

Figure 1.1: GRUPPO E1

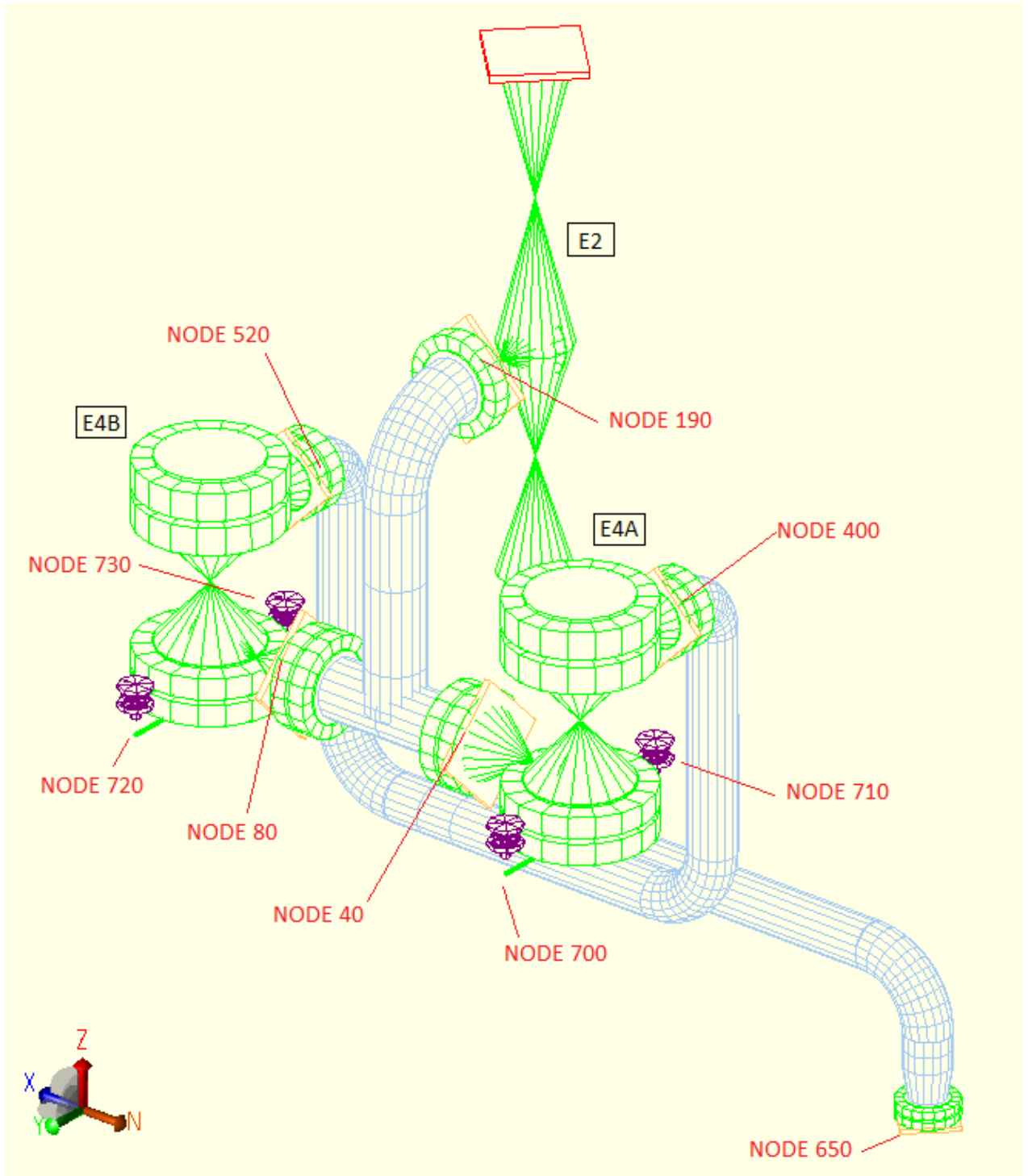


Figure 2.2: GRUPPO E1 (ALL PIPES)

