APPLIED ENGINEERING CONCEPTS
Larry O'Keefe • Consulting Engineer

April 9, 2001

Mr. Grady Calcote
Optima Electronic Packaging Systems
2166 Mountain Industrial Boulevard
Tucker, GA 30084-5008

Dear Mr. Calcote:

Applied Engineering Concepts has completed a finite element structural analysis on four Optima cabinets configured per Raytheon Systems Company's letter dated January 8, 2001.

The enclosed summary reports show the results of the analysis. Each of the four cabinets meets all of the requirements and objectives for earthquake zone 4 shock as defined in Telcordia Technologies specification GR-63-Core.

Sincerely,

Lawrence P. O'Keefe

Lawrence P. O'Keefe, PE

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Structural Analysis Of Four Cabinets

Prepared For

Optima Electronics Packaging Systems
`2166 Mountain Industrial Boulevard
Tucker, GA 30084-5088
Purchase Order T87099

April 12, 2001

Applied Engineering Concepts
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Gainesville, GA 30506
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Introduction

By transmittal letter to Optima Electronic Packaging Systems (Optima) dated April 9, 2001, Applied Engineering Concepts (AEC) submitted a report summarizing the results of a finite element structural analysis (FEA) conducted on four cabinets in accordance with Optima purchase order T87099. The summary report was transmitted to Raytheon Electronic Systems (Raytheon) at the same time for submission to the FAA. This report complements the summary report, and contains more data.

Scope Of Work

In a letter dated January 8, 2001, Raytheon specified four configurations of a standard Optima cabinet to be analyzed for compliance with the requirements of selected sections of Telcordia Technologies specification GR-63-CORE.
AEC simulated the following tests:

- Static pull testing in X and Y axes
- Natural frequency determination
- Response to zone 4 earthquake shock in the X, Y and Z axes
- Office vibration in the X, Y and Z axes

The simulations were conducted on the ASI Equipment Rack, the Comm Equipment rack with 40 pound cable load, the RTI Expansion Equipment Rack, and the Comm Equipment rack with 100 pound cable load.

Performance Requirements

The Telcordia performance requirements included :

- Displacement at the top of the rack not to exceed 3 inches
- No permanent structural or mechanical damage
- A required natural mechanical frequency of greater than 2 HZ, with a goal of more than 6 HZ

For evaluating mechanical damage, stresses greater than the yield strength of any cabinet structural material constitutes a failure. The principal cabinet structural materials and yield strengths are:

- Aluminum 6061 35,000 PSI
- Aluminum 6063 16,000 PSI
- Steel A569 42,000 PSI

During the analysis, all critical stresses showed up in the interior steel horizontal and vertical support members. Therefore, a Von Mises stress value of 42,000 PSI was used as the failure criteria.

Changes To The Standard Cabinet.

As the analysis progressed, stresses exceeding 42,00 PSI showed up, and changes were made to cabinet components. These included:

- Changing the Front To Rear Stiffener from aluminum to steel
- Adding two Front To Rear Stiffeners for a total of five.
- Adding a return leg to the front/middle panel mount brackets
- Changing the front/middle panel mount bracket thickness from 11 gauge to 10 gauge.
- Changing the front/middle panel mount brackets to A569 steel.
- Using the front/middle panel mount brackets in place of the rear panel mount bracket.
- Mounting a standard EIA 5-1/4 inch aluminum panel on the rear panel mount brackets approximately 30 Inches up from the bottom of the bezel.
- Requiring that a 7-inch plate be mounted on the rear panel mount brackets in place of the blower if the blower is not installed.

Graphic Depictions Of Mode Shapes, Stresses And Displacements

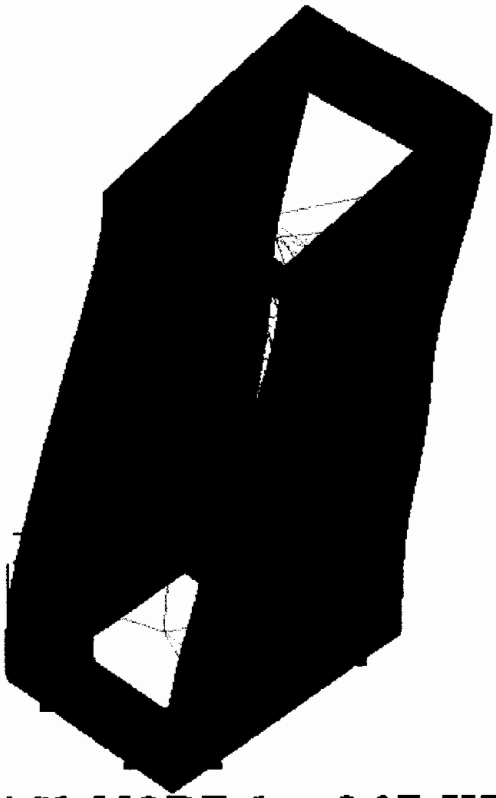
The following pages show the following isometric views of the analysis results for each cabinet:

