitter Narrows October1, 1987
Magnitude ( $M_L$ )	7.2	7.2	5.9	5.9
E. C. D (km)	122	122	25	25
Acc. at Base (g's)	0.06	0.04	0.11	0.06
Acc. at Top (g's)	0.12	0.15	0.20	0.19
Amplification Factor	2.00	3.75	1.82	3.17

**Table A.1. (continued)**

Building Name	Hollywood	Storage Building	Santa Clara	County Office
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. frame 14/149.5'	R.C. frame 14/149.5'	Steel frame 13/186'7"	Steel frame 13/186'7"
Period (sec.)	1.86	0.64	2.05	2.16
Soil Conditions	Pile Foundation	Pile Foundation	-----	-----
Earthquake	Whitter Narrows October 4, 1987	Whitter Narrows October 4, 1987	Morgan Hill April 24, 1984	Morgan Hill April 24, 1984
Magnitude ( $M_L$ )	5.3	5.3	6.2	6.2
E. C. D (km)	25	25	20	20
Acc. at Base (g's)	0.06	0.03	0.03	0.04
Acc. at Top (g's)	0.11	0.08	0.17	0.18
Amplification Factor	1.83	2.67	5.67	4.50

**Table A.1. (continued)**

Building Name	Town Park Towers		Great Western S & L Building	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. shear wall 10/95'	R.C. shear wall 10/95	R.C. frame 10/124'	R.C. shear wall 10/124'
Period (sec.)	—	—	—	—
Soil Conditions	—	—	—	—
Earthquake	Morgan Hill April 24, 1984	Morgan Hill April 24, 1984	Morgan Hill April 24, 1984	Morgan Hill April 24, 1984
Magnitude ( $M_L$ )	6.2	6.2	6.2	6.2
E. C. D (km)	20	20	20	20
Acc. at Base (g's)	0.06	0.06	0.06	0.06
Acc. at Top (g's)	0.22	0.14	0.18	0.22
Amplification Factor	3.67	2.33	3.00	3.67

**Table A.1. (continued)**

Building Name	Building 180 JPL, CalTech		Bank of California	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Steel Frame 9/146'	Steel Frame 9/146'	R.C. Frame 12/174'	R.C. Frame 12/174'
Period (sec.)	1.33	1.05	1.41	2.52
Soil Conditions	—	—	—	—
Earthquake	San Fernando February 9, 1971	San Fernando February 9, 1971	San Fernando February 9, 1971	San Fernando February 9, 1971
Magnitude ( $M_L$ )	6.5	6.5	6.5	6.5
E. C. D (km)	24	24	22.5	22.5
Acc. at Base (g's)	0.14	0.21	0.22	0.15
Acc. at Top (g's)	0.210	0.38	0.29	0.20
Amplification Factor	1.50	1.81	1.32	1.33

**Table A.1. (continued)**

Building Name	Imperial County	Service Building	Freitas Building (Santa Babara)	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. frame 6/81.5'	R.C. wall 6/81.5'	R.C Shear wall 4/53'	R.C. Shear wall 4/53'
Period (sec.)	0.44-0.61	0.64-1.25	0.5	-----
Soil Conditions	-----	-----	-----	-----
Earthquake	Imperial Valley October 15,1979	Imperial Valley October 15,1979	Santa Barbara August 13, 1978	Santa Barbara August 13, 1978
Magnitude ( $M_L$ )	6.6	6.6	5.1-5.7	5.1-5.7
E. C. D (km)			20	-----
Acc. at Base (g's)	0.29	0.33	0.23	-----
Acc. at Top (g's)	0.58	0.45	0.55	-----
Amplification Factor	2.00	1.36	2.39	-----

**Table A.1. (continued)**

Building Name	Kajima Int. Building		Holiday Inn	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Steel Frame 15/208.5'	Steel Frame 15/208.5"	R.C. Frame 7/66'	R.C. Frame 7/66'
Period (sec.)	2.9	2.9	1.6	1.8
Soil Conditions	—	—	—	—
Earthquake	San Fernando February 9,1971	San Fernando February 9,1971	San Fernando February 9,1971	San Fernando February 9,1971
Magnitude ( $M_L$ )	6.5	6.5	6.5	6.5
E. C. D (km)	33.6	33.6	13	13
Acc. at Base (g's)	0.10	0.12	0.25	0.134
Acc. at Top (g's)	0.166	0.162	0.382	0.32
Amplification Factor	1.66	1.30	1.50	2.40