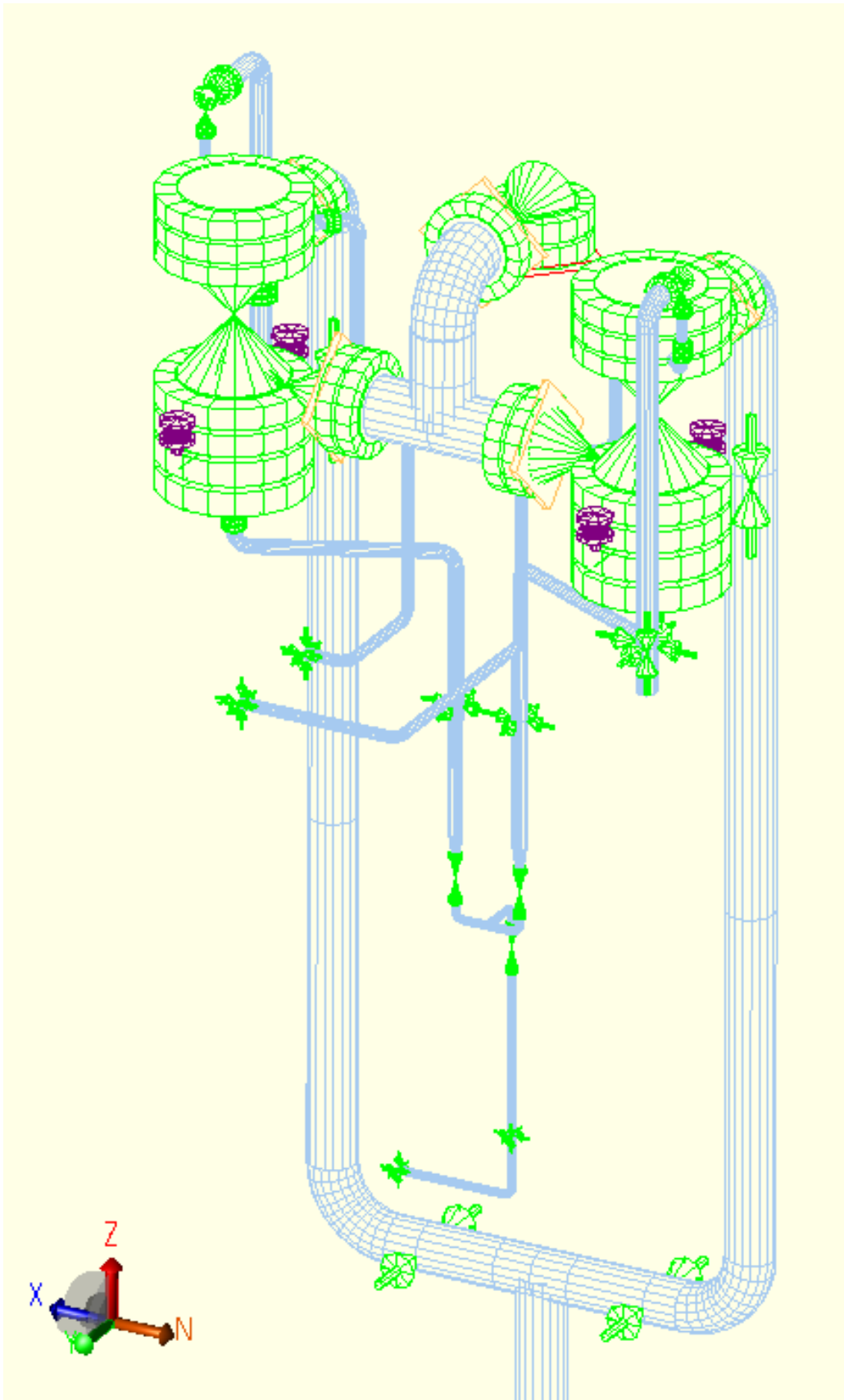


Figure 2.1: GRUPPO E2

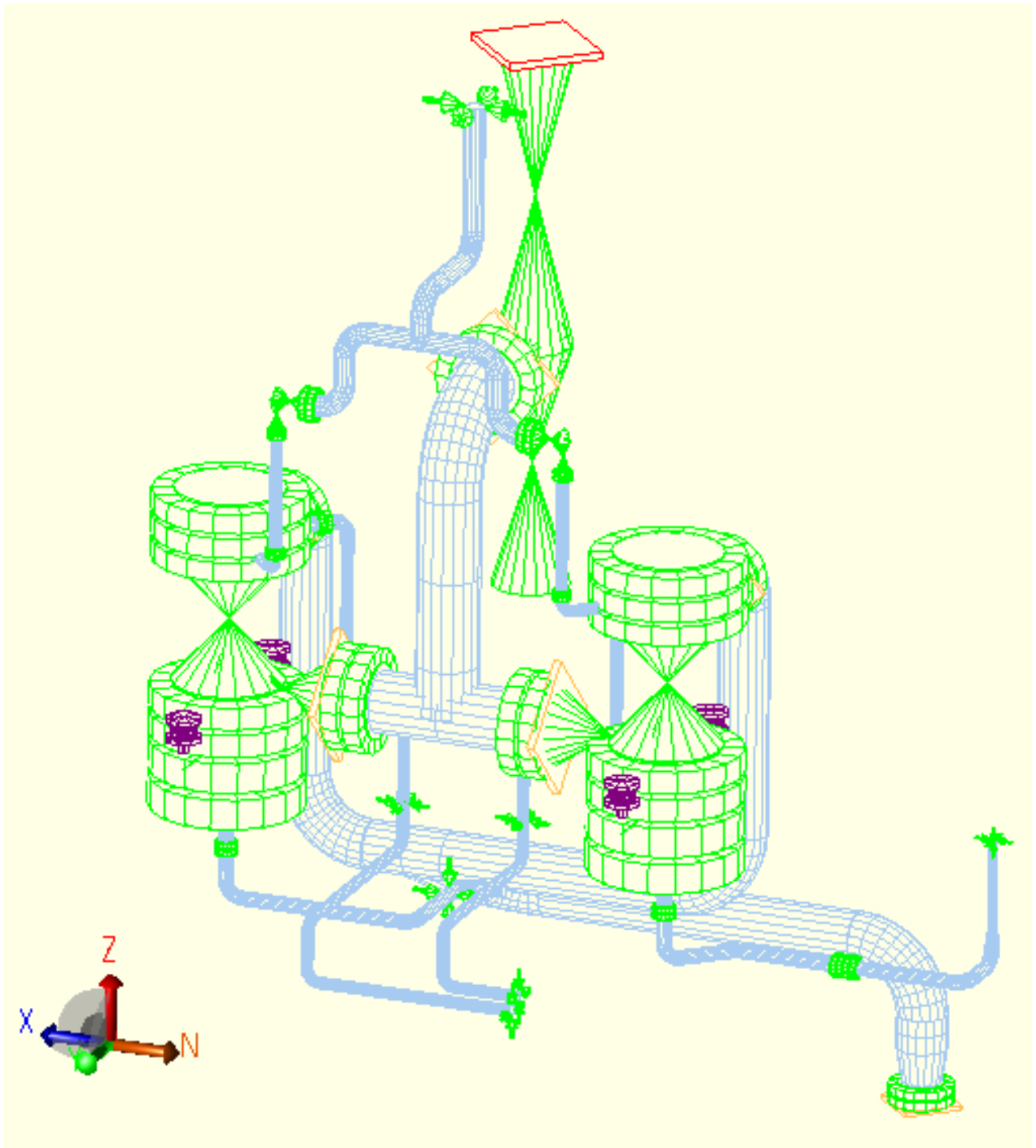


Figure 2.2: GRUPPO E2 (ALL PIPES)

LOAD CASES

Load cases analyzed in piping flexibility calculation are listed and described in below table

CASE N°	TYPE	CASE COSTRUCTION	DESCRIPTION
3	(HYD)	WW+HP	Hydrotest case (NOT APPLIED)
4	(OPE)	W+D1+T1+P1+H	Operating case 1
5	(OPE)	W+D1+T2+P2+H	Operating case 2
6	(OPE)	W+D1+T3+P3+H	Design case
7	(SUS)	W+P1+H	Sustained case
8	(SUS)	W+P2+H	Sustained case
9	(SUS)	W+P3+H	Sustained case
10	(EXP)	L10=L4-L7	Thermal expansion Operating case 1
11	(EXP)	L11=L5-L8	Thermal expansion Operating case 2
12	(EXP)	L12=L6-L9	Thermal expansion Design case