- The first two mode shapes
- Pull test stresses in the X and Y axes
- Earthquake zone 4 stresses in the X, Y and Z axes
- Office vibrations stresses in the X, Y and Z axes

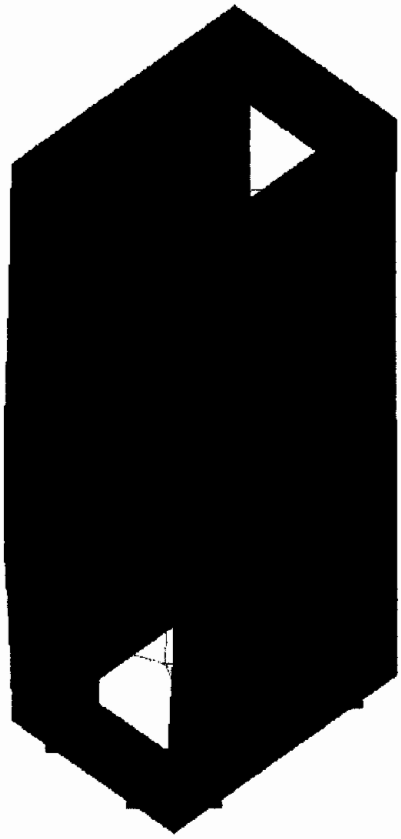
In addition, displacements are shown for the most critical load case, the AT1 cabinet zone 4 earthquake X axis.

Tabular Data

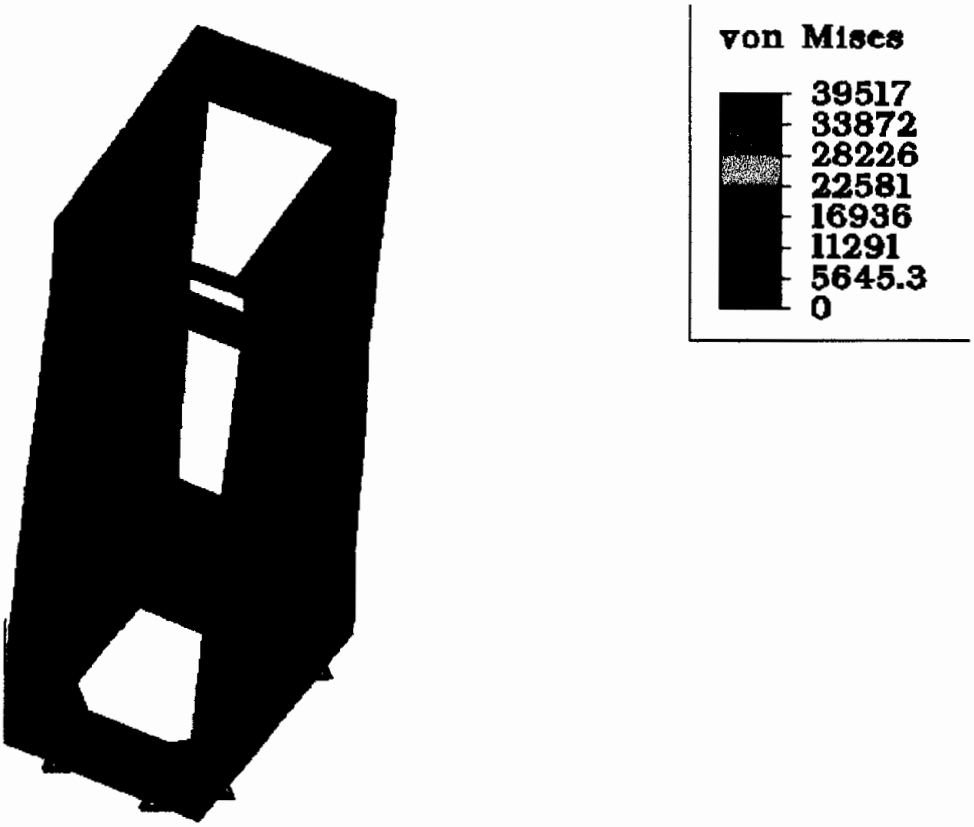
The enclosed spreadsheet document " Structural Analysis Results" tabulates the three modal frequencies and the stress and displacement results for each of the four cabinets. The document "Optima Raytheon Cabinet Total Weights* shows the cabinet weights calculated by the FEA model, and the cable and equipment weights provided by Raytheon. The weights will be close to, but not the same as, actual weights due to simplifications used in the cabinet FEA model.