**Table A.1. (continued)**

Building Name	Millikan Library		Watsonville Commercial	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. Shear wall 9/144'	R.C. Shear wall 9/144'	Concrete shear 4/66.4'	Concrete shear 4/66.4'
Period (sec.)	0.8	1.0	0.3	0.4
Soil Conditions	—	—	—	—
Earthquake	San Fernando February 9, 1971	San Fernando February 9, 1971	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	6.5	6.5	7.0	7.0
E. C. D (km)	30.5	30.5	13	13
Acc. at Base (g's)	0.20	0.18	0.28	0.39
Acc. at Top (g's)	0.311	0.35	0.44	1.24
Amplification Factor	1.55	1.94	1.57	3.18



**Table A.1. (continued)**

Building Name	Gilroy Historic	Commercial	San Jose Residential	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Steel Frame 3/49.6'	Steel Frame 3/49.6'	Concrete shear 10/90'	Concrete shear 10/90"
Period (sec.)	0.6	0.6	1.0	0.6
Soil Conditions	—	—	—	—
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	7.0	7.0	7.0	7.0
E. C. D (km)				
Acc. at Base (g's)	0.20	0.20	0.10	0.13
Acc. at Top (g's)	0.67	0.58	0.37	0.24
Amplification Factor	3.4	2.9	3.7	1.85

**Table A.1. (continued)**

Building Name	San Jose Govenrment		San Jose Commercial	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Steel Frame 13/186.5'	Steel Frame 13/186.5'	R.C. frame 10/124'	R.C. frame 10/124'
Period (sec.)	2.0	2.0	1.0	0.9
Soil Conditions	—	—	—	—
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	7.0	7.0	7.0	7.0
E. C. D (km)				
Acc. at Base (g's)	0.11	0.09	0.09	0.11
Acc. at Top (g's)	0.35	0.32	0.26	0.29
Amplification Factor	3.18	3.55	2.89	2.63

**Table A.1. (continued)**

Building Name	S. San Francisco Hospital		San Francisco Comm. Building	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Steel Frame 4/52.5'	Steel Frame 4/52.5'	Steel Frame 18/241.4'	Steel Frame 18/241.4'
Period (sec.)	0.6	0.6	0.9	1.1
Soil Conditions	—	—	—	—
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	7.0	7.0	7.0	7.0
E. C. D (km)				
Acc. at Base (g's)	0.14	0.15	0.17	0.14
Acc. at Top (g's)	0.57	0.61	0.23	0.20
Amplification Factor	4.07	4.06	1.35	1.43

**Table A.1. (continued)**

Building Name	San Bruno Government		San Bruno Office Building	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Concrete shear 9/104''	Concrete shear 9/104''	R.C. frame 6/78'	R.C. frame 6/78'
Period (sec.)	1.1	1.0	1.0	1.1
Soil Conditions	—	—	—	—
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	7.0	7.0	7.0	7.0
E. C. D (km)				
Acc. at Base (g's)	0.11	0.11	0.14	0.12
Acc. at Top (g's)	0.23	0.32	0.25	0.32
Amplification Factor	2.09	2.91	1.78	2.67

**Table A.1. (continued)**

Building Name	San Francisco Office Building		Santa Rosa Residential	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Steel Frame 47/564'	Steel Frame 47/564'	R.C. frame 14/125'	R.C. frame 14/125'
Period (sec.)	1.5	1.5	1.4	1.5
Soil Conditions	————	————	————	————
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	7.0	7.0	7.0	7.0
E. C. D (km)				
Acc. at Base (g's)	0.13	0.26	0.04	0.05
Acc. at Top (g's)	0.48	0.39	0.21	0.21
Amplification Factor	3.7	1.5	5.25	4.2

**Table A.1. (continued)**

Building Name	Milpitas Industrial Bldg.		Hayward Office Bldg.	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Concrete shear 2/31.5'	Concrete shear 2/31.5'	Concrete shear 6/72'	Concrete shear 6/72'
Period (sec.)	0.33	0.2	0.7	0.8
Soil Conditions	—	—	—	—
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	7.0	7.0	7.0	7.0
E. C. D (km)				
Acc. at Base (g's)	0.10	0.14	0.10	0.11
Acc. at Top (g's)	0.14	0.58	0.24	0.34
Amplification Factor	1.4	4.14	2.4	3.09

