

# **TSTOWER FOR LATTICED**

**GUYED MASTS** 

# STRUCTURAL ANALYSIS SOFTWARE FOR COMMUNICATION TOWERS

**USER'S MANUAL** 

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## Chapter 1 INTRODUCTION

*TSTower* is a general computer program for the analysis and design of latticed guyed masts. Towers can either have triangular or square cross sections. The program will solve using the American codes TIA/EIA 222-F, TIA/222-G and the Canadian equivalent CSA S37-94 and CSA S37-01. Load generation, capacity assessments follow the applicable codes, and analysis is based on a three-dimensional beam model.

The program analyzes the tower for all specified wind, ice loads and Earthquake loads and determines the capacity of the members. The results are displayed graphically on the screen. This allows the designer to visually check the adequacy of the design and quickly make adjustments to achieve the optimum solution. The program allows for a full printout or a summary printout of the results. A graphical printout of the profile is also available.

#### HARDWARE REQUIRMENTS

The following minimum system requirements to run TSTower:

- An IBM compatible PC equipped with a Pentium processor running under Windows 2000, or XP
- 50 MB free disk space
- 128 MB RAM
- 14 inch SVGA monitor with (800 x 600 min resolution)
- A pointing device, a mouse or graphical tablet configured to work under windows.
- An optional printer that is set from windows

## INSTALLING TSTOWER

The TSTower installation is initiated from windows. From start menu choose run, and choose file setup.exe

The setup program will create a TSTower directory on the hard drive at a location designated by the user. The user may change the name of the folder in which the program will copy all necessary files required to run TSTower.

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Choose the folder name and click OK, the installation program will copy all necessary files into the different directories of your system. Follow the program instructions and place the subsequent disks into the disk drive.

At the end of the installation the program will notify you that the installation was completed successfully. Refer to the purchasers agreement regarding the number of authorized users allowed to run the program.

#### DISCLAIMER

Extensive care has been taken during the development and testing of TSTower program to ensure that both the source code and the underlying engineering principles comply with standard engineering practice. Should any discrepancies or possible program errors occur, please notify TowerSoft immediately.

TOWERSOFT DISCLAIMS ALL WARRANTIES IMPLIED OR OTHERWISE WITH REGARDS TO THE SOFTWARE. BY USING THE SOFTWARE, THE USER AGREES THAT NEITHER TOWERSOFT NOR ITS EMPLOYEES SHALL BE LIABLE FOR ANY LOSS, DAMAGE, OR EXPENSE OF ANY KIND WHICH IS CAUSED DIRECTLY OR INDIRECTLY BY THE USE, PERFORMANCE, MAINTAINANCE, SERVICE OR CONDITION OF THE SOFTWARE. IN NO EVENT WILL TOWERSOFT BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGE RESULTING FROM USE OF THIS SOFTWARE.

User's comments and suggestions are welcomed. Please forward all your comments to support@towersft.com.

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## **Chapter 2 INPUT**

*TSTower* is an analysis software program. The user inputs all the necessary information required to perform the analysis, the finite element program is run, and the results are shown in a graphical format on the screen.

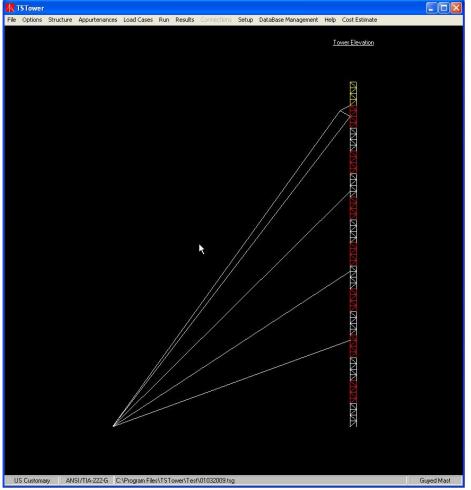
For design purpose, the user decides on a tentative geometry and performs an analysis. The user examines the results of the preliminary selection and modifies any of the design parameters before reanalyzing the structure. Using successive runs, the user can quickly arrive at an optimum solution. The designer makes the choices, interprets the output and has full control on the design process.

This Chapter illustrates how *TSTower* works by explaining the input screens. The input values and screens are shown on the figures in this chapter utilizing an example. This example may not use all the features of the software, however it gives the user a quick introduction to the main features and the use of the program. Features available in the program that are not used for this example are explained in the context.

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#### START THE PROGRAM

When TSTower starts, the main screen shows a blank page. The user selects a structure type from the Structure menu. The three options are either tubular SS, latticed SS, or guyed mast structures.



Note the status bar at the bottom of the windows showing the following data in order:

- 1- The current mode of units (metric or US Customary)
- 2- The applicable code of design (CSA S37-01, CSA S37-94, EIA 222-F, ANSI/TIA 222-G)

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- 3- The problem file name, and path
- 4- Structure type (Tubular , Latticed or Guyed Mast)

Select **Options** from the main menu and from the list choose the required code and the system of units.

<u>F</u> ile	0 ptions	<u>G</u> eometry	Appurtenances	Load Cases	<u>R</u> un	R <u>e</u> sults	<u>B</u> ase Plate	<u>S</u> etup	<u>H</u> elp
	Units	• •	Metric						
	Standa	ard 🕨	US Customary						
	Project	t Data 🗍							

#### **PROJECT DEFINITION**

Select **Project Data** from the **Options** menu. Type in any identification data required as shown.

Project Data	
Customer	TowerSoft
Site ID	A0001
Location	Mississauga-ON-CANADA
Project	03-00-001
Revision	0
Engineer	Any Engineer
	OK Cancel

To add data to any box, move the cursor into the box, click inside the box and type in the data using the keyboard. To change any existing data in an edit

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box, delete the entry using the <Del> key or the <Backspace> key. Alternatively, highlight the existing characters by pressing and dragging the left mouse button, then type over the existing entry. This is a standard Windows feature.

#### **GEOMETRY DEFINITION**

Select **Structure/Guyed Mast/Mast** from the main menu, this will show the Geometry Definition Window. Initially the window will show default geometry data and the user changes that to the required parameters.

Structure Typical S	- 1		) Top W Bot. W Cross-S	/idth 5	5.00 <b>\$</b>	(in) (in)	Total H		15 00.000	🜲 (ft)	
Height	Section 20.0	00 00	C1088-3	ection  Tri	angular _	Sec	tion Gene	erator	Restra	iints at Base	2
Sectio	n Geometry	Panel G	eometry	Memb	er Geome	try Mi	ember Cap	pacities	Sec	tion Proper	ty
Sect. No.	Description	Height (ft)	Bot. Elev. (ft)	Bot. Width (in)	Locked Bot. Width	Top Width (in)	Locked Top Width	No. of Panels	Mass (lbs)	Database Mass (Ibs)	
7	S7	20.000	120.000	55.00	U	55.00	U	4	1378.1	0.0	
6	S6	20.000	100.000	55.00	U	55.00	U	4	1378.1	0.0	
5	S5	20.000	80.000	55.00	U	55.00	U	4	1378.1	0.0	
4	S4	20.000	60.000	55.00	U	55.00	U	4	1378.1	0.0	
3	S3	20.000	40.000	55.00	U	55.00	U	4	1378.1	0.0	
2	S2	20.000	20.000	55.00	U	55.00	U	4	1378.1	0.0	
1	S1	20.000	0.000	55.00	U	55.00	U	4	1378.1	0.0	
											~
Add s	ection at top	Add section	n at bottom	Delete	section at	top	Delete se	ction			
Defaul	ts Import S	ection	Export Sec	tion		ОК	i i	То	wer View	_ Section \	lia

In this window the user inputs the total height, top and bottom widths of the tower, typical section height and clicks on the Section Generator button. This will create the general outline of the tower sections based on the selected typical section height. The user can model multiple slopes on the tower or straight sections for example on the top of the tower by locking top or bottom width of a selected section. From this screen, the user can add sections to the top or bottom of the tower, delete sections at the top of the tower or delete a selected number of sections.

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Note that the defaults of the sections generation can be edited from the Defaults button. The user can also switch from Tower View or zoom to Section View to see an enlarged view of the selected section.

The user can also utilize the import and export section functionality to save or retrieve a section from the user-defined database of standard sections.

eight	110 110	(#)		on Triangul		-	~~~	Generator
Section No.	ction Data Panel No.	Туре	Panel Da Secondary Bracing	Top Horiz Member	Membe Height (ft)	er Geome Plan Bracing	try Hip Bracing	Member Capacities
	1	×	(None)	No	10.00	No	No	1
	2	X	(None)	No	10.00	No	No	
			edefine section				1	<u>.</u>

On the next Tab "Panel Data" the user can define the number, type, height of panels for the selected section. From the section column, other sections can be selected for Panel definition. Also on the same window the user can modify selected panels, change heights for different panels, redefine section panels and or copy section panels to other section(s).

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	Sec	tion Data		Panel Data	<u> </u>	M	ember Go	eometry		Member C	apacities	
Sec. No.	Pan. No.	Туре	Description	Steel Grade	Conn. Type	No. of Bolts	Bolt Size (in)	Bolt Grade	End Dist. (in)	Edge Dist. (in)	Gusset Thick. (in)	1 IV
	1	Leg Diag	SR 4 L4x4x3/8	A36 A36	Tension Bolted	7	0.625 0.625	A325X A325X	n/a 0.938	n/a 0.938	n/a 0.394	

From the Member Geometry Screen, the user defines the member sizes, steel grades, connection type, number of bolts, bolt size, bolt grade, end distance, edge distance and gusset thickness. The following is a definition of the different fields:

Member Description: By double clicking the user can select another member from the same type of members (Angles, Tubes, Solid Rounds, etc.). By left clicking the Member Data form will open and allow the user to change the member type or size.

Steel Grade or Bolt Grade: By double clicking the user selects from a drop down list of available grades. The user can add or edit different grades from the Database Management Menu. By left clicking the yield and ultimate values of the selected grade are displayed. Note that for bolt grades, the threads included or excluded from the shear plane are available.

Connection Type: By double clicking the user can select connection type. For legs the user selects from tension, single shear or double shear. For other members the selections are either welded to bolted.

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Number of Bolts: the user selects or types in the number of bolts for the connection.

End distance: defined as distance from the center of bolt to the end of the member along the axis of the member (force).

Edge Distance: defined as the distance from the center of bolt to the edge of the member (normal to the line of force).

Gusset Thickness: the gusset thickness for connection of legs to other members. For leg angles, the thickness of the leg is assumed to be the gusset thickness but can be over written by the user.

Note that the click button at the bottom allows the user to select either identical or different members for each of the panels of the section.

ection Property
Critical Comp. Comp. apacity (Kips)
58.08 10.41
<b>•</b>

The Member Capacities tab displays the following data:

- Section number (from bottom to top)
  - Panel number (From bottom to top)

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.

:	Member Description Length of member KL/R slenderness ratio – can be	(m or ft) (program calculated overwritten by User	
•	User Def. kL/R	(No) means kL/R c program, (Yes) mea has overwritten the Users entry will be	ans that the User e kL/r and the
-	Compression Capacity Tension Capacity Bearing Capacity Block Shear Capacity Bolt Capacity Critical (Governing) Comp Critical (Governing) Tensi	(kN or Kips) (kN or Kips) (kN or Kips) (kN or Kips) (kN or Kips) pression Capacity	(kN or Kips) (kN or Kips)

## **GUY SYSTEM CONFIGURATION**

Select **Structure/Guyed Mast/Mast** from the main menu, this will show the Guy System Configuration Window.