W= Weight

D= Imposed Displacements

T= Temperature (table parag. 2.1)

P= Pressure (table parag. 2.1)

H= Hanger

3	RESULTS
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3.1. STRESS SUMMARY

GRUPPO E1

Piping Code: B31.3 = B31.3 -2016, Jan 31, 2017

CODE STRESS CHECK PASSED : LOADCASE 7 (SUS) W+P1+H

Highest Stresses: (N/sq.mm) LOADCASE 7 (SUS) W+P1+H

Ratio (%): 61.1 @Node 125

Code Stress: 84.3 Allowable Stress: 137.9

Axial Stress: 3.1 @Node 2200

Bending Stress: 83.5 @Node 125

Torsion Stress: 7.3 @Node 1510

Hoop Stress: 5.4 @Node 1988

Max Stress Intensity: 84.5 @Node 125

CODE STRESS CHECK PASSED : LOADCASE 8 (SUS) W+P2+H

Highest Stresses: (N/sq.mm) LOADCASE 8 (SUS) W+P2+H

Ratio (%):	61.1	@Node	125
Code Stress:	84.3	Allowable Stress:	137.9
Axial Stress:	11.7	@Node	440
Bending Stress:	83.5	@Node	125
Torsion Stress:	7.3	@Node	1510
Hoop Stress:	22.5	@Node	429
Max Stress Intensity:	84.5	@Node	125

CODE STRESS CHECK PASSED : LOADCASE 9 (SUS) W+P3+H

Highest Stresses: (N/sq.mm) LOADCASE 9 (SUS) W+P3+H

Ratio (%):	62.1	@Node	125
Code Stress:	85.6	Allowable Stress:	137.9
Axial Stress:	13.0	@Node	180
Bending Stress:	83.5	@Node	125
Torsion Stress:	7.3	@Node	1510
Hoop Stress:	25.3	@Node	60
Max Stress Intensity:	85.4	@Node	125

CODE STRESS CHECK PASSED : LOADCASE 10 (EXP) L10=L4-L7

Highest Stresses: (N/sq.mm) LOADCASE 10 (EXP) L10=L4-L7

Ratio (%):	25.1	@Node	1439
Code Stress:	51.9	Allowable Stress:	206.9
Axial Stress:	1.5	@Node	650
Bending Stress:	51.1	@Node	1439
Torsion Stress:	4.0	@Node	619
Hoop Stress:	0.0	@Node	20
Max Stress Intensity:	51.9	@Node	1439

CODE STRESS CHECK PASSED : LOADCASE 11 (EXP) L11=L5-L8

Highest Stresses: (N/sq.mm) LOADCASE 11 (EXP) L11=L5-L8

Ratio (%):	22.8	@Node	1439
Code Stress:	47.2	Allowable Stress:	206.9
Axial Stress:	1.5	@Node	650
Bending Stress:	46.5	@Node	1439
Torsion Stress:	4.1	@Node	619

Hoop Stress: 0.0 @Node 20
Max Stress Intensity: 47.2 @Node 1439

CODE STRESS CHECK PASSED : LOADCASE 12 (EXP) L12=L6-L9

Highest Stresses: (N/sq.mm) LOADCASE 12 (EXP) L12=L6-L9
Ratio (%): 85.7 @Node 1439
Code Stress: 176.4 Allowable Stress: 205.7
Axial Stress: 5.1 @Node 1730
Bending Stress: 173.4 @Node 1439
Torsion Stress: 19.5 @Node 1710
Hoop Stress: 0.0 @Node 20
Max Stress Intensity: 176.4 @Node 1439

GRUPPO E2

Piping Code: B31.3 = B31.3 -2016, Jan 31, 2017

CODE STRESS CHECK PASSED : LOADCASE 7 (SUS) W+P1+H

Highest Stresses: (N/sq.mm) LOADCASE 7 (SUS) W+P1+H
Ratio (%): 8.1 @Node 60
Code Stress: 10.8 Allowable Stress: 133.5
Axial Stress: 3.5 @Node 1220
Bending Stress: 12.3 @Node 60
Torsion Stress: 2.4 @Node 1649
Hoop Stress: 4.0 @Node 1418
Max Stress Intensity: 13.9 @Node 60