**Table A.1. (continued)**

Building Name	Hayward School	Office Bldg.	Oakland Residential Bldg	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Steel R.C. Frame 13/201''	Steel R.C.Frame 13/201'	Concrete shear 24/219'	Concrete shear 24/219'
Period (sec.)	0.4	0.5	0.9	0.8
Soil Conditions	—	—	—	—
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	7.0	7.0	7.0	7.0
E. C. D (km)				
Acc. at Base (g's)	0.08	0.09	0.18	0.14
Acc. at Top (g's)	0.15	0.24	0.38	0.25
Amplification Factor	1.87	2.66	2.11	1.78

**Table A.1. (continued)**

Building Name	Okland Office Bldg.		Berkeley Hospital	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. Shear wall 2/28'	R.C. Shear wall 2/28'	EB steel frame 2/25.3'	EB steel frame 2/25.3'
Period (sec.)	0.3	0.6	0.4	0.3
Soil Conditions	—	—	—	—
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	7.0	7.0	7.0	7.0
E. C. D (km)				
Acc. at Base (g's)	0.20	0.25	0.12	0.13
Acc. at Top (g's)	0.25	0.45	0.28	0.26
Amplification Factor	1.25	1.8	2.33	2.0



**Table A.1. (continued)**

Building Name	Richmond Govt. Office		Walnut Creek Commercial Bld	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. Frame 3/37.5'	R.C.Frame 3/37.5'	R.C. Frame 10/128.5'	R.C. Frame 10/128.5'
Period (sec.)	0.4	0.3	0.7	0.9
Soil Conditions	—	—	—	—
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989
Magnitude ( $M_L$ )	7.0	7.0	7.0	7.0
E. C. D (km)				
Acc. at Base (g's)	0.12	0.09	0.10	0.05
Acc. at Top (g's)	0.23	0.20	0.21	0.17
Amplification Factor	1.92	2.22	2.1	3.4

**Table A.1. (continued)**

Building Name	Pleasant Hill	Commercial Bldg.	Watsonville Tel	Building
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Concrete shear 3/40.5'	Concrete shear 3/40.5'	R.C Shear wall 4/66.3'	R.C Shear wall 4/66.3'
Period (sec.)	0.3	0.6	0.4	0.4
Soil Conditions	—	—	—	—
Earthquake	Loma Prieta Oct. 17, 1989	Loma Prieta Oct. 17, 1989	Morgan Hill April 24, 1984	Morgan Hill April 24, 1984
Magnitude ( $M_L$ )	7.0	7.0	6.2	6.2
E. C. D (km)				
Acc. at Base (g's)	0.08	0.12	0.06	0.11
Acc. at Top (g's)	0.14	0.15	0.14	0.33
Amplification Factor	1.75	1.25	2.33	3.0

Building Name	Kaiser Medical Center Bldg.		CSULA Admst. Bldg	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C.Steel Frame 4/52.5'	R.C.Steel Frame 4/52.5'	R.C. shear wall 8/114'	R.C. shear wall 8/114'
Period (sec.)	0.4	0.5	0.8	0.6
Soil Conditions	—	—	—	—
Earthquake	Morgan Hill April 24,1984	Morgan Hill April 24,1984	Whittier Oct. 1,1987	Whittier Oct. 1,1987
Magnitude ( $M_L$ )	6.2	6.2	6.1	6.1
E. C. D (km)				
Acc. at Base (g's)	0.02	0.03	0.31	0.39
Acc. at Top (g's)	0.11	0.17	0.48	0.27
Amplification Factor	5.5	5.6	1.55	0.69