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w. #       Elevation (ft)       Guy Size       Breaking Strength (Kips)       Efficiency Factor (%)       Radius (ft)       No. of Guys       Torsion Resistor       kL/r of Span         1       75.000       EH 7/16       20.80       100.00       240.000       3       (None)       40.08         2       135.000       EH 7/16       20.80       100.00       240.000       3       (None)       32.07         3       205.000       EH 1/2       26.90       100.00       240.000       3       (None)       37.41         4       275.000       EH 1/2       26.90       100.00       240.000       6       Truss Type       37.41         4       275.000       EH 1/2       26.90       100.00       240.000       6       Truss Type       37.41         4       275.000       EH 1/2       26.90       100.00       240.000       6       Truss Type       37.41         4       275.000       EH 1/2       26.90       100.00       240.000       6       Truss Type       37.41         5       F       F       F       F       F       F       F       F         6       F       F       F       F       F
2         135,000         EH 7/16         20.80         100.00         240.000         3         (None)         32.07           3         205,000         EH 1/2         26.90         100.00         240.000         3         (None)         37.41           4         275,000         EH 1/2         26.90         100.00         240.000         6         Truss Type         37.41
3         205.000         EH 1/2         26.90         100.00         240.000         3         (None)         37.41           4         275.000         EH 1/2         26.90         100.00         240.000         6         Truss Type         37.41
4 275.000 EH 1/2 26.90 100.00 240.000 6 Truss Type 37.41
dd Guy Level Sort Balance Initial Tension

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The following is a definition of the different fields:

Elevation: Distance from base of the tower to guy attachment at mast Guy Size: Selected from Database table

Breaking Strength: Read-only field – matching selected guy size with Breaking Strength from Database table

Efficiency Factor: By default 100%. Users should determine if lesser efficiency factor should be used depending on guy hardware

Radius: Distance from the center of the mast to guy attachment at anchor Number of Guys: Default (minimum) 3 for triangular towers and 4 for square towers at given guy level. For Torsion Resisting (Torque Arm) systems the number of guys is twice the default (6 for triangular and 8 for square towers). KL/R of Span: Span slenderness calculated by the program.

From the Guy System Configuration Screen, the user defines the guy level' elevation, guy size, guy efficiency factor, guy radius, number of guys and torsion resistor type (if applicable).

Clicking on "Add Guy Level" button creates a new guy level. The choice of elevations in form of "drop-down" box will appear in cell of "Elevation" column. Please, note that the program chooses the available elevations as nodes (panel points). You may, however, type desired elevation directly in the cell instead of selecting it from the drop-down box.

A guy level can be deleted by selecting (setting focus) at given row and by clicking on "Remove Guy Level" button.

Guy size and type can be determined by clicking in the cell of column "Guy Size". A drop-down box allowing selection of any guy from available Guys database appears. Breaking Strength (read only) appears in the column adjacent to Guy Size column.

Torsion Resistor type (applicable only when the number of guys is two times more than the number of tower legs – 6 guys for triangular tower and 8 guys for square tower) can be selected from drop-down box as "Truss Type" or "Beam Type". Please note that the selection of 6 guys for triangular and 8 guys for square towers with guys attached symmetrically to torque arms, even without selecting Torsion Resistor, will still be treated by the analysis as a torsion resisting system. The difference of choosing explicitly a torsion resistor will make the program to consider the Torsion Resistor members for loading (both wind load and their weights) and will show in the output the assessment of the Torsion Resistor members.

Please note that the values contained in the tab "Guy Levels, Sizes" of the form are general and some of them (such as Guy Sizes and Radiuses) may differ for each guy at a given level. More detailed definitions of the guys' parameters for a given level are maintained in tab "Guy Details" of the form.

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	Guy Lev	/els, Sizes	ĭ		Guy Detai	s	L	Torsion Re	esistors	
Lev. #	t Guy #	Guy Size	Guy Azimuth (Deg.)	Anchor Elevation (ft)	Anchor Radius (ft)	Attachment Radius (ft)	Attachment Azimuth (Deg.)	Initial Tension (Kips)	Initial Tension %	<b>^</b>
3	1	EH 1/2	0	0.000	240.000	2.646	0	2.69	10.00	
	2	EH 1/2	120	0.000	240.000	2.646	120	2.69	10.00	
	3	EH 1/2	240	0.000	240.000	2.646	240	2.69	10.00	
										~
	/									

The following is a definition of the different fields:

Guy Azimuth: Azimuth of guy anchor measured from tower's North (triangular towers have North going through the apex leg and for square towers the North line is perpendicular to the face).

Anchor Elevation: Vertical Distance of the anchor from the tower's base. Positive elevations above the base, negative below the base.

Attachment Radius: Distance from the center of the tower to the attachment of the guy at mast (for Torsion Resistors to the attachment of the guy to the arm). Attachment Azimuth: Angle between the tower's North and line going through the guy's attachment.

Initial Tension: By default 10% of the Breaking strength but may be overwritten by User.

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System Co	onfiguratio	n				R					
Guy I	Levels, Sizes		Ť		Guy Detai	ls	Ĩ	T	orsion A	esistors	
iuy Level		4	1	-							
Jpper Arm Att	ach. Elevatior	r F	280.00	(ft)							
ower Arm Att.	ach. Elevatior	n	270.00	(ft)			/				
Jpper Truss B	}racing	(N	lone)	18	-	<	_		2		>
ower Truss E	}racing	(N	lone)	1	-						
ertical Truss	Bracing	(N	lone)	18	-						
				2.0	_	Select V		Top Vie		Bottom Vi	
					L	Side				BOUUIII VI	
	Membe	r Geom	etry		L		Me	mber Cap	acities		
Туре	Description	Steel Grade	Conn. Type	No. of Bolts	Bolt Size (in)	Bolt Grade	End Dist. (in)	Edge Dist. (in)	Gusset Thick. (in)	Bolt Spacing (in)	
UpperArm	L4x4x3/8	A36	Bolted	2	0.625	A325X	0.938	2.000	0.394	1.875	
LowerArm	L4x4x3/8	A36	Bolted	2	0.625	A325X	0.938	2.000	0.394	1.875	
											~
L											
orsion Resist											ок

Torsion Resistor Geometry and members:

The following is a definition of the different fields:

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For Torsion Resistor Geometry and Bracing type (for Truss Type):

Upper Arm Attach. Elevation: Elevation of the attachment of the upper arm of the Torsion Resistor to the mast

Lower Arm Attach. Elevation: Elevation of the attachment of the lower arm of the Torsion Resistor to the mast

Upper Truss Bracing: Available choices are None, Single Braced, X-Braced Lower Truss Bracing: Available choices are None, Single Braced, X-Braced Vertical Truss Bracing: Available choices are None, Diagonal, Diagonal + Horizontal

Each of the above-mentioned bracings, if selected, will be shown in Selected View (Side, Top and Bottom Views) and the default bracing members will be added to the grid below (Member Geometry tab).

For Member Geometry:

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Member Size: the cell in column "Description" serves to select the member size and type from Steel Database tables. Double clicking on selected cell allows to re-select member from the same member type table (e.g. equal angles). Right hand clicking on the selected cell allows to choose any table of steel shapes and to select a member from such table.

Steel Grade or Bolt Grade: By double clicking the user selects from a drop down list of available grades. The user can add or edit different grades from the Database Management Menu. By left clicking the yield and ultimate values of the selected grade are displayed. Note that for bolt grades, the threads included or excluded from the shear plane are available.

Connection Type: By double clicking the user can select connection type. For arms the user selects from tension or bolted. For other members the selections are either welded to bolted.

Number of Bolts: the user selects or types in the number of bolts for the connection.

End distance: defined as distance from the center of bolt to the end of the member along the axis of the member (force).

Edge Distance: defined as the distance from the center of bolt to the edge of the member (normal to the line of force).

Gusset Thickness: the gusset thickness for connection of arms to other members. For leg angles, the thickness of the leg is assumed to be the gusset thickness but can be over written by the user.

Bolt Spacing: defined as the distance between the centers of adjacent bolts (normal to the line of force).

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5	uy System Config	uration									
	Guy Level:	s, Sizes	ľ	Gu	uy Detail:	s	ľ	To	rsion Re	sistors	
	Guy Level Upper Arm Attach.	2	4 _	(ft)							
	Lower Arm Attach.	Elevation	270.00	(ft)		/	/				
	Upper Truss Bracin	g [	None)	•		$\langle$			*	$\geq$	
	Lower Truss Bracin	9 <u>[</u>	None)	•							
	Vertical Truss Braci	Member Geom	None) etry	•	102	Select Vie Side V	iew C	Top View Der Capa		ottom Viev	~
	Member Type	Description	Length (ft)	kL/R	User Def. kL/R	Comp. Capacity (Kips)	Tens. Capacity (Kips)	Bearing Capacity (Kips)	Block Shear Capacity (Kips)	Bolt Capacity (Kips)	
	UpperArm	L4x4x3/8	9.580	145.52	No	30.51	90.25	36.31	42.64	30.36	1
	LowerArm	L4x4x3/8	9.580	145.52	No	30.51	90.25	36.31	42.64	30.36	
										>	~
	Torsion Resistor De	faults								0	к

The Member Capacities tab displays the following data:

- Member Type
- Member Description
- Length of member (m or ft)
   kL/R (calculated)
  - (calculated effective slenderness ratio)
- but User can directly overwrite this value User Def. kL/R (No) means kL/R calculated by program, (Yes) means that the User has overwritten the kL/r and the Users entry will be used for capacities Compression Capacity (kN or Kips) **Tension Capacity** (kN or Kips) **Bearing Capacity** (kN or Kips)
- Block Shear Capacity (kN or Kips)
- Bolt Capacity (kN or Kips)
- Critical (Governing) Compression Capacity (kN or Kips)
- Critical (Governing) Tension Capacity
   (kN or Kips)

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E	Torsion Resistor Defaults	k	
ſ	General M	1embers	
	Solid Round Single Diagonal Weldement	Cut at Ends	•
	Solid Round X-brcd Diagonal Weldement	One Continuous, one Broken, Welded	•
	Tubular Bracing connection	Through Single Wall	•
	Solid Rounds > 51 mm Stress Relieved		
L		1	
	OK 8	Save in File	Cancel

It is recommended that the User sets up Torsion Resistor Defaults before working with the details of the members.

The form above illustrates the General properties of the members.

The next tab, "Members", allows declaring default member types, steel grades, connections, number of bolts, bolt sizes and grades. Separate selections can be made for beam arm, truss arm and for truss bracing members.

When defaults are defined the User may choose to:

Save in File – that will keep the current selection until the next change and saving – Button "OK & Save in File", Save for the current tower only – Button "OK", Cancel – to ignore all selections – Button "Cancel".

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General	Members	
Beam Arm Description:	Truss Arm Description:	Truss Bracing Description:
C6x13	L4x4x3/8	L4x4x3/8
Steel Grade:	Steel Grade:	Steel Grade:
A36	A36	A36
Conn. Type:	Conn. Type:	Conn. Type:
Tension 💌	Bolted	Bolted
Bolts Num:	Bolts Num:	Bolts Num:
2	2	1
Bolts Size:	Bolts Size:	Bolts Size:
0.625 👻	0.625 👻	0.625 👻
Bolts Grade:	Bolts Grade:	Bolts Grade:
A325X	A325X	A325X

Balancing Initial Tension

The variations in anchor radiuses and elevations at particular guy level may cause significant lack of balance of the resultant horizontal force acting at this guy level. For newly designed towers and for proposed modifications, reinforcing and maintenance of existing towers it is recommended to bring the guy system to the balanced state, where the resultant horizontal is equal or close to zero.

Click on "Balance Initial Tension" button on the form "Guy System Configuration", tab "Guy Levels, Sizes".

Following screen "Balance Initial Tension" will show for each guy level the value of Horizontal Resultant Force.