CODE STRESS CHECK PASSED : LOADCASE 8 (SUS) W+P2+H

Highest Stresses: (N/sq.mm) LOADCASE 8 (SUS) W+P2+H
Ratio (%): 11.6 @Node 60
Code Stress: 15.5 Allowable Stress: 133.5
Axial Stress: 6.7 @Node 160
Bending Stress: 12.3 @Node 60
Torsion Stress: 2.4 @Node 1649
Hoop Stress: 12.6 @Node 60
Max Stress Intensity: 18.6 @Node 60

CODE STRESS CHECK PASSED : LOADCASE 9 (SUS) W+P3+H

Highest Stresses: (N/sq.mm) LOADCASE 9 (SUS) W+P3+H

Ratio (%):	16.3	@Node	60
Code Stress:	21.7	Allowable Stress:	133.5
Axial Stress:	12.9	@Node	160
Bending Stress:	12.3	@Node	60
Torsion Stress:	2.4	@Node	1649
Hoop Stress:	25.3	@Node	60
Max Stress Intensity:	26.5	@Node	60

CODE STRESS CHECK PASSED : LOADCASE 10 (EXP) L10=L4-L7

Highest Stresses: (N/sq.mm) LOADCASE 10 (EXP) L10=L4-L7

Ratio (%):	14.9	@Node	1828
Code Stress:	50.9	Allowable Stress:	341.1
Axial Stress:	1.0	@Node	150
Bending Stress:	50.5	@Node	1828
Torsion Stress:	6.5	@Node	1490
Hoop Stress:	0.0	@Node	20
Max Stress Intensity:	50.9	@Node	1828

CODE STRESS CHECK PASSED : LOADCASE 11 (EXP) L11=L5-L8

Highest Stresses: (N/sq.mm) LOADCASE 11 (EXP) L11=L5-L8

Ratio (%):	19.6	@Node	1828
Code Stress:	67.0	Allowable Stress:	341.1
Axial Stress:	1.3	@Node	150
Bending Stress:	66.6	@Node	1828
Torsion Stress:	7.8	@Node	1490
Hoop Stress:	0.0	@Node	20
Max Stress Intensity:	67.0	@Node	1828

CODE STRESS CHECK PASSED : LOADCASE 12 (EXP) L12=L6-L9

Highest Stresses: (N/sq.mm) LOADCASE 12 (EXP) L12=L6-L9

Ratio (%):	27.5	@Node	1828
Code Stress:	93.9	Allowable Stress:	341.1
Axial Stress:	1.7	@Node	150
Bending Stress:	93.3	@Node	1828
Torsion Stress:	14.9	@Node	1490
Hoop Stress:	0.0	@Node	20
Max Stress Intensity:	93.9	@Node	1828