**Table A.1. (continued)**

Building Name	Burbank Federal	Savings Bldg.	Burbank Pacific	Manor
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Steel frame 6/82.5'	Steel frame 6/82.5'	Concrete shear 10/88.7'	Concrete shear 10/88.7'
Period (sec.)	0.8	0.8	0.7	0.6
Soil Conditions	—	—	—	—
Earthquake	Whittier Oct. 1,1987	Whittier Oct. 1,1987	Whittier Oct. 1,1987	Whittier Oct. 1,1987
Magnitude ( $M_L$ )	6.1	6.1	6.1	6.1
E. C. D (km)				
Acc. at Base (g's)	0.22	0.17	0.18	0.22
Acc. at Top (g's)	0.30	0.17	0.34	0.54
Amplification Factor	1.37	1	1.89	2.45

**Table A.1. (continued)**

Building Name	N. Holloywood Shearaton Hotel		CSULB Engr. Bldg	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. Frame 23/177'	Steel R.C.Frame 23/177'	Concrete shear 5/71'	Concrete shear 5/71'
Period (sec.)	0.6	0.5	0.35	0.4
Soil Conditions	—	—	—	—
Earthquake	Whittier Oct. 1,1987	Whittier Oct. 1,1987	Whittier Oct. 1,1987	Whittier Oct. 1,1987
Magnitude ( $M_L$ )	6.1	6.1	6.1	6.1
E. C. D (km)				
Acc. at Base (g's)	0.11	0.09	0.1	0.1
Acc. at Top (g's)	0.17	0.13	0.13	0.36
Amplification Factor	1.54	1.44	1.3	3.6

**Table A.1. (continued)**

Building Name	Long Beach Harbor Adm.		UCLA Math Sci. Bldg	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	Steel Frame 7/91'	Steel Frame 7/91'	R.C. Frame 7/94.5'	R.C. Frame 7/94.5'
Period (sec.)	1.2	1.5	0.6	0.5
Soil Conditions	—	—	—	—
Earthquake	Whittier Oct. 1,1987	Whittier Oct. 1,1987	Whittier Oct. 1,1987	Whittier Oct. 1,1987
Magnitude ( $M_L$ )	6.1	6.1	6.1	6.1
E. C. D (km)				
Acc. at Base (g's)	0.05	0.07	0.05	0.04
Acc. at Top (g's)	0.12	0.11	0.12	0.05
Amplification Factor	2.4	1.57	2.4	1.2

**Table A.1. (continued)**

Building Name	Union Bank Building		Van Nuys Holiday Inn	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. Frame 13/164'	R.C.Frame 13/164'	R.C. Frame 7/66'	R.C. Frame 7/66'
Period (sec.)	—	—	—	—
Soil Conditions	—	—	—	—
Earthquake	Whittier Oct. 1,1987	Whittier Oct. 1,1987	Whittier Oct. 1,1987	Whittier Oct. 1,1987
Magnitude ( $M_L$ )	6.1	6.1	6.1	6.1
E. C. D (km)				
Acc. at Base (g's)	0.18	0.11	0.16	0.16
Acc. at Top (g's)	0.14	0.14	0.20	0.17
Amplification Factor	0.77	1.27	1.26	1.06

**Table A.1. (continued)**

Building Name	1st Federal Savings Bldg		Pasadena Office Bldg	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. Frame 2/30'	R.C. Frame 2/30	Masonry wall 6/82'	Masonry wall 6/82'
Period (sec.)	0.33	0.3	0.5	0.5
Soil Conditions	—	—	—	—
Earthquake	Whittier Oct. 1,1987	Whittier Oct. 1,1987	Sierra Madre,CA June 28, 1991	Sierra Madre,CA June 28, 1991
Magnitude ( $M_L$ )	6.1	6.1	5.8	5.8
E. C. D (km)				
Acc. at Base (g's)	0.05	0.05	0.20	0.14
Acc. at Top (g's)	0.15	0.14	0.24	0.16
Amplification Factor	3	2.8	1.2	1.11



**Table A.1. (continued)**

Building Name	Pasadena Comm. Bldg		Burbank Residential	
	N-S	E-W	N-S	E-W
Configuration (story/ height)	R.C. Frame 9/117'	R.C. Frame 9/117'	R.C. shear wall 10/88'	R.C. shear wall 10/88'
Period (sec.)	1.2	1.2	0.8	0.8
Soil Conditions	—	—	—	—
Earthquake	Sierra Madre, CA June 28, 1991	Sierra Madre, CA June 28, 1991	Sierra Madre, CA June 28, 1991	Sierra Madre, CA June 28, 1991
Magnitude ( $M_L$ )	5.8	5.8	6.6	6.6
E. C. D (km)				
Acc. at Base (g's)	0.24	0.11	0.12	0.08
Acc. at Top (g's)	0.43	0.14	0.34	0.18
Amplification Factor	1.79	1.27	2.83	2.25