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Guy Level	Elevation (ft)	# of Guys	Hor. Resultant Force (Kips)			
1	75.00	3	0.0251			
2	135.00	3	0.0330			
3	205.00	3	0.0421			
4	275.00	6	0.0724			
				L	¢	
				۵	¢	

In case the horizontal resultants are considered too large (need for balancing) please click on "Adjust unbalanced Level" button for a selected guy level.

Following screen appears. You may choose to execute the balancing with Initial Tension kept "as is" for selected guy, to execute the balancing without any preference or to cancel the balancing.

	Guy Level	Elevation (ft)	# of Guys	Hor. Resultant Force (Kips)			Guys at 135	5.00 (ft)	
Þ	1 2 3	75.00 135.00 205.00	3 3 3	0.0251 0.0330 0.0421		Guy #	Azimuth	Angle at Mast	Init. Tension (Kips)
	4	275.00	6	0.0724		1	0.00	58.579	2.080
						2	120.00	60.370	2.080
						3	240.00	60.370	2.080
E	syit Pr	rint	Adiu	st unbalanced Level	-		240.00 - Keep IT fo	0000000	

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Setting the Restraints of the mast at base

Click on "Restraints at Base" button
--------------------------------------

Structure Typical 9 Height	1.000		′ Bot. ₩ Cross-S		5.00 🔶 angular _	(in)	Total H			(ft) ints at Base	
Section	n Geometry	Panel G	eometry	Memb	er Geome	try Mi	ember Cap	pacities	Sec	tion Proper	ty
Sect. No.	Description	Height (ft)	Bot. Elev. (ft)	Bot. Width (in)	Locked Bot. Width	Top Width (in)	Locked Top Width	No. of Panels	Mass (lbs)	Database Mass (lbs)	
7	S7	20.000	120.000	55.00	U	55.00	U	4	1378.1	0.0	
6	S6	20.000	100.000	55.00	U	55.00	U	4	1378.1	0.0	
5	S5	20.000	80.000	55.00	U	55.00	U	4	1378.1	0.0	
4	S4	20.000	60.000	55.00	U	55.00	U	4	1378.1	0.0	
3	S3	20.000	40.000	55.00	U	55.00	U	4	1378.1	0.0	
2	S2	20.000	20.000	55.00	U	55.00	U	4	1378.1	0.0	
1	S1	20.000	0.000	55.00	U	55.00	U	4	1378.1	0.0	
Add s	ection at top	Add section	n at bottom	Delete	section at	top	Delete se	ction			

And select the restraints conditions:

Aast Restraints at Base	- De
Deflection in North - South direction	Restrained
Deflection in East - West direction	Restrained
Downward Deflection	🔽 Restrained
Rotation in North - South direction	🔲 No Restraint
Rotation in East - West direction	🔲 No Restraint
Twist	Restrained

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#### ANTENNAS DEFINITION

From the main menu choose **Appurtenance** and then select **Antennas**, the following window is displayed.

	nas				7			1		
	Anter	nnas	Po	int Load	s	TxLine	es	Lac	ders	
inte iec.	nna No. Diam. =	<u>1</u> 5.00 ft	7		フ ご				New Selec Copy	;t
Ante No.	enna Da	ta Antenna Type	No.	Ant.	Radius	Mount Type	Mount	TxLine Type	Delet	e
	(ft)		of Ant.	Az. (deg.)	(ft)		Az. (deg.)		of TxL	
1					5.00					

In this window the tower elevation is shown along with the plan cross-section at the marked antenna. To add a new antenna select **New** and a blank line with an antenna type (none) is shown. The user inputs the following data as defined below:

- *Elevation:* Elevation of the center of the antenna marked from the bottom of the tower and shown in meters or ft.
- *Antenna Type:* Type of antenna and can be chosen from the antennas database available. To choose an antenna click on this field and an antenna type window will be displayed and the required type and size is specified.

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- Antenna Azimuth: Antenna beam azimuth measured from the North. The tower azimuth from north is specified at the bottom of the tower (specified in degrees).
- *Radius:* Radius is measured from the tower center to the mounting point of the antenna (m or ft.). Also, note that the tower radius at that elevation is shown for guidance on the section drawing.
- *Mount Type:* Type of antenna mount and can be chosen from the database available. To choose a mount click on this field to select from the database.
- *Mounting Azimuth:* angle between the tower's north and the antenna radius measured in the clockwise direction.
- *Tx-Line Type:* Type of transmission lines and quantity associated with that antenna and can be chosen from a database available.

#### Antenna Type:

Click on type in the antenna table and the following window is displayed and from which the antenna type and size is specified.

A	ntenna Type		
	м	icrowave	Other
	Dish Type Dish Size	Shielded	Frequency (GHz)
	Radome © Yes C No		Allowable signal loss
		ОК	Cancel

For microwave dishes available in the database the following dish types and sizes are available:

(2, 4, 6, 8, 10, 12, 15 ft.)
(4, 6, 8, 10, 12 ft with or without radome)
(2, 4, 6, 8, 10, 12 ft. – with or without radome)
(4, 6, 8, 10, 12, 15 ft.)
(4, 6, 8, 10, 12, 13 ft.)

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Also, for microwave antennas the allowable Tilt/Twist is calculated by the program as a function of frequency, dish diameter and allowable signal degradation (3 db or 10 db) based on the following formula:

a) For a parabolic reflector with an allowable 10dB signal degradation:

$$\theta = \frac{C_{10}}{D \alpha}$$

b) For a parabolic reflector with an allowable 3dB signal degradation:

$$\theta = \frac{C_3}{D \alpha}$$

where:

 $\theta$  = twist or sway limit, degrees  $C_{10}$  = 53.1 GHz.ft.deg [16.2 GHz.m.deg]  $C_3$  = 31.0 GHz.ft.deg [9.45 GHz.m.deg] D = Diameter of dish, ft [m]  $\alpha$  = Dish Frequency, GHz.

For "Other" (Non-Dish Antennas) a variety of Antennas, organized by manufacturers is available from the database. Following screen is displayed when the Tab "Other" is clicked.

19 records           Catalogue Name         Description         Height (ft)         Width (ft)         Depth (ft)         Fr. <sup>-</sup> AP199014         DIRECTIONAL PANEL         4.265         0.164         0.650           AP199015         DIRECTIONAL PANEL         5.000         0.164         0.650           AP199016         DIRECTIONAL PANEL         6.070         0.164         0.650           AP906510         CELLite DIRECT.PANL         1.969         0.869         0.427           AP906513         CELLite DIRECT.PANL         3.238         0.869         0.427	Mic	rowave		OI WAVE	her	-
Name         Description         (ft)         (ft)         Depth (ft)         Presented (ft)           AP199014         DIRECTIONAL PANEL         4.265         0.164         0.650           AP199015         DIRECTIONAL PANEL         5.000         0.164         0.650           AP199016         DIRECTIONAL PANEL         6.070         0.164         0.650           AP906510         CELLIKE DIRECT.PANL         1.969         0.869         0.427		19 reco	ords			
AP199015         DIRECTIONAL PANEL         5.000         0.164         0.650           AP199016         DIRECTIONAL PANEL         6.070         0.164         0.650           AP906510         CELLike DIRECT.PANL         1.969         0.869         0.427		Description			Depth (ft)	Fr
AP199016 DIRECTIONAL PANEL 6.070 0.164 0.650 AP906510 CELLite DIRECT.PANL 1.969 0.869 0.427	AP199014	DIRECTIONAL PANEL	4.265	0.164	0.650	
AP906510 CELLIke DIRECT.PANL 1.969 0.869 0.427	AP199015	DIRECTIONAL PANEL	5.000	0.164	0.650	
	AP199016	DIRECTIONAL PANEL	6.070	0.164	0.650	
AP906513 CELLIite DIRECT.PANL 3.238 0.869 0.427	AP906510	CELLIIte DIRECT.PANL	1.969	0.869	0.427	
	AP906513	CELLIIte DIRECT.PANL	3.238	0.869	0.427	•
	•					•

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The data shown includes all parameters of these antennas necessary for the program to calculate wind loads and weight effects.

The User may add any type of Non-Dish Antenna to the database –using the "Database Management" option from the main menu. Refer to Database Management Chapter for details.

After specifying an antenna, the user may wish to copy it by highlighting the specific line and click on **select** and then on **Copy**. A new line of antenna will be displayed and the user may edit that line. A similar procedure is used to delete an antenna.

Loads are calculated for microwave dishes as per Andrew's catalogue number 36. Also load calculations for wind loads under different directions are based on EIA-222-F tables.

Also, from this window the user can define the TX-lines type and number that are used for this antenna.

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#### POINT LOADS DEFINITION

From the main menu choose **Appurtenance** and then select **Point Loads**, the following window is displayed.

	Antennas		Poi	nt Loads		T	xLines		Ladders
'oint L 'oint L ec. D	<u>.oad View</u> .oad No. 1 !iam. = 5.00	(ft) - ∠			/	а. С			New Select Copy
Point	Load Data-					k	1		Delete
No.	Desc.	Elev. (ft)	Azi. (deg.)	Radius (ft)	Wind Area (bare)	Wind Area (iced)	Weight (bare) (Kips)	Weight (iced) (Kips)	Comments
No.	Desc. PLd 1				Area	Area	(bare)	(iced)	

In this window the pole elevation is shown along with the plan cross-section at the point load elevation. To add a new point load select **New** and input line with zero values is shown. The user inputs the following data as defined below:

**Description:** Text description of the point load. This description will be displayed on the design profile. If the default description is not over written no description is displayed on the profile.

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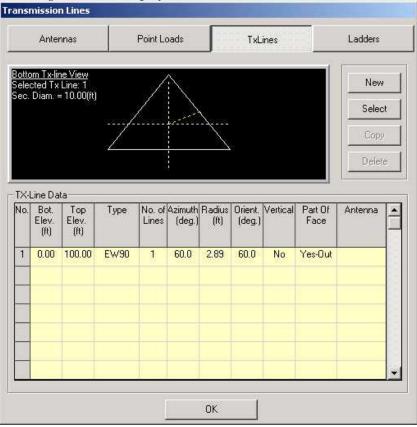
- *Elevation:* Elevation from the bottom of the tower to the center of the applied load (m or ft.)
- *Azimuth:* angle between the north and the point load radius measured in the clockwise direction (specified in degrees).
- **Radius:** Radius is measured from the tower center to the point load (m or ft.). Also, note that the tower radius at that elevation is shown for guidance on the section drawing.
- *Wind Area (Bare):* Bare wind area of the load (antenna) multiplied by the appropriate force coefficient or drag factor depending on the shape of the appurtenance (m<sup>2</sup> or ft<sup>2</sup>).
- *Wind Area (Iced):* Iced wind area of the load (antenna) multiplied by the appropriate force coefficient or drag factor depending on the shape of the appurtenance and the ice accretion (m<sup>2</sup> or ft<sup>2</sup>).
- *Weight (Bare):* Bare weight of the load (kN or kips)
  - *Weight (Iced):* weight of the load including ice (kN or kips)
- *Comments:* A comments field that does not get displayed on the profile.

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#### INPUT

#### TRANSMISSION LINES DEFINITION

From the main menu choose **Appurtenance** and then select **Tx-lines**, the following window is displayed.



In this window the tower elevation is shown along with the tower cross-section at the bottom of the Tx-line. To add a new line or group of lines select **New** and a blank line with a line type (none) is shown. The user inputs the following data as defined below:

- **Bottom Elevation:** Elevation of the bottom of the lines (m or ft.)
- *Top Elevation:* Elevation of the top of the lines (m or ft.), please note that the length of TX line located above the tower top will be ignored by the program for loading.