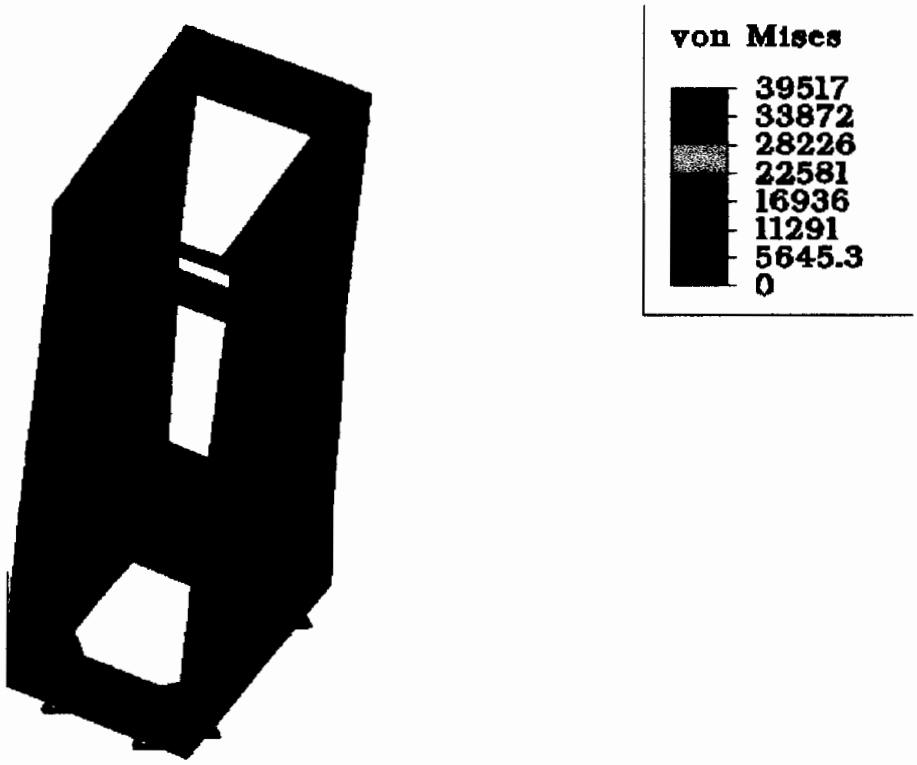
AS1 MODE 1 – 8.07 HZ



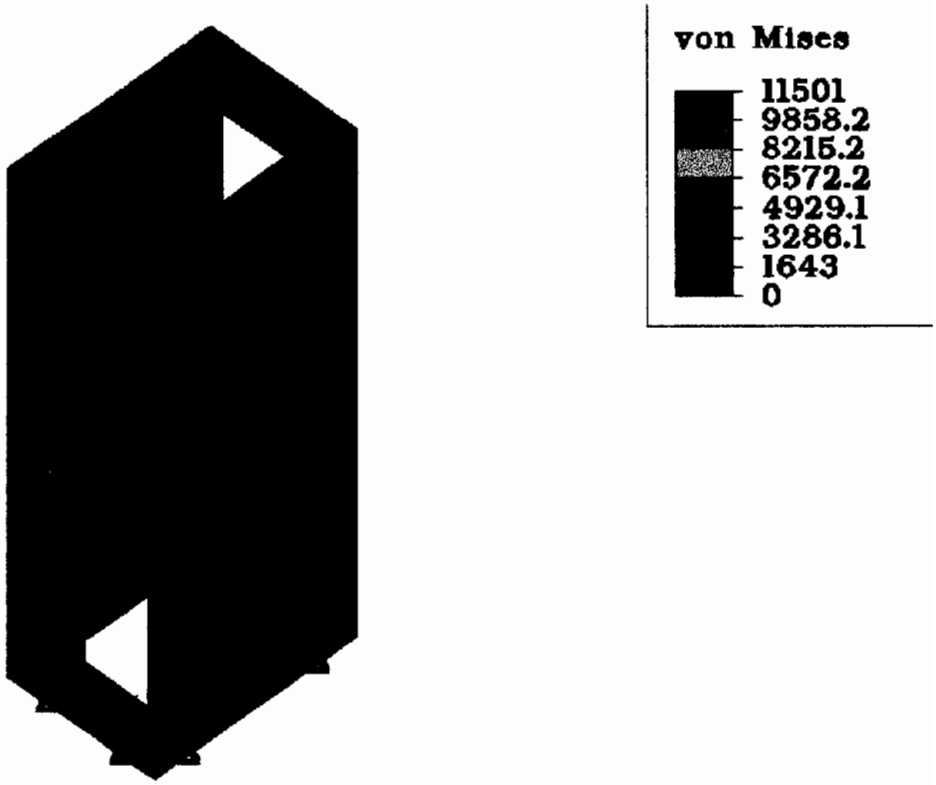
AS1 MODE 2 – 11.33 HZ