**NATIONAL CENTER FOR EARTHQUAKE ENGINEERING RESEARCH  
LIST OF TECHNICAL REPORTS**

The National Center for Earthquake Engineering Research (NCEER) publishes technical reports on a variety of subjects related to earthquake engineering written by authors funded through NCEER. These reports are available from both NCEER's Publications Department and the National Technical Information Service (NTIS). Requests for reports should be directed to the Publications Department, National Center for Earthquake Engineering Research, State University of New York at Buffalo, Red Jacket Quadrangle, Buffalo, New York 14261. Reports can also be requested through NTIS, 5285 Port Royal Road, Springfield, Virginia 22161. NTIS accession numbers are shown in parenthesis, if available.

- NCEER-87-0001 "First-Year Program in Research, Education and Technology Transfer," 3/5/87, (PB88-134275/AS).
- NCEER-87-0002 "Experimental Evaluation of Instantaneous Optimal Algorithms for Structural Control," by R.C. Lin, T.T. Soong and A.M. Reinhorn, 4/20/87, (PB88-134341/AS).
- NCEER-87-0003 "Experimentation Using the Earthquake Simulation Facilities at University at Buffalo," by A.M. Reinhorn and R.L. Ketter, to be published.
- NCEER-87-0004 "The System Characteristics and Performance of a Shaking Table," by J.S. Hwang, K.C. Chang and G.C. Lee, 6/1/87, (PB88-134259/AS). This report is available only through NTIS (see address given above).
- NCEER-87-0005 "A Finite Element Formulation for Nonlinear Viscoplastic Material Using a Q Model," by O. Gyebe and G. Dasgupta, 11/2/87, (PB88-213764/AS).
- NCEER-87-0006 "Symbolic Manipulation Program (SMP) - Algebraic Codes for Two and Three Dimensional Finite Element Formulations," by X. Lee and G. Dasgupta, 11/9/87, (PB88-219522/AS).
- NCEER-87-0007 "Instantaneous Optimal Control Laws for Tall Buildings Under Seismic Excitations," by J.N. Yang, A. Akbarpour and P. Ghaemmaghami, 6/10/87, (PB88-134333/AS).
- NCEER-87-0008 "IDARC: Inelastic Damage Analysis of Reinforced Concrete Frame - Shear-Wall Structures," by Y.J. Park, A.M. Reinhorn and S.K. Kunnath, 7/20/87, (PB88-134325/AS).
- NCEER-87-0009 "Liquefaction Potential for New York State: A Preliminary Report on Sites in Manhattan and Buffalo," by M. Budhu, V. Vijayakumar, R.F. Giese and L. Baumgras, 8/31/87, (PB88-163704/AS). This report is available only through NTIS (see address given above).
- NCEER-87-0010 "Vertical and Torsional Vibration of Foundations in Inhomogeneous Media," by A.S. Veletsos and K.W. Dotson, 6/1/87, (PB88-134291/AS).
- NCEER-87-0011 "Seismic Probabilistic Risk Assessment and Seismic Margins Studies for Nuclear Power Plants," by Howard H.M. Hwang, 6/15/87, (PB88-134267/AS).
- NCEER-87-0012 "Parametric Studies of Frequency Response of Secondary Systems Under Ground-Acceleration Excitations," by Y. Yong and Y.K. Lin, 6/10/87, (PB88-134309/AS).
- NCEER-87-0013 "Frequency Response of Secondary Systems Under Seismic Excitation," by J.A. HoLung, J. Cai and Y.K. Lin, 7/31/87, (PB88-134317/AS).
- NCEER-87-0014 "Modelling Earthquake Ground Motions in Seismically Active Regions Using Parametric Time Series Methods," by G.W. Ellis and A.S. Cakmak, 8/25/87, (PB88-134283/AS).
- NCEER-87-0015 "Detection and Assessment of Seismic Structural Damage," by E. DiPasquale and A.S. Cakmak, 8/25/87, (PB88-163712/AS).

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