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- *Type:* Type of lines and can be chosen from the tx-lines database available. To choose line type click on this field and the required type and size can be specified as explained in the sequel.
- *No of lines.*: Number of lines having the same properties shown on that line
- *Azimuth:* Group of lines azimuth (specified in degrees).
- *Radius:* Radius is measured from the pole center to the center of the lines group (m or ft.).
- **Orient.:** angle between the pole's north and the lines group radius measured in the clockwise direction.
- *No of Shielded Lines:* For shielded lines (e.g. inside the pole) only gravity loads are considered.

#### Transmission Line Type:

Click on type in the tx-lines table and the following window is displayed and from which the tx-lines type and size is specified.

Transmissio	on Line Type
Туре	Foam-Dielectric
Description	LDF5P-50A
Size	0.875 (in)
	OK Cancel

The following Transmission Line types are available:

Air-Dielectric Foam-Dielectric Elliptical Waveguide Circular Waveguide Rectangular Waveguide

Different sizes can be chosen from the description field and the actual size for the chosen lines is displayed in the size field (mm or in.).

Data for transmission lines mechanical properties are based on Andrew's catalogue number 36.

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#### LADDER DEFINITION

From the main menu choose **Appurtenance** and then select **Ladders**, the following window is displayed.

_	Anten	nds		Point	Loads		TxLi	nes	Ladders
adde	m Ladde er No. 1 Diam. =	<u>er View</u> 10.00(ft)			$\wedge$				New
				/	$\square$	·			Select
				/	+	- Ar			Copy Delete
ado ło.	ler Data Bot. Elev. (ft)	Top Elev. (ft)	Width (in)	Dist. (in)	Azimuth (deg.)	Radius (ft)	Orient. (deg.)	Rung Type	Rail Type
							Mar		
1	0.00	100.00	17,7	11.8	120.0	6.50	120.0	SR 0.75	SR 1.0
1	0.00	100.00	17.7	11.8	120.0	6.50	120.0	SR 0.75	SR 1.0

In this window the pole elevation is shown along with the plan cross-section at the bottom of the ladder. To add a new ladder select **New** and a blank line with a rail type, and rung type (none) is shown. The user inputs the following data as defined below:

- **Bottom Elevation:** Elevation of the bottom of the ladder (m or ft.)
- **Top Elevation:** Elevation of the top of the ladder (m or ft.), please note that the length of ladder, located above the tower top, will be ignored by the program for loading
- *Width:* Width of ladder rungs (mm or in.)
- Distance (spacing) between rungs (mm or in.)
- *Azimuth:* ladder azimuth (specified in degrees).

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- *Radius:* Radius is measured from the pole center to the center of the ladder (m or ft.).
- **Orient.:** angle between north and the ladder's center measured in the clockwise direction.
- *Rung Type:* Rung size chosen from available steel sections database for angles and solid rounds.
- *Rail Type:* Rail size chosen from available steel sections database for angles and solid rounds.

#### Steel Section Type:

Click on rail type or rung type in the ladder data table and the following window is displayed, from which the steel section type and size is specified.

Steel Section	Туре	
Туре	Solid Round	
Description	SR 0.625	•
	эк	Cancel

The following steel sections for ladders are available:

Solid Round (SR13, SR16, SR19, SR25, SR50) (SR.5, SR.625, SR.75, SR1.0, SR2.0)

Angle (L51x51x6, L51x51x13) (2x2x1/4, l2x2x1/2)

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## **Chapter 3 ANALYSIS**

This Chapter explains the input of the code-related data and material data. Also, the assumptions and the underlying theory of the analysis are explained in the sequel.

## CODE DATA

#### Wind Loads

From the main menu choose **Load Cases**, and then he following window will appear depending on the design standard specified:

## a) TIA/EIA 222-F

Having the EIA 222-F as the design code, the wind Loads window will be as shown:

TIA/EIA-222-F-1996 Code	e Data				
Wind Speed	80.00	(mph)			
Service Wind Speed	50.00	(mph)			
Ice Thickness	0.50	(inch)			
Ice Density	56.00	(pcf)			
Start wind direction	0.00	(degrees)			
End wind direction	330.00	(degrees)			
Increment wind direction	30.00	(degrees)			
Elev. above ground	0.00	(ft)			
Wind pressure reduction for ic	ed conditions:	0.75 💌			
Temp. Reduction with Ice	50.0	(Fahrenheit)			
✓ Increase allowable stress	es				
✓ Strength - Wind only	Service - Wind only				
🔽 Strength - Wind and Ice	Service - Wind and Ice				
	ок	US Counties			

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The input data is explained as follows:

- Wind Speed: Design wind speed for the structure (m/sec or mph).
- Service Wind Speed: for the calculation of deflections (tilt/twist) under service load conditions (m/sec or mph).
- Ice Thickness: specified ice thickness for the design of the structure depending on the location (mm or inches).
- Start Wind Direction: Starting wind directions from which the wind loads are considered.
- End wind directions: Last wind direction for which the wind loads are considered
- Increment Wind direction: Wind increment in degrees at which wind loads are calculated. For example, in the above shown example wind will be considered at the following directions (0, 30, 60, 330)
- Elevation above ground: The elevation of the structure base above ground this is used for wind loads calculations. The height factor is increased accordingly.
- Allowable stress factor: For the structural assessment of the tower, the allowable stress is increased to 1.33 as per EIA 222-F when applicable. However, the user has the option to limit the allowable stress to 1.0
- Wind pressure reduction for the case of iced conditions (default is 0.75 as per code).
- Options to mark the analysis loading cases for wind only or for combined case of wind and ice under strength conditions and service conditions.

#### b) ANSI/TIA-222-G-2005

Having the TIA-222-G as the design code, the Wind Loads window will be displayed as shown:

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ANSI/TIA-222-G Code Data				
Wind Speed (V) Wind Speed with Ice (Vi) Serviceability Wind Speed Ice Thickness (ti)	1100.00 40.00 60.00 0.50	<ul> <li>(mph)</li> <li>(mph)</li> <li>(mph)</li> <li>(mph)</li> <li>(inch)</li> </ul>	Ice Density	56.00 (pcf)
Start wind direction End wind direction Increment wind direction Elev. above ground Structure Class Exposure Category Topographic Category	0.00 330.00 30.00 0.00 2 C 1	<ul> <li>♦ (degrees)</li> <li>♦ (degrees)</li> <li>♦ (degrees)</li> <li>♦ (ft)</li> <li>♦</li> </ul>	Gust Effe	ct Factor (Gh) 0.85
Temperature Reduction with Ice Survival Wind (as per Annex A - A Min. Bracing Resistance: Pr=1.5% Mast Shear & Torsion: 40% min. ne Strength - Wind only Strength - Wind and Ice Pattern Loading	.2.3.2) Fs (15.6.b.) eed not apply ( Service - Wir Service - Wir	nd only nd and Ice		
ОК				US Counties

The input data is explained as follows:

- Basic Wind Speed (V): 3-second gust speed for the structure (m/sec or mph).
- Wind Speed with Ice (Vi): 3-second gust speed concurrent with the design ice at 33 ft above the ground (m/sec or mph).
- Serviceability Wind Speed: for the calculation of deflections (tilt/twist) under service load conditions (m/sec or mph).
- Ice Thickness (ti): specified ice thickness for the design of the structure depending on the location (mm or inches).

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- Start Wind Direction: Starting wind directions from which the wind loads are considered.
- End wind directions: Last wind direction for which the wind loads are considered
- Increment Wind direction: Wind increment in degrees at which wind loads are calculated. For example, in the above shown example wind will be considered at the following directions (0, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300 and 330)
- Elevation above ground: The elevation of the structure base above ground this is used for wind loads calculations. The height factor is increased accordingly.
- Structure Class as defined in Table 2-1 of ANSI/TIA-222-G.
   Values are 1 through 3 with class 2 as default.
- Exposure Category as defined in clause 2.6.5.1 of ANSI/TIA-222 G. Options are Exposure B, C or D with Exposure B as default.
- Topographic Category as defined in clause 2.6.6.2 of ANSI/TIA 222-G ranging from Category 1 through 5 with Category 1 as default.

Please note that in addition to wind, wind and ice, and serviceability loading cases the program may optionally run the pattern loading as defined in Figure 3-3. The Earthquake Loading case may be analyzed as well with usage of Seismic Analysis Procedure Method 1 as defined by ANSI/TIA-222-G.

### c) CSA S37-94

Having the CSA S37-94 as the design code, the wind Loads window will be displayed as shown:

Wind Pressure	600.00	(Pa)	aļ
Ice Thickness	25.00	(mm	m) Ice Density 900.00 (kg/m^3)
Importance Facto	м <b>1.00</b>		
Serviceability Fac	otor 1.00		
Start wind direction	on 0.00	(deg	grees)
End wind directio	n 330.00	(deg	grees)
Increment wind d	lirection 30.00	(deg	grees) Hydro-Quebec Coefficients? Hydro-Quebec Ce and Cg
Elev. above grou	ind 0.00	(m)	values
Temp. Reduction	with Ice 10.0	(Celsius	191
	1		••)
🔽 Strength - V	1		
-	Wind only	Serviceab	bility - Wind only
-	Wind only	Serviceab	bility - Wind only
-	Wind only	Serviceab	bility - Wind only
Strength -	round 0.00 (m) values tion with Ice 10.0 (Celsius) h · Wind only  ✓ Serviceability · Wind only h · Wind and Ice  ✓ Serviceability · Wind and Ice	- bility - Wind only bility - Wind and Ice	
Site	Wind only	Serviceab     Serviceab     deficients     O - z	s bility - Wind only bility - Wind and Ice s → z
Site	Wind only Wind and Ice – Site Specific Wir	Serviceab     Serviceab     Serviceab     Ocefficients     Oce     0.0000	s s s s s s s s s s s s s s
Site	Wind only Wind and Ice Site Specific Wir Coefficient a1:	✓ Serviceab ✓ Serviceab ✓ Oreflicients 0 · z 0.0000 0.00000	s S 0.00000
Site	Wind only Wind and Ice Site Specific Win Coefficient a1: Coefficient a2:	✓ Serviceab ✓ Serviceab ✓ O-z 0.0000 0.0000 0.0000 0.0000	s s v - Wind only bility - Wind and Ice s v - Z 0.0000 0.00000 0.0000
Site	Wind only Wind and Ice Site Specific Win Coefficient a1: Coefficient a2: Coefficient a3:	✓ Serviceab ✓ Serviceab ✓ O-z 0.0000 0.0000 0.0000 0.0000 0.0000	bility - Wind only bility - Wind and Ice S S 0.0000 0.0000 0.000 0.000
Site Specific	Wind only Wind and Ice Site Specific Win Coefficient a1: Coefficient a2: Coefficient a3: Coefficient Zh:	✓ Serviceab ✓ Serviceab ✓ O-z 0.0000 0.0000 0.0000 0.0000	s s v - Wind only bility - Wind and Ice s v - Z 0.0000 0.00000 0.0000

The data for which is explained as follows:

- Wind Pressure: Reference wind pressure (q) as per CSA S37-94
- Ice thickness: Radial ice thickness for the design
- Importance factor: Importance factor as per S37-94
- Serviceability factor: Serviceability factor for service load conditions as per S37-94
- Start Wind Direction: Starting wind directions from which the wind loads are considered.
- End wind directions: Last wind direction for which the wind loads are considered
- Increment Wind direction: Wind increment in degrees at which wind loads are calculated. For example, in the above shown window, wind will be considered only from 0 degrees.