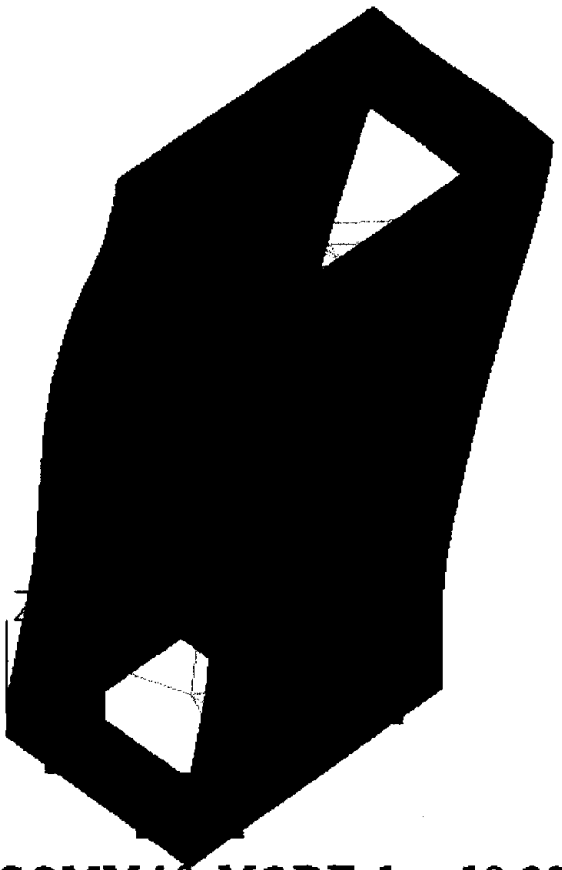
AS1 ZONE 4 - X AXIS STRESS, PSI



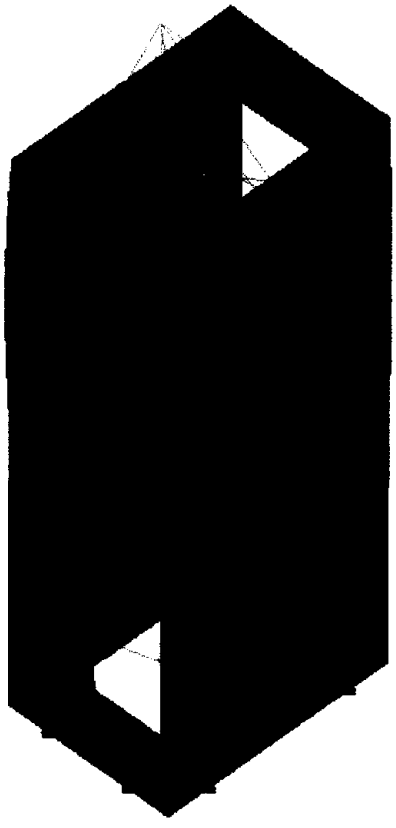
AS1 ZONE 4 - X AXIS DISPLACEMENTS, In.