RESTRAINT SUMMARY

GRUPPO E1

Node	Load Case	FX N	FY N	FZ N	MX Nm	MY Nm	MZ Nm	DX mm	DY mm	DZ mm
40		TYPE=Rigid ANC;								
	4(OPE)	231	-412	1903	873	838	572	-0.777	1.594	-0.949
	5(OPE)	-30	-287	615	956	192	322	-0.243	1.685	-0.245
	6(OPE)	-525	100	2060	1581	1080	329	-1.000	2.485	-1.831
	7(SUS)	-53	108	950	39	358	-51	-0.004	-0.025	-0.024
	8(SUS)	-53	108	950	39	358	-51	-0.004	-0.025	-0.024
	9(SUS)	-53	108	950	39	358	-51	-0.004	-0.025	-0.024
100		TYPE=Rigid ANC;								
	4(OPE)	700	812	-2535	812	1009	631	1.181	1.300	-0.606
	5(OPE)	394	823	-1175	264	356	383	0.692	1.325	0.115
	6(OPE)	1060	974	-4037	1887	1347	785	2.051	1.570	-0.987
	7(SUS)	17	-99	-1030	-11	352	-49	-0.004	-0.018	-0.026
	8(SUS)	17	-99	-1030	-11	352	-49	-0.004	-0.018	-0.026
	9(SUS)	17	-99	-1030	-11	352	-49	-0.004	-0.018	-0.026
270		TYPE=Rigid ANC;								
	4(OPE)	-469	-1224	185	-617	-166	-89	-0.000	1.371	0.643
	5(OPE)	-424	-1109	-2463	-865	-153	-176	-0.000	1.372	0.641
	6(OPE)	-1585	-874	1844	-144	-168	-420	-0.001	1.541	0.724
	7(SUS)	-70	207	-2273	-535	15	20	-0.000	0.000	-0.002
	8(SUS)	-70	207	-2273	-535	15	20	-0.000	0.000	-0.002
	9(SUS)	-70	207	-2273	-535	15	20	-0.000	0.000	-0.002
400		TYPE=Rigid ANC;								
	4(OPE)	-357	288	373	99	333	-96	-1.530	1.778	-0.090
	5(OPE)	-140	195	1119	76	159	-55	-1.078	1.475	0.179
	6(OPE)	-216	74	1359	-242	198	-196	-3.399	1.906	-0.059
	7(SUS)	67	-213	152	244	4	28	0.006	-0.024	-0.013
	8(SUS)	67	-213	152	244	4	28	0.006	-0.024	-0.013
	9(SUS)	67	-213	152	244	4	28	0.006	-0.024	-0.013
440		TYPE=Rigid Z;								
	4(OPE)	-282	300	-1373	0	0	0	-1.025	1.090	-0.000
	5(OPE)	-103	153	-616	0	0	0	-0.699	1.035	-0.000
	6(OPE)	-127	61	-469	0	0	0	-2.736	1.304	-0.000
	7(SUS)	107	-235	-2856	0	0	0	0.001	-0.001	-0.000
	8(SUS)	107	-235	-2856	0	0	0	0.001	-0.001	-0.000
	9(SUS)	107	-235	-2856	0	0	0	0.001	-0.001	-0.000
465		TYPE=Rigid Y;								
	4(OPE)	26	100	-15	0	0	0	1.764	0.000	-1.055
	5(OPE)	55	216	-35	0	0	0	1.669	0.000	-1.065
	6(OPE)	127	510	-86	0	0	0	1.504	0.000	-1.016
	7(SUS)	2	9	-2	0	0	0	0.035	0.000	-0.046
	8(SUS)	2	9	-2	0	0	0	0.035	0.000	-0.046
	9(SUS)	2	9	-2	0	0	0	0.035	0.000	-0.046
495		TYPE=Rigid Y;								
	4(OPE)	53	202	-29	0	0	0	2.083	0.000	-1.128
	5(OPE)	71	274	-41	0	0	0	1.987	0.000	-1.133
	6(OPE)	46	-177	-27	0	0	0	1.823	-0.000	-1.095