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- Elevation above ground: The elevation of the structure base above ground. This is used for wind loads calculations.
- Options to mark the analysis loading cases for wind only or for combined case of wind and ice under strength conditions and service conditions.
- Option to use site specific wind data

# d) CSA S37-01

Having the CSA S37-01 as the design code, the wind Loads window will be displayed as shown:

CSA-S37 Code	Data				
Wind Pressure	600.00	(Pa)			
Ice Thickness	25.00	(mm	) loe	Density 900.00	(kg/m^3)
Importance Facto	or 1.00	-			
Serviceability Fac	tor 1.00	-			
Start wind direction	on 0.00	(deg	prees)		
End wind directio	n 330.00	(deg	prees)		
Increment wind d	irection 30.00	(deg	prees)	Hydro-Quebec Co Hydro-Quebec Co	
Elev. above grou	nd 0.00	(m)		values	
Temp. Reduction	with Ice 10.0	(Celsius	:)		
✓ Strength · <sup>1</sup> ✓ Strength · <sup>1</sup>	Wind only Wind and Ice	✓ Serviceab ✓ Serviceab			
	– Site Specific Wi	nd Coefficients			
Site Specific 🔽	Coefficient a1:	0 · z	0.0000		
Wind	Coefficient a2:	0.00000	0.0000	0	
	Coefficient a3:	0.000	0.000		
	Coefficient Zh:	0.000	0.000	_	
	Coefficient Z01:	0.000	0.000		
	Coefficient V01:	0.000	0.000		
OK	Height (z) for 2nd	d curve: (m)	0.00		

The design parameters are as explained under S37-94.

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# ANALYSIS THEORY

The analysis is based on an elastic three-dimensional beam-column where the mast is modeled as equivalent three-dimensional beam-column members supported by cables represented as cable elements. Wind load calculations and analysis are based on the following assumptions:

# Wind Loads Calculations

- 1. Wind is assumed horizontal and is blowing from a certain direction throughout the whole mast height.
- 2. Force coefficients (drag factors) are calculated as per applicable code.

3	Tx-lines declared as part of the face are considered in the force coefficient calculations of the structure. Tx-Lines as part of the face and outside shield the structural members and vice versa for lines inside the tower (that is not applied for ANSI/TIA-222-G standard).	<b>.</b>	Formatted: Bullets and Numbering
4	<u>.</u> Ice built up is considered uniform on the structure and appurtenances except for ANSI/TIA-222-G standard where the ice effect is changing in function of the height.	<b>.</b>	Formatted: Bullets and Numbering
5	. Wind loads considered on iced structures are reduced as per applicable code.	<b>4</b>	Formatted: Bullets and Numbering
<u>6</u>	For wind load calculations, wind load is calculated for each section.	<b>*</b>	Formatted: Bullets and Numbering
Z	<u>Loads</u> that are offset from the tower center are applied at the tower center with the corresponding moments (torsional and bending).	<b>4</b>	Formatted: Bullets and Numbering
8	<u>.</u> Loads that extend beyond the height of the structure are applied at the top of the structure with the corresponding additional moments (torsional and bending).	<b>.</b>	Formatted: Bullets and Numbering
A	nalysis and Capacities		
1	Each member is modeled as two-nodded three-dimensional truss elements with three degrees of freedom at each node.	<b>.</b>	Formatted: Bullets and Numbering
2	Element properties are assumed constant for the full length of the member.	<b>.</b>	Formatted: Bullets and Numbering

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- 3. Uniform loads applied to the tower are distributed to each level of the section at the three or four leg points.
- <u>4.</u> Capacities are calculated based on applicable codes and the structure is assessed for each member.

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### **Calculation Parameters**

From the main menu, choose "setup" and select "Calculation Parameters". In this menu, the user may change the equivalent wind area calculations for nondish antennas and setup the shielding factor Ka for linear appurtenances (for CSA-S37 and for EIA-222-F standards).

-	a for Non-Dish Antennas
C Eq. Area = Fron Late	tal Area x Cos( Angle of Attack) + ral Area x Sin( Angle of Attack)
Eq. Area = Front     Late	tal Area x Cos^2( Angle of Attack) + ral Area x Sin^2( Angle of Attack)
🔿 Eq. Area = Maxi	mum Area( Frontal or Lateral )
Shielding Factor (Ka)	for linear appurtenances
💽 Ka = 1.0	
C Ka calculated a:	s per ANSI/TIA-222-G cl. 2.6.9.2
Minimum Embedment	Depth for Tubular Structures
Min. Embedmen	t Depth = 3 x Bottom Diameter
C Min. Embedmen 1612.3.3 for "El.	t Depth as per 1997 UBC Sect. A''Normal Soil

For non-dish antennas, the user can select the calculation method for the equivalent wind area of non-symmetric antennas.



# **Material Data**

Clicking on **Setup** from the main menu the material data can be defined. The user inputs the material density (lbs/ft<sup>3</sup> or kg/m<sup>3</sup>), Young's modulus (ksi or MPa) and Poisson's ratio.

Poisson Ratio	0.00 (ksi) 1.30	
Weight Increment		
weight Increment	00	
· • • • • • • •	.00	
ne dead weight of structural mer ccount for the additional hardw ashers etc.). The increment is reight load factors (if applicable)	are (bolts, nuts, in addition to d	

### **Guy Rupture Analysis**

Please note, that for ANSI/TIA-222-G standard the program can perform the guy rupture analysis as per Annex E of the standard.

When this option is selected from the Run menu the program shows following form:

Guy	Elevation(ft)	Guy Size	Guy Azimuth (deg)
1	75.00	EH 7/16	0
1	75.00	EH 7/16	120
1	75.00	EH 7/16	240
2	135.00	EH 7/16	0
2	135.00	EH 7/16	120
2	135.00	EH 7/16	240
3	205.00	EH 1/2	0
3	205.00	EH 1/2	120
3	205.00	EH 1/2	240
4	275.00	EH 1/2	0
4	275.00	EH 1/2	0
4	275.00	EH 1/2	120
4	275.00	EH 1/2	120
4	275.00	EH 1/2	240
4	275.00	EH 1/2	240

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The User may select any guy elevation and any guy number at this elevation to perform this analysis.

### **Analytical Engine**

In addition to using the TSTower finite element analytical engine the users may select two additional programs (the User shall have the license to use these programs in order to utilize these options):

- GUYMAST by Weisman Consultants Inc.
- Robot Millenium by RoboBat

In order to run the analysis with one of these engines the User should change the analytical engine from Menu Setup/ Default Standard, Units & Analysis Engine as shown in the screen shot below:

Select Default Standard:	American ANSI/TIA-222-G-2005	•
Units		
C Metric	US Customary	
Default Analysis Engine —		
Monopoles	TSTower	
Lattice - Self Support	TSTower	
Lattice - Guyed Mast	Robot	Robot Options
Set STAAD Paths Path to executable: Path to Input/Output Folder:		<u>.</u>
Path to executable:		
Path to executable:	AN	<u>.</u>
Path to executable: Path to Input/Output Folder: Set GUYMAST Paths Path to executable: C:\WEISM	AN C:\WEISMAN.DAT	<u>.</u>
Path to executable: Path to Input/Output Folder: Set GUYMAST Paths Path to executable: C:\WEISM	C.WEISMAN.DAT	(
Path to executable: Path to Input/Dutput Folder: Set GUYMAST Paths Path to executable: C:\WEISM Path to Input/Dutput Folder: 0	C.WEISMAN.DAT	

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# **Chapter 4 RESULTS**

In this Chapter the printed and viewable output options for the program are explained. After the input data phase is completed, the user chooses **Run** from the main menu. The program performs the wind load calculations and executes the structural analysis. From the main menu the user may choose **Results** and the user chooses one from the following menu options:

- Preliminary Results
- Final Results
- Print
- .DXF Profile

# **Preliminary Results**

Choosing Preliminary results the following screen is displayed which allows the user to see the different calculated wind pressure and effective projected areas for each of the different load combinations and wind directions.

### Wind Pressure

and Pressu	re <u> </u>	Wind Area	<u>ү</u> Арр.	UDL Y	App. Conc.	<u>. Loads Y Se</u>	ection We
Section	Panel	Bot. Elev. (ft)	Top Elev. (ft)	Kz	Kzt	QzGh (psf)	Ice Thio (tiz) (ir
15	4	295.00	300.00	1.59	1.00	38.13	0.000
	3	290.00	295.00	1.59	1.00	37.99	0.000
	2	285.00	290.00	1.58	1.00	37.85	0.000
	1	280.00	285.00	1.57	1.00	37.71	0.000
14	4	275.00	280.00	1.57	1.00	37.57	0.000
	3	270.00	275.00	1.56	1.00	37.43	0.000
	2	265.00	270.00	1.56	1.00	37.28	0.000
	1	260.00	265.00	1.55	1.00	37.14	0.00
13	4	255.00	260.00	1.54	1.00	36.99	0.00
	3	250.00	255.00	1.54	1.00	36.83	0.00
	2	245.00	250.00	1.53	1.00	36.68	0.00
	1	240.00	245.00	1.53	1.00	36.52	0.00
12	4	235.00	240.00	1.52	1.00	36,36	0.00
	3	230.00	235.00	1.51	1.00	36.20	0.00
	2	225.00	230.00	1.50	1.00	36.03	0.00
	-	00.000	225.00	1 50	1.00	70.30	0.00

This screen shows bottom and top elevation of each section the applied wind pressure and the relevant height factors and ice thickness for each of the load combination and wind directions.

YY 11	nd Pressi	lie	Wind	Area	LA	pp. UDL	<u> </u>	App. L	Conc. Loa	ds I	Section	Weid
Sec.	Panel	Flat Area (ft^2)	App. Flat Area (ft^2)	Round Area (ft^2)	App. Round Area (ft^2)	Area Ice (ft^2)	Solid. Ratio	Flat Drag	Round Drag	Flat Dir	Round Dir	Eff Are (ft^;
15	4	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	3	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	2	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	1	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
14	4	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	3	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	2	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	1	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
13	4	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	3	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	2	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	1	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
12	4	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	3	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
ļ.	2	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7
	1	5.96	0.00	0.00	0.00	0.00	0.24	2.46	0.00	0.80	1.00	11.7

This screen shows flat and round areas of the structure and that of the appurtenances included as part of the structure in the calculations. Solidity ratios are also show for each panel and the calculated force coefficients (drag coefficients) for both flat and round members. Also the directionality factors and the total effective wind areas are shown for each of the load combinations and wind directions.

Wind	Pressure	i T Wi	nd Area Y	App. UDL	Y App. Conc. Loads Y Section Weights				
Sec.	Panel	Flat Area (ft^2)	Round Area (ft^2)	Flat Drag	Round Drag	Ka	Eff. Area (EF (ft^2)		
15	4	1.70	0.74	1.50	1.20	0.60	2.06		
	3	1.70	0.74	1.50	1.20	0.60	2.06		
	2	1.70	0.74	1.50	1.20	0.60	2.06		
	1	1.70	0.74	1.50	1.20	0.60	2.06		
14	4	1.70	0.74	1.50	1.20	0.60	2.06		
	3	1.70	0.74	1.50	1.20	0.60	2.06		
	2	1.70	0.74	1.50	1.20	0.60	2.06		
	1	1.70	0.74	1.50	1.20	0.60	2.06		
13	4	1.70	0.74	1.50	1.20	0.60	2.06		
	3	1.70	0.74	1.50	1.20	0.60	2.06		
	2	1.70	0.74	1.50	1.20	0.60	2.06		
	1	1.70	0.74	1.50	1.20	0.60	2.06		
12	4	1.70	0.74	1.50	1.20	0.60	2.06		
	3	1.70	0.74	1.50	1.20	0.60	2.06		
	2	1.70	0.74	1.50	1.20	0.60	2.06		
	1	1.70	0.74	1.50	1.20	0.60	2.06		

# Appurtenances Uniformly Distributed Loads (UDL)

The appurtenances uniformly distributed loads not included as part of the face are shown on this screen. The window shows the calculated flat and round areas as well as the corresponding force coefficients (drag factors) for each of the load combinations and wind directions.