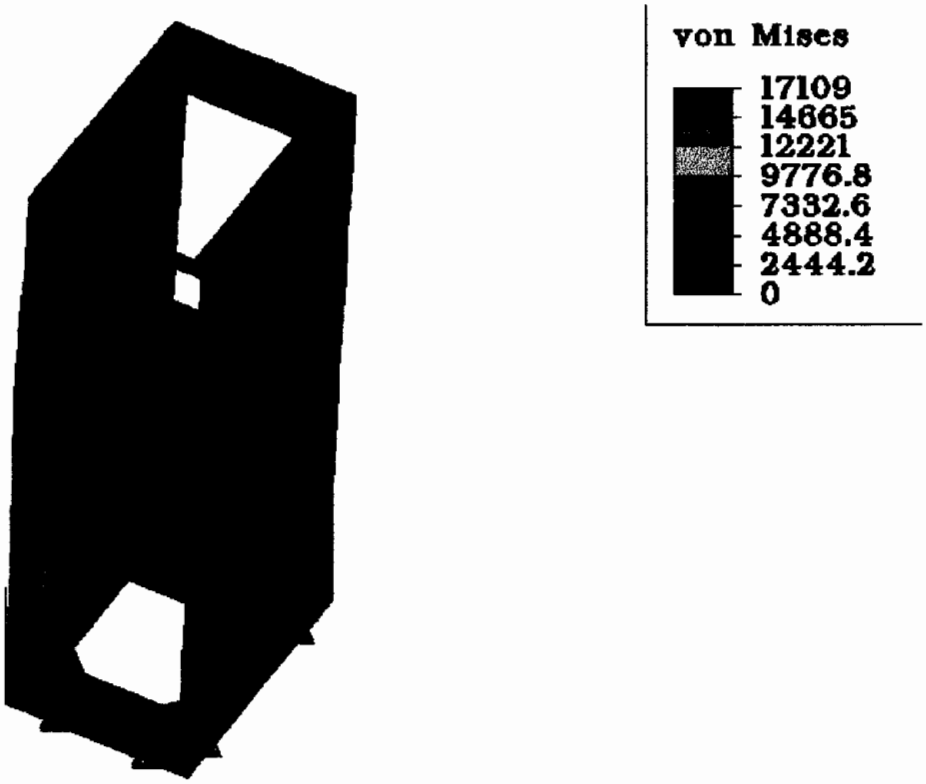
AS1 OFFICE VIBR – Z AXIS STRESS, PSI



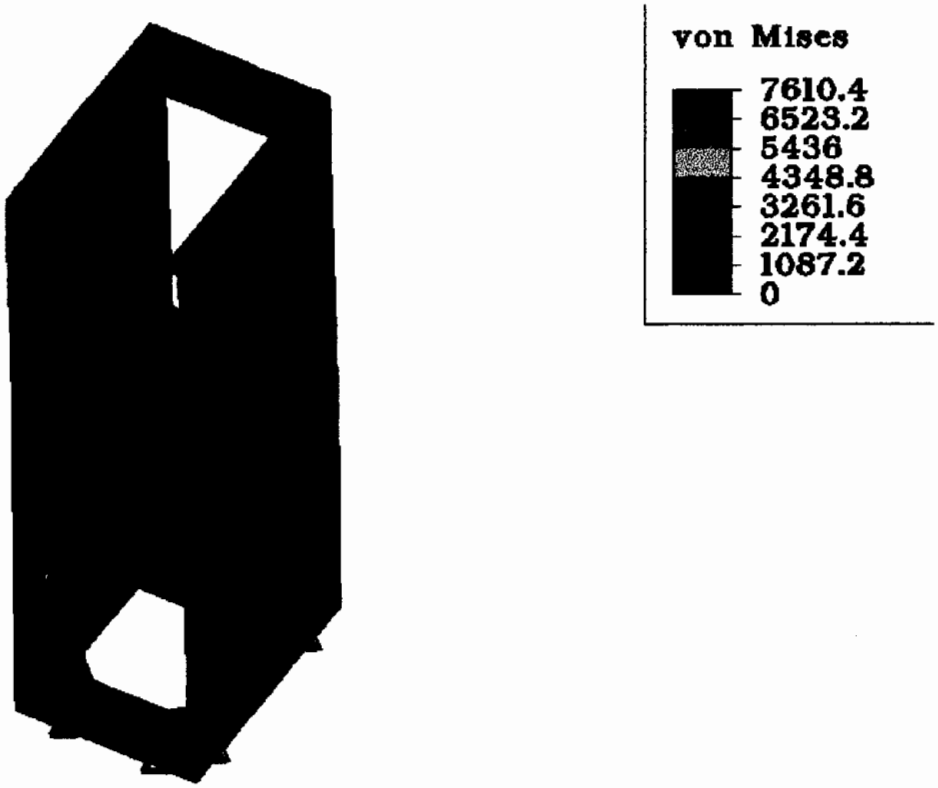
COMM40 MODE 1 – 10.92 HZ



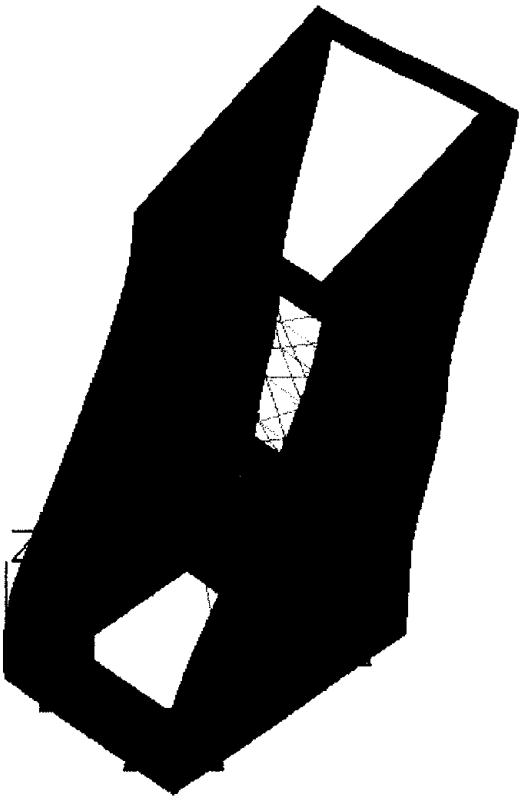
COMM40 MODE 2 – 17.81 HZ



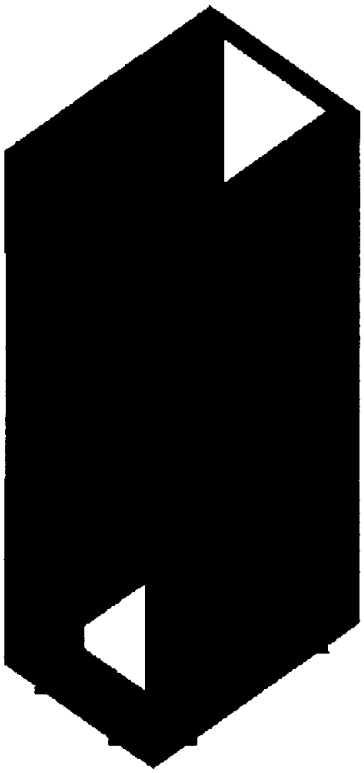
COMM40 ZONE 4 – X AXIS STRESS, PSI



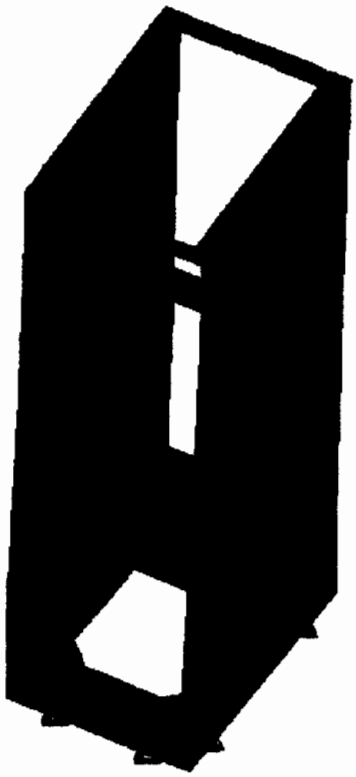
COMM40 OFFICE VIBR – X AXIS STRESS, PSI



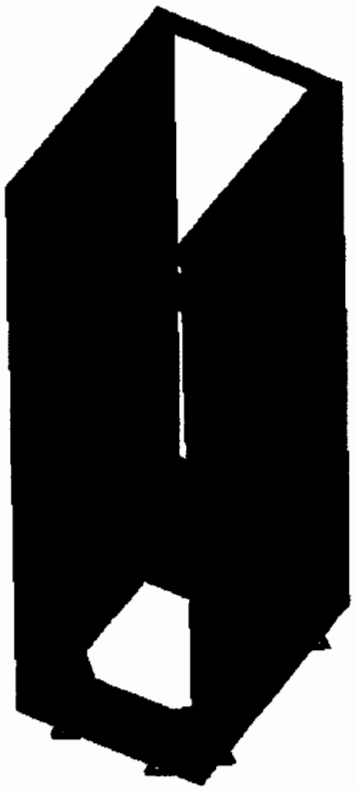
RTI MODE 1 – 10.92 HZ



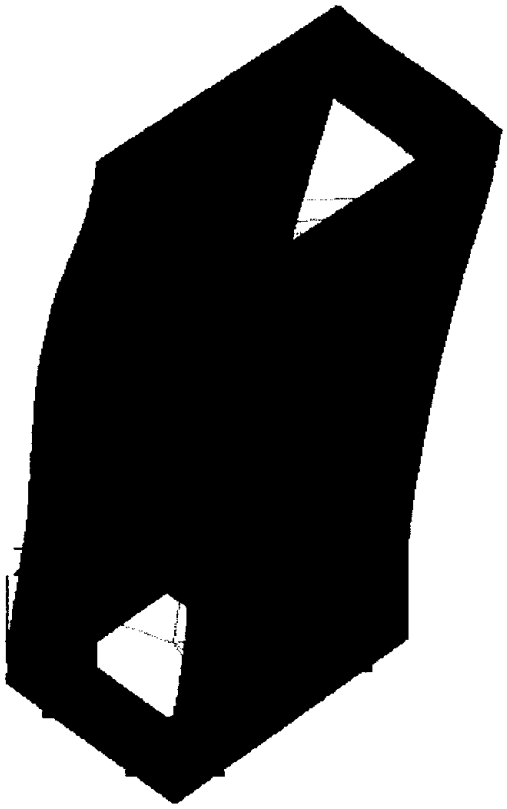
RTI MODE 2 – 11.33 HZ



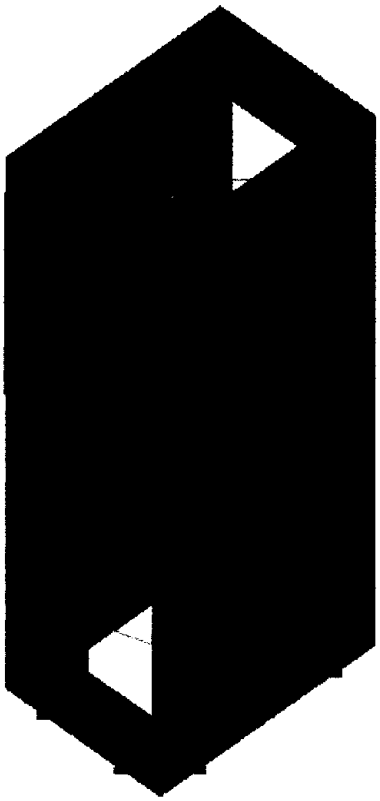
RTI ZONE 4 – X AXIS STRESS, PSI



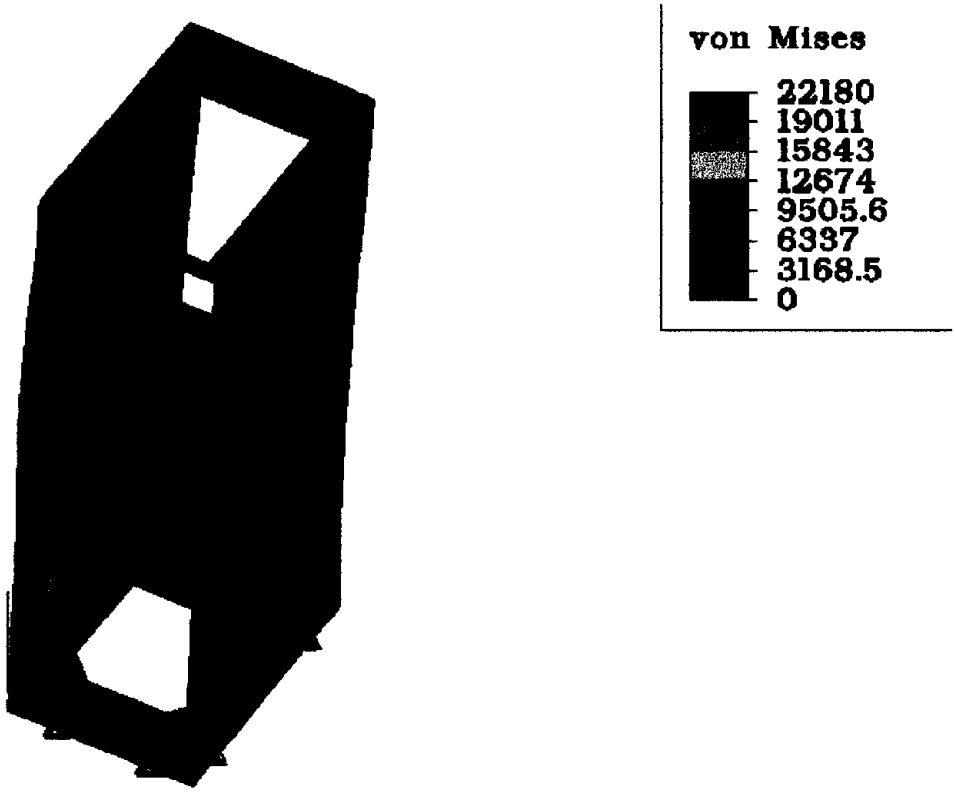
RTI OFFICE VIBR – X AXIS STRESS, PSI



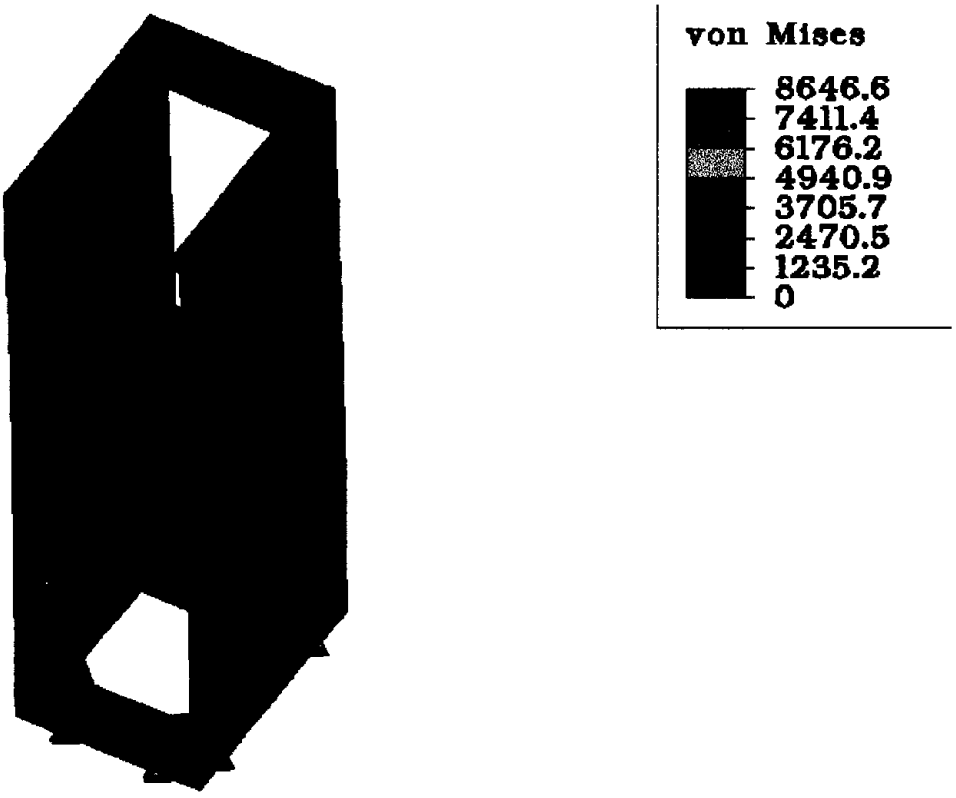
COM100 MODE 1 – 9.61 HZ



