In this tip, let us understand how the numbers on the NEMA SM-23 report are calculated. Let us take a look at a sample report shown below, generated from CAEPIPE v4.0A. Notes are shown in red letters (T-1 etc.).

```
CAEPIPE                                P23                                Page 4
Version 4.0A   VERIFICATION OF CAEPIPE, PROBLEM 23 (NEMA SM-23)   Sep 22,97
-------------------------------------------------------------------------------
NEMA SM-23 (1985) Report                    Load case: Operating (W+P1+T1)
-------------------------------------------------------------------------------
Desc: P23-NEMA SM23 Shaft axis: Xcomp = 1.000  Ycomp = 0.000  Zcomp = 0.000
-------------------------------------------------------------------------------
```

T-1

Node	Type	Forces (lb) fx	fy	fz	Moments (ft-lb) mx	my	mz
5	Inlet	567	-301	497	2527	1981	-29
25	Exhaust	-252	-337	-549	-1075	2854	-2830
30	Extr. 1	38	-140	-74	133	-200	420

<- Applied forces and moments at each nozzle

T-2

Node	Type	Size (inch)	Resultant F(lb)	Resultant M(ft-lb)	F + M/3	Allowable	Ratio
5	Inlet	8.000	812	3211	1882	1336	1.409
25	Exhaust	12.000	692	4161	2079	1559	1.334
30	Extr. 1	4.000	163	484	324	668	0.485

<- Resultants at each nozzle

Combined resultants at the Exhaust node 25 <- Combined inlet, exhaust, extraction force and moment resultants resolved at exhaust nozzle centerline

T-3

	Forces (lb) fx	fy	fz	Moments (ft-lb) mx	my	mz
Calculated	353	-778	-126	1789	6848	330

	Allowable		549	1374	1099	2747	1374	1374
	Ratio		0.642	0.566	0.115	0.651	4.986	0.240

			--- Resultant ---			Allow-	
			F(lb)	M(ft-lb)	F + M/2	able	Ratio
T-4		Combined	864	7086	4406	1374	3.208

Let us take the first table T-1. These are the forces and moments that are applied to the turbine by the system. As you can see from table T-2, there are three nozzles on this turbine, an 8" inlet (node 5), a 12" exhaust (node 25) and a 4" extraction (node 30).

T-1		------ Forces (lb) -------			---- Moments (ft-lb) -----		
Node	Type	fx	fy	fz	mx	my	mz
5	Inlet	567	-301	497	2527	1981	-29
25	Exhaust	-252	-337	-549	-1075	2854	-2830
30	Extr. 1	38	-140	-74	133	-200	420

Let us see how to calculate the numbers (resultants) that are shown in T-2.
For the nozzle at inlet (node 5),

F = sqrt (567^2 + (-301)^2 + 497^2) = 812 lb.
M = sqrt (2527^2 + 1981^2 + (-29)^2) = 3211 ft-lb.
F + M/3 = 812 + 3211/3 = 1882

Similarly, the resultants are calculated for the exhaust and the extraction nozzles.

T-2		Size	--- Resultant ---			Allow-	
Node	Type	(inch)	F(lb)	M(ft-lb)	F + M/3	able	Ratio
5	Inlet	8.000	812	3211	1882	1336	1.409
25	Exhaust	12.000	692	4161	2079	1559	1.334

30	Extr. 1	4.000	163	484	324	668	0.485

Now, let us calculate the combined inlet, exhaust and extraction force and moment resultants resolved at the exhaust nozzle centerline, as per the NEMA SM-23 guideline (shown in T-3).

```
Calculated fx = (567 -252 + 38) = 353 lb., similarly fy and fz.
Calculated mx = (mx5 + mx25 + mx30 - (fy5 * dz5) - (fy30 * dz30) + (fz5 * dy5) + (fz30 * dy30)
              = 1789 ft-lb., similarly my and mz.
```

Note that dy and dz are the offsets in the Y and Z directions from the mentioned nodes (5 and 30) to the exhaust node 25. In this case, dz5=0.594 ft. (z5-z25), dz30=1.375 ft. (z30-z25), dy5=-0.719 ft. (y5-y25), dy30=-2.5625 ft. (y30-y25).

Combined resultants at the Exhaust node 25

T-3

	------ Forces (lb) -------			---- Moments (ft-lb) -----		
	fx	fy	fz	mx	my	mz
Calculated	353	-778	-126	1789	6848	330
Allowable	549	1374	1099	2747	1374	1374
Ratio	0.642	0.566	0.115	0.651	4.986	0.240

Finally, let us compute the combined Force and Moment resultant at exhaust using numbers from T-3.

```
Force Resultant = sqrt (353^2 + (-778)^2 + (-126)^2 ) = 864 lb.
Moment Resultant = sqrt (1789^2 + 6848^2 + 330^2 ) = 7086 ft-lb.
F + M/2 = 864 + 7086/2 = 4406
```

T-4

		--- Resultant ---			Allow-	
		F(lb)	M(ft-lb)	F + M/2	able	Ratio
	Combined	864	7086	4406	1374	3.208

For details on how to calculate the allowables, please refer Appendix B, page B-8 of CAEPIPE User's Manual (Rev 20).