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## Appurtenances Concentrated Loads (UDL)

Ant	Desc.	Qty	Nount Desc	Elev. (ft)	CaAc X-Dir E-W (ft^2)	CaAc Y-Dir N-S (ft^2)		p. Cone YForce N-S (Kips)	ZForce	M-x	M-y (Kipsft)	M-z
1	TA-803-60	1		300.00	0.00	-6.75	0.00	-0.26	-0.04	-0.10	0.00	0.0
2	TA-803-60	1		300.00	0.00	-4.80	0.00	-0.18	-0.04	0.05	0.09	-0.4
3	TA-803-60	1		300.00	0.00	-4.80	0.00	-0.18	-0.04	0.05	-0.09	0.4
4	HP6	1		290.00	0.00	-40.35	0.00	-1.53	-0.28	-0.83	0.00	0.0
5	SRL-480	1		305.00	0.00	-2.87	0.00	-0.11	-0.03	-0.08	0.00	0.0
1	Pnt. Load			0.00	0.00	-45.00	0.00	-0.92	-1.25	0.00	0.00	0.0
2	Pnt. Load			298.00	0.00	-40.00	0.00	-1.53	0.00	0.00	0.00	0.0
4	Torsion			275.00	0.00	-32.45	0.00	-1.22	-1.12	0.00	0.00	0.00

The appurtenances calculated concentrated loads are shown on this screen. The window shows the calculated flat and round areas in the direction of each axis and the corresponding forces and moments in the three axes. This value can be selected for each of the load combinations and wind directions.

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# **Section Weights**

			App. UDL Y App. Conc. Loads Y Section W						
Sec.	Legs (lbs)	Bracing (Ibs)	Sec. Bracing (lbs)	Int. Bracing (Ibs)	Total Section (Ib				
1	583.8	794.3	0.0	0.0	1378.1				
2	583.8	794.3	0.0	0.0	1378.1				
3	583.8	794.3	0.0	0.0	1378.1				
4	583.8	794.3	0.0	0.0	1378.1				
5	583.8	794.3	0.0	0.0	1378.1				
6	583.8	794.3	0.0	0.0	1378.1				
7	583.8	794.3	0.0	0.0	1378.1				
8	583.8	794.3	0.0	0.0	1378.1				
9	583.8	794.3	0.0	0.0	1378.1				
10	583.8	794.3	0.0	0.0	1378.1				
11	583.8	794.3	0.0	0.0	1378.1				
12	583.8	794.3	0.0	0.0	1378.1				
13	583.8	794.3	0.0	0.0	1378.1				
14	583.8	794.3	0.0	0.0	1378.1				
15	583.8	794.3	0.0	0.0	1378.1				
Total:	8757.0	11915.2	0.0	0.0	20672.2				

The section weights with divisions for Legs, Bracing, Secondary Bracing, Internal Bracing and Totals are shown in this grid.

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# **Final Results**

Choosing final results the following screen is displayed which allows the user to view the results of the analysis for either the maximum envelope or any of the different load combinations and wind directions.

## Legs

The assessment of the tower legs is shown in tabular form and graphical format by plotting the tensile or compression forces versus the corresponding capacities of the member. The diagram is refreshed based on the selection of either the tensile or compression columns.

eas L	Diaq	Y Horiz	Sec. Melli	Summary Y	Found. Y	Disp. Y	Ant. Disp.	Guy	<u>Compression Diagram</u>
Sect.	Panel	Elev. (ft)	Description	Tensile Force (Kips)	Compress. Force (Kips)	Tensile Capacity (Kips)	Compress. Capacity (Kips)	Assess.	
15	4	295.00	V4x4x3/8	3.234	3.837	128.788	96.186	0.04	300
	3	290.00	V4x4x3/8	6.549	7.301	128.788	96.186	0.08	280
	2	285.00	V4x4x3/8	13.031	15.197	128.788	96.186	0.16	260
	1	280.00	V4x4x3/8	20.200	22.414	128.788	96.186	0.23	260
14	4	275.00	V4x4x3/8	28.206	31.153	128.788	96.186	0.32	240
	3	270.00	V4x4x3/8	0.000	23.050	128.788	96.186	0.24	220
	2	265.00	V4x4x3/8	0.000	17.848	128.788	96.186	0.19	200
	1	260.00	V4x4x3/8	0.000	15.595	128.788	96.186	0.16	
13	4	255.00	V4x4x3/8	0.000	16.566	128.788	96.186	0.17	180
	3	250.00	V4x4x3/8	0.000	16.825	128.788	96.186	0.17	160
	2	245.00	V4x4x3/8	0.000	17.609	128.788	96.186	0.18	140
	1	240.00	V4x4x3/8	0.000	18.153	128.788	96.186	0.19	120
12	4	235.00	V4x4x3/8	0.000	18.492	128.788	96.186	0.19	100
	3	230.00	V4x4x3/8	0.000	18.038	128.788	96,186	0.19	100
	2	225.00	V4x4x3/8	0.000	18.513	128.788	96.186	0.19	80
	1	220.00	V4x4x3/8	0.000	18.039	128.788	96.186	0.19	60
11	4	215.00	V4x4x3/8	0.000	18.268	128.788	96.186	0.19	40
	3	210.00	V4x4x3/8	0.000	18.949	128.788	96.186	0.20	20
	2	205.00	V4x4x3/8	2.628	24.404	128.788	96.186	0.25	
	1	200.00	V4x4x3/8	0.000	24.036	128.788	96.186	0.25	50
10	4	195.00	V4x4x3/8	0.000	23.949	128.788	96.186	0.25	-Force -Capacity

## Diagonals

The assessment of the tower diagonals is shown in tabular form and graphical format by plotting the tensile or compression forces versus the corresponding capacities of the member. The diagram is refreshed based on the selection of either the tensile or compression columns. Similar results can be viewed for tower horizontals from the next tab.

/ Resul	IS					R			
eqs	Diag	Horiz	YSec. Mem YS	ummary Y	Found. Y	Disp.	í Ant. Disp.	Guys	Compression Diagra
Sect.	Panel	Elev. (ft)	Description	Tensile Force (Kips)	Compress. Force (Kips)	Tensile Capacity (Kips)	Compress. Capacity (Kips)	Assess.	
15	4	295.00	L3x3x5/16	2.457	2.457	12.080	15.180	0.20	300 300 30 30 30 30 30 30 30 30 30 30 30
	3	290.00	L3x3x5/16	2.455	2.455	12.080	15.180	0.20	280
	2	285.00	L3x3x5/16	4.722	4.722	12.080	15.180	0.39	
	1	280.00	L3x3x5/16	4.722	4.722	12.080	15.180	0.39	260
14	4	275.00	L3x3x5/16	5.584	5.584	12.080	15.180	0.46	240
	3	270.00	L3x3x5/16	4.033	4.033	12.080	15.180	0.33	220
	2	265.00	L3x3x5/16	3.183	3.183	12.080	15.180	0.26	200
	1	260.00	L3x3x5/16	3.183	3.183	12.080	15.180	0.26	
13	4	255.00	L3x3x5/16	2.051	2.051	12.080	15.180	0.17	180
	3	250.00	L3x3x5/16	2.051	2.051	12.080	15.180	0.17	160
	2	245.00	L3x3x5/16	1.613	1.613	12.080	15.180	0.13	140
	1	240.00	L3x3x5/16	1.613	1.613	12.080	15.180	0.13	120
12	4	235.00	L3x3x5/16	1.613	1.613	12.080	15.180	0.13	
	3	230.00	L3x3x5/16	1.613	1.613	12.080	15.180	0.13	100
	2	225.00	L3x3x5/16	1.868	1.868	12.080	15.180	0.15	80
	1	220.00	L3x3x5/16	1.869	1.869	12.080	15.180	0.15	60
11	4	215.00	L3x3x5/16	2.837	2.837	12.080	15.180	0.23	40
	3	210.00	L3x3x5/16	2.838	2.838	12.080	15.180	0.23	20
	2	205.00	L3x3x5/16	3.550	3.550	12.080	15.180	0.29	
	1	200.00	L3x3x5/16	3.614	3.614	12.080	15.180	0.30	5 10
10	4	195.00	L3x3x5/16	2.816	2.816	12.080	15.180	0.23	-Force -Capacity
Combina				ind Directio				~	

Also, on the bottom of the screen, the user may select the load combination for which results are to be displayed. Load combinations selected from the analysis

menu are shown in the load combination list. Specific wind direction may be chosen or simply the envelope of the maximum values.

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## **Results Summary**

The user may view the summary of the assessment based on colored contours of the tower. The contours summarize the results depending on the governing either compressive or tensile forces.

Legs	~	Diag	Horiz	YSec. Mem	Summary	Found.	Y Disp.	Y Ant. Dis	p. Y Gi	Strength Assessment	
iec.	Panel	Elev. (ft)	Туре	KL/R	Comp. Force (Kips)	Comp. Capacity (Kips)	Tens. Force (Kips)	Tens. Capacity (Kips)	Assess.		
15	4	295.00	Leg	63.158	3.837	96.186	3.234	128.788	0.04	B	
			Diag	134.442	2.457	15.180	2.457	12.080	0.20	WW .	
			Horiz	103.968	0.034	15.180	0.034	12.080	0.00	VIN	
	3	290.00	Leg	63.158	7.301	96.186	6.549	128.788	0.08	NA	
			Diag	134.442	2.455	15.180	2.455	12.080	0.20		
			Horiz	103.968	0.065	15.180	0.065	12.080	0.01	WW.	
	2	285.00	Leg	63.158	15.197	96.186	13.031	128.788	0.16	ANNANANANANANANANANANANANANANANANANANA	
			Diag	134.442	4.722	15.180	4.722	12.080	0.39		
			Horiz	103.968	0.136	15.180	0.136	12.080	0.01	M	
	1	280.00	Leg	63.158	22.414	96.186	20.200	128.788	0.23		
			Diag	134.442	4.722	15.180	4.722	12.080	0.39		
			Horiz	103.968	0.201	15.180	0.201	12.080	0.02		
14	4	275.00	Leg	63.158	31.153	96.186	28.206	128.788	0.32	WW.	
14	4	273.00	Diag	134.442	5.584	15.180	5.584	12.080	0.32		
										AVA.	
			Horiz	103.968	0.279	15.180	0.279	12.080	0.02	WW.	
	3	270.00	Leg	63.158	23.050	96.186	0.000	128.788	0.24		
			Diag	134.442	4.033	15.180	4.033	12.080	0.33		
			Horiz	103.968	0.207	15.180	0.207	12.080	0.02		
	2	265.00	Leg	63.158	17.848	96.186	0.000	128.788	0.19	0.2 0.6 1.0	
			Diag	134.442	3.183	15.180	3.183	12.080	0.26		
			Horiz	103.968	0.160	15.180	0.160	12.080	0.01	0.0 0.4 0.8	
	nbinati					ction (Deg)					

Also, on the bottom of the screen, the user may select the load combination for which results are to be displayed. Load combinations selected from the analysis menu are shown in the load combination list. Specific wind direction may be chosen or simply the envelope of the maximum values.

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# Foundations

Legs	Y Diag Y Axial (Kips)	Horiz YS Shear N-S (Kips)	Shear E-W (Kips)	Moment N-S (Kipsft)	<u>CDisp.YAr</u> Moment N-W (Kipsft)	nt. Disp. Y Gu Torsion (Kipsft)	
Base	117.96	-2.76	k <sup>2.45</sup>	0.03	0.06	-2.17	
unchoi # 1	Azimuth (deg) 0.00 120.00	Radius (ħ) 240.00 240.00	Horizontal Load (Kips) 38.98 40.25	Vertical Load (Kips) 34.13 33.04	Ахіаl Load (Крр) 51.81 52.07	Angle (deg) 41.20 39.38	
3	240.00	240.00	36.07	29.65	46.69	39.42	
							✓

The program calculates the foundations reactions for the mast's base. The reactions at guy anchors are shown in the grid below the base reactions.