COMM100 MODE 2 – 17.81 HZ



COMM100 ZONE 4 – X AXIS STRESS, PSI



COMM100 OFFICE VIBR – X AXIS STRESS, PSI

Optima-Raytheon Cabinet Total Weights R1 4/6/01				
	Config 1	Config 2	Config 3	Config 4
	ASI	Comm (40)	RTI	Comm (100)
Cabinet + Fan	251	251	251	251
Doors (Est)	64	64	64	64
Cab Subtot	315	315	315	315
Cable	40	40	40	100
Equipment	11.2	18.3	0	18.3
	30.8	18.3	0	18.3
	15	18.3	0	18.3
	15	21.6	14	21.6
	30.8	60	30.8	60
	42	11.25	30.8	11.25
	30.8	11.25	14	11.25
	30.8	11.25	30.8	11.25
	30.8	11.25	30.8	11.25
	30	11	14	11
	30	11	30.8	11
	30	11	30.8	11
	32	11		11
		30		30
		32		32
	359.2	287.5	226.8	287.5
Total Weight	714.2	642.5	581.8	702.5
Source Cab Wt	Cabbasecf	Cabbasecf	Cabbasecf	Cabbasecf

	STRUCTURAL ANALYSIS RESULTS					
	Rev 1 4/10/01					
	Mode 1	Mode 2	Mode 3	X Axis	Y Axis	Z Axis
Configuration 1 - AS1						
Modal Analysis						
Frequency - HZ	8.07	11.33	13.04			
Pull Test						
Stress - PSI				34,657	5,580	
Displacement - In.				0.488	0.054	
Earthquake Zone 4						
Stress - PSI				(R1) 39517	2,008	25,178
Displacement - In.				0.6	0.009	0.244
Office Vibration						
Stress - PSI				8260	410	11502
Displacement - In.				0.139	0.004	0.111
Configuration 2 Comm 40						
Modal Analysis						
Frequency - HZ	10.92	17.81	18.28			
Pull Test						
Stress - PSI				16,877	5,453	
Displacement - In.				0.277	0.004	
Earthquake Zone 4						
Stress - PSI				17,109	37	1,174
Displacement - In.				0.306	0.003	0.063
Office Vibration						
Stress - PSI				7,610	16	481
Displacement - In.				0.136	0.002	0.043
Configuration 3 - RTI						
Modal Analysis	12.14	13.65	14.47			
Frequency - HZ						
Pull Test						
Stress - PSI				16,860	5,580	
Displacement - In.				0.376	0.054	
Earthquake Zone 4						
Stress - PSI				11,714	56	6,560
Displacement - In.				0.237	0.002	0.048
Office Vibration						
Stress - PSI				5811	31	3847
Displacement - In.				0.118	0	0.058
Configuration 4 - Comm 100						
Modal Analysis						
Frequency - HZ	9.61	17.81	18.28			
Pull Test						
Stress - PSI				18,334	6,036	
Displacement - In.				0.303	0.045	
Earthquake Zone 4						
Stress - PSI				22,180	46	1,154
Displacement - In.				0.411	0.003	0.067
Office Vibration						
Stress - PSI				(R1) 8647	18	475
Displacement - In.				0.16	0.002	0.042