Also, on the bottom of the screen, the user may select the load combination for which results are to be displayed. Load combinations selected from the analysis menu are shown in the load combination list. Specific wind direction may be chosen or simply the envelope of the maximum values.

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# **Tower Displacements**

The user may view the tower displacement and rotations in the three directions from the **Disp.** Tab.

Legs	Y Diaq	Y Horiz	Y Sec. Mem Y	Summary	Found. Y	Disp. Ant	. Disp. Y Gu	Horiz. Disp. Diagram	E
Node	Elev. (ft)	N-S disp (in)	W-E disp(in)	Vert. disp(in)	N-S rot. (Deg)	W-E rot. (Deg)	Twist (Deg)		
183	300.0	30.2	-23.2	-1.1	-0.40	-0.30	0.31		
180	295.0	29.8	-22.9	-1.1	-0.39	-0.30	0.31		
177	290.0	29.4	-22.6	-1.1	-0.39	-0.29	0.31		
174	285.0	29.0	-22.3	-1.1	-0.37	-0.28	0.30		
171	280.0	28.6	-22.0	-1.1	-0.35	-0.26	0.28		
168	275.0	28.2	-21.7	-1.1	-0.32	-0.23	0.27		
165	270.0	27.9	-21.5	-1.1	-0.31	-0.22	0.27		
162	265.0	27.6	-21.3	-1.1	-0.30	-0.22	0.27		
159	260.0	27.3	-21.0	-1.0	-0.30	-0.22	0.27		
156	255.0	26.9	-20.8	-1.0	-0.31	-0.22	0.27		
153	250.0	26.6	-20.6	-1.0	-0.32	-0.23	0.27		
150	245.0	26.3	-20.3	-1.0	-0.33	-0.24	0.27		
147	240.0	25.9	-20.1	-1.0	-0.34	-0.25	0.27		
144	235.0	25.6	-19.8	-1.0	-0.35	-0.26	0.26		
141	230.0	25.2	-19.5	-1.0	-0.36	-0.27	0.26		
138	225.0	24.8	-19.2	-1.0	-0.37	-0.28	0.26		
135	220.0	24.4	-18.9	-1.0	-0.38	-0.28	0.26		
132	215.0	24.0	-18.6	-0.9	-0.37	-0.28	0.26		
129	210.0	23.6	-18.3	-0.9	-0.37	-0.28	0.26		
126	205.0	23.2	-18.1	-0.9	-0.36	-0.27	0.25		
123	200.0	22.9	-17.8	-0.9	-0.36	-0.27	0.25		

The displacements can also be viewed for the maximum envelope or any of the load combinations or wind directions.

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# **Antenna Displacements**

On this screen, the user can see the antenna number (for this example, the tower has 1 antenna at 100 ft. elevation), and the elevation at each antenna, displacements in the orthogonal three directions, rotations and twist.

Legs		Horiz		em Y Sum			Disp.	n::::	Guys	
Ant.	Descript.	Elev. (It)	N-S disp (in)	W-E disp (in)	Vert. disp (in)	N-S rot. (Deg)	W-E rot. (Deg)	Twist (Deg)	Allow. (Deg)	
1	TA-803-60	300.0	30.0	-23.0	-1.1	-0.40	-0.30	0.31	0.00	
2	TA-803-60	300.0	30.0	-23.0	-1.1	-0.40	-0.30	0.31	0.00	
3	TA-803-60	300.0	30.0	-23.0	-1.1	-0.40	-0.30	0.31	0.00	
4	HP6	290.0	29.2	-22.4	-1.1	-0.38	-0.29	0.30	1.48	
5	SRL-480	305.0	30.2	-23.2	-1.1	-0.40	-0.30	0.31	0.00	
_										
_										

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#### **Guys Assessment**

This screen shows the assessment of the guys for each guy level as well as the assessment of the Torsion Resistors (if applicable).

Level ‡	Elevation (ft)	Guy Size	Breaking	ary Found. Tension at	<u>Disp.</u> An	t.Disp.) taiu Ratio	
			Strength (Kips)	Anchor (Kips)	Mast (Kips)		
1	75.0	EH 7/16	20.80	7.60	7.62	0.61	
2	135.0	EH 7/16	20.80	9.40	9.46	0.76	
3	205.0	EH 1/2	26.90	12.57	12.67	0.79	
4	275.0	EH 1/2	26.90	12.34	12.49	0.77	
		Γ	Torsion Re	esistors	J		
Level #	Elevation (ft)	Туре	Tensile Force (Kips)	Compr. Force (Kips)	Bending Moment (Kipsft)	Assessment	
4	275.0	UpperArm	12.72	0.66	0.00	0.42	
4	275.0	LowerArm	2.86	9.94	0.00	0.33	
-							

Also, on the bottom of the screen, the user may select the load combination for which results are to be displayed. Load combinations selected from the analysis menu are shown in the load combination list. Specific wind direction may be chosen or simply the envelope of the maximum values.

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### Printout

From the main menu, click on **Results**, and the following screen will be displayed. From this screen the user may choose the required printout sections by clicking on the corresponding check box.

View and Print		
Printing Schedule		
Input Data	<u>Output Data</u>	<u>Diagrams</u>
🥅 Project Data	🔲 Wind Load Data	F Profile
📕 Structure Data	🔲 Structure Displ. Data	Displacements
📕 Guy System Data	🥅 Antenna Displ. Data	Leg Load Compression
🦵 Antenna Data	🔲 Assessment Data	🔲 Leg Load Tension
🥅 Tx Line Data	🔲 Section Capacities	🔲 Diag. Load Compression
🔲 Ladder Data	🦵 Guy Tension Data	🦵 Diag. Load Tension
🦵 Point Load Data	🔲 Base Reaction Data	🦵 Horiz. Load Compression
🔲 Guy Tension Chart	🦳 Anchor Load Data	🦵 Horiz. Load Tension
	C Torsion Resistor Assessment Data	□ Mast Moment & Shear (N-S)
		□ Mast Moment & Shear (E-W)
<u>_</u>	iew & Print	

Note that for analysis including several load combinations and different wind directions as well the user has the option to select the required sections for printing and also the desired wind directions. This may result in a relatively large number of pages in the printout. By choosing the profile, the program prints a simple profile on which the project data, design specification, base reactions and tower geometry are printed in a graphical format.

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# **Export Profile**

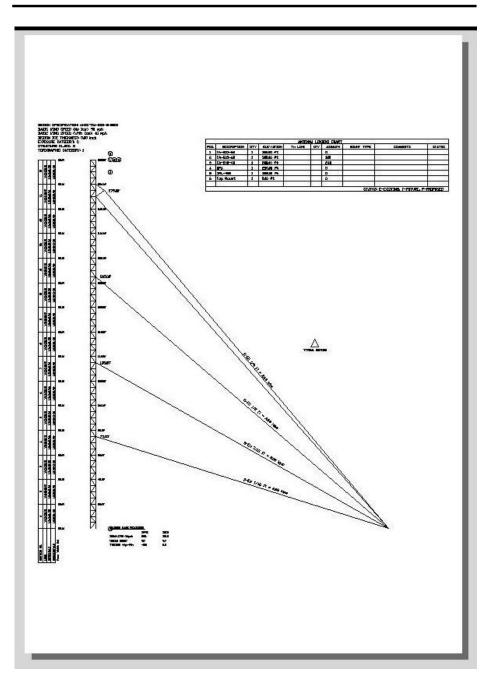
Select sub-menu "**Export Profile (\*.dxf)**" from main menu "**Results**". Following screen will be displayed.

xport Profile	e as DXF file	
- System of U	nits	
C Metric	🖲 US Cu	istomary
	Specifications	V
	Structure Description Table	V
	Antennas	V
	Antenna Loading Table	
	Reactions	$\overline{\mathbf{v}}$
	Cross Section	V
Export D>	<f file<="" td=""><td><u>C</u>ancel</td></f>	<u>C</u> ancel

# Click on "Export DXF file" button.

If you have selected DXF viewer you will find additional button "<u>View</u> **Profile**" as shown below.

Export Profile	as DXF file	
System of U	nits	
O Metric	US Cus	tomary
	Specifications	V
	Structure Description Table	<b>V</b>
	Antennas	
	Antenna Loading Table	V
	Reactions	
	Cross Section	<b>v</b>
·		
Export DX	(F file	Exit
<u>V</u> iew Pro	ofile	



Attached is sample printout of the .dxf profile that can be further edited using AutoCad.

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# Chapter 5 DATABASE MANAGEMENT

The program uses "USER" Antenna database for selection of the antennas, mounts and TX Lines.

Apart from the "USER" database there is "MASTER" database (not to be modified) and "REMOTE" database or databases, which can be placed in commonly accessed server and thus shared by different users typically within the same organization.

The "USER" and "REMOTE" databases can be modified by the users.

#### Antennas Database

From the main menu, click on **Database Management** and **Antennas** submenu. Following screen will be displayed.

D	ish /	Antennas		Ion-Dish Antenn Manufacturers	No No	on-Dish Antennas		TX Lines
_					39 records.			
	ID	Manufactur er	Microw ave Code	Shielded Type	Catalogue Name	Description	Radome	Diameter( 📤
	1	Andrews	<b>&gt;</b>	Shielded	HP2	M/W Shielded		2.001
	2	Andrews	✓	Shielded	HP4	M/W Shielded		4.003
	3	Andrews	✓	Shielded	HP6	M/W Shielded		6.004
	4	Andrews	<ul><li>✓</li></ul>	Shielded	HP8	M/W Shielded		8.005
	5	Andrews	✓	Shielded	HP10	M/W Shielded		10.007
	6	Andrews	✓	Shielded	HP12	M/W Shielded		12.008
	7	Andrews	<ul><li>✓</li></ul>	Shielded	HP15	M/W Shielded		14.993
	8	Andrews	<ul><li>✓</li></ul>	Focal Plane	FP4	M/W Focal Plane		4.003
	9	Andrews	<ul><li>✓</li></ul>	Focal Plane	FP6	M/W Focal Plane		6.004
	10	Andrews	<ul><li>✓</li></ul>	Focal Plane	FP8	M/W Focal Plane		8.005
	11	Andrews	<ul><li>✓</li></ul>	Focal Plane	FP10	M/W Focal Plane		10.007
	12	Andrews		Focal Plane	FP4	M/W Focal Plane		4.003
•								•
	Ē	Print			Note: This tal	ole is non-editable (re	ad only.	

The first group "Dish Antennas" is non-editable (read only), as it covers practically all types and sizes of Microwave Dish Antennas.



#### Non-Dish Antenna Manufacturers

1	Dish Antennas	Non-Dish Antenna Manufacturers	Non-Dish Antennas	TX Lines
	14 records.		Add new Manufacturer (Tab	ole)
	Manufacturer (Tabl	e) Name		
►	ALLGON		Delete Manufacturer (Tabl	e)
	ANDREW			<u> </u>
	ANTEL			
	CAL			
	CELWAVE			
	COMSAT-RSI			
	DECIBEL			
	EMS Wireless			
	KATHREIN			
	LINDSAY			
	SCALA			
	SINCLAIR			
	SWEDCOM			
	TIL-TEK			
_				
<u>E</u> xil	H Database: U	CED		<u>C</u> hange Databa

User can add new manufacturers. Such action will create an empty table and the user will then add records to such table. Deletion of manufacturer will cause removal of the manufacturer name from the list as well as deletion of a table of non-dish antennas associated with the manufacturer.

Default database is "USER" but any other "REMOTE" database can be selected (if present) and then the modifications are performed in the selected database. Once such "Remote" database is created and located remotely (on a server) other users can synchronize their local "USER" database with the "REMOTE".

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### **Non-Dish Antennas**

	Dish Antennas	Non-Dish Antenna Manufacturers	Non-	Dish Ante	nnas	TΧ	Lines
		Table: ALLG	ON - 10 rec	cords.			
	Catalogue Name	Description	Height (ft)	Width (ft)	Depth (ft)	Frontal Area (ft^2)	Frontal Area Iced 10mm
►	7145.21	CITY PANEL 105 deg	0.984	0.984	0.427	1.001	1.130
	7145.22	CITY PANEL 105 deg	1.969	0.984	0.427	1.981	2.174
	7145.23	CITY PANEL 105 deg	2.953	0.984	0.427	2.960	3.229
	7145.24	CITY PANEL 105 deg	3.937	0.984	0.427	3.950	4.284
	7145.26	CITY PANEL 105 deg	5.906	0.984	0.427	6.146	6.383
	7145.48	CITY PANEL 105 deg	7.546	0.984	0.427	7.901	8.148
	7183.15	PCS	3.281	0.459	0.164	3.057	3.563
	7184.14	PCS	4.265	0.459	0.164	3.057	3.541
	7184.15	PCS	4.265	0.459	0.164	3.057	3.541
	7185.15	PCS	3.281	0.853	0.164	4.155	4.575
▲ Se	ect Table ALLG		<u>E</u> dit Reco	rd <u>A</u> c	dd Record		▶ e Record Print
	Database: U					<u>C</u> hange	

To edit or add record for selected table click on "Edit Record" or Add Record" buttons. Following screen will be displayed.

Edit Non-Dish Antenna,	table: ALLGON			
Catalogue Name:	7145.21			
Description:	CITY PANEL	105 deg		
Height:	0.984	(ft)	Weight :	4.41 (lbs)
Width :	0.984	(ft)	Weight Iced 10 mm (1/2") :	11.01 (lbs)
Depth :	0.427	(ft)	Weight Iced 50 mm (2'') :	37.44 (lbs)
Frontal Area (EPA)N :	1.001	(ft^2)	Round	
Frontal Area Iced 10 mm (1	/2''): 1.130	(ft^2)	Frontal Area ,	Antenna Azimuth
Frontal Area Iced 50 mm	2"): 1.776	(ft^2)	FIORICALAIREA	Antenna Azinium
Lateral Area (EPA)L :	0.441	(ft^2)		Depth
Lateral Area Iced 10 mm (*	/2''): 0.538	(ft^2)		+
Lateral Area Iced 50 mm	2"): 1.023	(ft^2)	Lateral Area	
			Effective Projected Area (E Lateral includes all applicat coefficients but does not	ble drag factors or force
Accept	<u>C</u> ancel			

Changes of entries will become effective after "Accept" button is clicked.



## TX Lines

Dish Antennas Non-Dish Antenna Manufacturers		Non-Dish Antennas			TX Lines		
		Manufacturers					
	-	27	records.				
	Туре	Description	Size (in)	Width (in)	Depth (in)	Unit Mass (Ibs/ft)	Shape
۲	Air-Dielectric	HJ12P-50A	2.25	2.378	2.378	1.16	Round
	Air-Dielectric	HJ5P-50A	0.875	1.102	1.102	0.54	Round
	Air-Dielectric	HJ7P-50A	1.625	1.980	1.980	1.04	Round
	Circular Waveguide	WC109	1.09	1.087	1.087	1.21	Round
	Circular Waveguide	WC166	1.66	1.654	1.654	2.82	Round
	Circular Waveguide	WC281	2.81	2.795	2.795	3.63	Round
	Elliptical Waveguide	EW127	1.11	0.673	1.110	0.29	Elliptical
	Elliptical Waveguide	EW132	0.96	0.610	0.961	0.22	Elliptical
	Elliptical Waveguide	EW17	5.65	2.988	5.650	2.73	Elliptical
	Elliptical Waveguide	EW180	0.79	0.488	0.791	0.15	Elliptical
	Elliptical Waveguide	EW20	5.02	2.831	5.020	1.85	Elliptical
•	1 = 10 = 10 = 10 + 7 = 1 = 10 = 10 = 10 = 10 = 10 = 10 = 1	LE114000	07	0.441	0 701	0.10	
	Print 6	dd new Record	<u>D</u> ele	ete Record		<u>E</u> dit Reco	rd

To add or edit a record click on "Add new Record" or "Edit Record" buttons respectively. Following screen will be displayed.

Edit TX Line					
Туре:	Elliptical Wav	eguide			
Description:	EW127				
Size (in):	1.110		Round	Elliptic	Rectang.
Width :	0.673	(in)		Ĺ	
Depth :	1.110	(in)			
Unit Mass :	0.29	(lbs/ft)		Brackel	t
				sitions o perpendi Bracket)	
Shape					
C Round	Elliptical		C Rectang	ular	
Accept	<u>C</u> ancel				

Changes of entries will become effective after "Accept" button is clicked.

## Mounts

From the main menu, click on **Database Management** and **Mounts** submenu. Following screen will be displayed.

Antenna Mounts Management	
Table of Mounts Manufacturers	Antenna Mounts
1 records. Manufacturer (Table) Name	Add new Manufacturer (Table)
none	Delete Manufacturer (Table)
Exit Database: USER	<u>C</u> hange Database

User may add new manufacturers (as is the case with Non-Dish Antennas) or delete them.

	Table of Mounts Manufacturers			Antenna Mounts				
		Tab	ile: non	ie - 1 recor	ds.			
	Catalogue Name	Description		Height (ft)	Width (ft)	Depth (ft)	Frontal Area (ft^2)	Frontal Area Iced
►	none	n/a		0.000	0.000	0.000	0.000	0.000
Se	elect Table none	3	]	Edit Recor	<u>н</u>	ld Record		► e Record Print

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To add or edit a record click on "Add new Record" or "Edit Record" buttons respectively. Following screen will be displayed.

Edit Antenna Mount, tal	ole: none				
Catalogue Name:	none				
Description:	n/a				
Height :	0.000	(ft)	Weight :	0.00	(lbs)
Width :	0.000	(ft)	Weight Iced 10 mm:	0.00	(lbs)
Depth :	0.000	(ft)	Weight Iced 50 mm :	0.00	(lbs)
Frontal Area :	0.000	(ft^2)	Round		
Frontal Area Iced 10 mm:	0.000	(ft^2)			
Frontal Area Iced 50 mm:	0.000	(ft^2)			
Lateral Area :	0.000	(ft^2)			
Lateral Area Iced 10 mm:	0.000	(ft^2)			
Lateral Area Iced 50 mm:	0.000	(ft^2)			
	. ·	_			
Accept	<u>C</u> ancel				

Perform the editing and press "Accept" button to update or "Cancel" otherwise.

### Guys Database

From the main menu, click on **Database Management** and **Mounts** submenu. Following screen will be displayed.



_	Metric Descr.	Imperial Descr.	Diameter (in)	119 re Breaking Strength	Unit Mass	Metallic Area	Mod. of Elasticity	Thermal Coeff.	Avail.	F
•	GS 4.75	GS 3/16	0.1875	(Kips) 4.00	(lbs/ft) 0.08	(in^2) 0.023	(ksi) 25000	(/Deg. F) 0.0000065	~	
-	GS 6.35	GS 1/4	0.1875	6.40	0.08	0.023	25000	0.0000065	V	-
-	GS 7	GS 5/16	0.2500	11.10	0.13	0.038	25000	0.0000065	V	-
_	GS 9.5	GS 3/8	0.3750	13.50	0.22	0.065	25000	0.0000065		-
_	GS 11	GS 7/16	0.3750	19.50	0.27	0.073	25000	0.0000065		-
-	GS 12.7	GS 1/2	0.4375	25.50	0.55	0.150	25000	0.0000065		-
_	GS 14.28	GS 9/16	0.5625	33.20	0.51	0.130	25000	0.0000065	<b>v</b>	-
_	GS 15.875	GS 5/8	0.56250	40.20	0.80	0.134	25000	0.0000065		-
	EH 4.75	EH 3/16	0.8230	3.99	0.07	0.235	25000	0.0000065		-
_	EH 6.35	EH 1/4	0.1875	6.65	0.07	0.021	25000	0.0000065	V	
-	EH 7.9375	EH 1/4	0.2500	11.20	0.12	0.036	25000	0.0000065	V	-
_	EH 7.5375 EH 9.525	EH 3/8	0.3750	15.40	0.21	0.065	25000	0.0000065		-
_	EH 11.1125	EH 7/16	0.3750	20.80	0.27	0.075	25000	0.0000065		-
_	EH 11.1125 EH 12.7	EH 7/16	0.4375	20.80	0.39	0.114	25000	0.0000065		-
_	EH 12.7 EH 14.2875	EH 9/16	0.5000	35.00	0.51	0.150	25000	0.0000065	<b>v</b>	-
_	EH 14.2875 EH 15.875	EH 5/8	0.5625	42.40	0.67	0.194	25000	0.0000065		
	Print	<u>E</u> dit Reco	1	Record	Delete R		23000	0.0000000		-

When "Edit Record" button is clicked following form appears:

Metric Description	EH 7.9375		
Imperial Description	EH 5/16		
Diameter	0.3125	(in)	
Breaking Strength	11.20004	(Kips)	
Unit Mass	0.2050143	(lbs/ft)	
Metallic Area	6.499938E+	(in^2)	
Modulus of Elasticity	25000	(ksi)	
Thermal Coefficient	0.0000065	(/Deg. F)	

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Metric Description	
Imperial Description	
Diameter	(in)
Breaking Strength	(Kips)
Unit Mass	(lbs/ft)
Metallic Area	(in^2)
Modulus of Elasticity	(ksi)
Thermal Coefficient	(/Deg. F)

When "Add Record" button is clicked following form shows:

After the data is entered for the new addition clicking on "Accept" button will add the new guy to the table. "Cancel" button should be used to ignore the entries (new Guy will not be added).

## **Database Setup**

From the main menu, click on **Database Management** and **Database Setup** submenu.

Following screen will be displayed.

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Antenna Database Setup	
Create Remote Database	Synchronize Databases
	ecords
Remote Database Location	
n:\Engineering\Programs\TSTower	
, Add New Remote Database	
Populate from <u>M</u> aster Database	Check Integrity
Populate from User Database	
Get from Remote Location	Delete Link
Exit	

New remote database(s) can be created in three different ways:

"Populate from Master Database" – new "remote" database will be replicated from "Master Database" and then user will indicate the location of the new database – screen showing selection of "drives" and "folders" will be displayed.

Populate from Master Database

"Populate from User database" – new "remote" database will be replicated from "User Database" and then user will indicate the location of the new database – screen showing selection of "drives" and "folders" will be displayed.

"Get from Remote Location" this action will prompt you to select existing "remote" database not linked to you computer so far.

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Select Location (Folder) for Remote Database		
Select Drive:	<b>–</b> c:	
Select Folder (Directory):		
	Contract Con	
	🚞 DXF	
	Master DB	
	📄 OldCode Deckage 🔹 🔍	
Accept Selection	Cancel (No Selection)	
Accept Selection	<u>cancel (No Selection)</u>	

Once you selected the "remote" database it will be displayed in the "Remote Database Location" grid and you will have access to it via Database Management for Antennas or Mounts.

"Check Integrity" will perform the comparison of the records between selected remote database and "Master Database" and display differences.

"Delete Link" will remove a link between selected "remote" database and the program (such database will not be accessible to you).

Synchronize Databases - instructions as shown on attached screenshot.

tenna Database Setup	
Create Remote Database	Synchronize Databases
This function will synchronize remote databases with th you wish to synchronize. Including MASTER database	e current USER database. Select (tick) databases in the synchronization is optional.
Remote databa:	ses - 1 records.
Remote Database Location  In:\Engineering\Programs\TSTower	Select?
Include MASTER database?	
Exit	

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