Node	Load Case	FX N	FY N	FZ N	MX Nm	MY Nm	MZ Nm	DX mm	DY mm	DZ mm
	7(SUS)	5	27	-7	0	0	0	0.035	0.000	-0.047
	8(SUS)	5	27	-7	0	0	0	0.035	0.000	-0.047
	9(SUS)	5	27	-7	0	0	0	0.035	0.000	-0.047
520		TYPE=Rigid Z;								
	4(OPE)	482	771	-3031	0	0	0	0.698	1.117	-0.000
	5(OPE)	175	553	-1935	0	0	0	0.296	0.934	-0.000
	6(OPE)	787	982	-4195	0	0	0	0.812	1.013	-0.000
	7(SUS)	-38	-191	-2938	0	0	0	-0.000	-0.001	-0.000
	8(SUS)	-38	-191	-2938	0	0	0	-0.000	-0.001	-0.000
	9(SUS)	-38	-191	-2938	0	0	0	-0.000	-0.001	-0.000
560		TYPE=Rigid ANC;								
	4(OPE)	-349	-610	1477	-733	128	-11	0.490	2.019	-0.175
	5(OPE)	-96	-577	439	-629	-16	73	-0.003	1.567	0.110
	6(OPE)	-674	-743	2816	-1159	614	82	0.755	2.033	-0.236
	7(SUS)	13	179	-36	-290	7	5	-0.004	-0.008	-0.017
	8(SUS)	13	179	-36	-290	7	5	-0.004	-0.008	-0.017
	9(SUS)	13	179	-36	-290	7	5	-0.004	-0.008	-0.017
660		TYPE=Displ. Reaction;								
	4(OPE)	-240	-492	-3201	-518	779	-398	-0.000	-0.000	0.220
	5(OPE)	-267	-507	-3239	-517	755	-401	-0.000	-0.000	0.220
	6(OPE)	-310	-508	-3225	-509	694	-388	-0.000	-0.000	0.220
	7(SUS)	-22	-3	-555	-13	42	-1	-0.000	-0.000	-0.000
	8(SUS)	-22	-3	-555	-13	42	-1	-0.000	-0.000	-0.000
	9(SUS)	-22	-3	-555	-13	42	-1	-0.000	-0.000	-0.000
800		TYPE=VSH Redesign;								
	4(OPE)	0	0	-7628	0	0	0	-1.053	1.480	-1.785
	5(OPE)	0	0	-7487	0	0	0	-0.462	1.808	-0.724
	6(OPE)	0	0	-7847	0	0	0	-1.912	2.695	-3.423
	7(SUS)	0	0	-7390	0	0	0	-0.010	-0.028	0.002
	8(SUS)	0	0	-7390	0	0	0	-0.010	-0.028	0.002
	9(SUS)	0	0	-7390	0	0	0	-0.010	-0.028	0.002
810		TYPE=VSH Redesign;								
	4(OPE)	0	0	-6941	0	0	0	-1.305	1.480	-0.824
	5(OPE)	0	0	-6904	0	0	0	-0.793	1.808	-0.552
	6(OPE)	0	0	-7162	0	0	0	-2.793	2.695	-2.484
	7(SUS)	0	0	-6830	0	0	0	-0.007	-0.028	0.005
	8(SUS)	0	0	-6830	0	0	0	-0.007	-0.028	0.005
	9(SUS)	0	0	-6830	0	0	0	-0.007	-0.028	0.005
820		TYPE=VSH Redesign;								
	4(OPE)	0	0	-7307	0	0	0	1.156	0.860	-0.773
	5(OPE)	0	0	-7159	0	0	0	0.682	1.065	0.337
	6(OPE)	0	0	-7329	0	0	0	2.467	0.793	-0.936
	7(SUS)	0	0	-7205	0	0	0	-0.008	-0.014	-0.005
	8(SUS)	0	0	-7205	0	0	0	-0.008	-0.014	-0.005
	9(SUS)	0	0	-7205	0	0	0	-0.008	-0.014	-0.005
830		TYPE=VSH Redesign;								
	4(OPE)	0	0	-7078	0	0	0	0.819	0.860	0.306
	5(OPE)	0	0	-7039	0	0	0	0.294	1.065	0.595
	6(OPE)	0	0	-7086	0	0	0	1.512	0.793	0.243
	7(SUS)	0	0	-7118	0	0	0	0.004	-0.014	0.002
	8(SUS)	0	0	-7118	0	0	0	0.004	-0.014	0.002
	9(SUS)	0	0	-7118	0	0	0	0.004	-0.014	0.002

Node	Load Case	FX N	FY N	FZ N	MX Nm	MY Nm	MZ Nm	DX mm	DY mm	DZ mm
400		TYPE=Rigid ANC;								
	4(OPE)	15	-94	1205	-102	-103	-218	-0.034	0.470	-5.208
	5(OPE)	-372	-85	1009	-27	305	-276	-0.629	0.818	-6.705
	6(OPE)	-1365	-263	1009	-123	1135	-599	-2.573	0.656	-8.612
	7(SUS)	-55	32	1902	-294	41	-0	0.028	-0.078	-0.026
	8(SUS)	-55	32	1902	-294	41	-0	0.028	-0.078	-0.026
	9(SUS)	-55	32	1902	-294	41	-0	0.028	-0.078	-0.026
520		TYPE=Rigid ANC;								
	4(OPE)	592	178	-1402	256	-347	268	-0.378	2.617	-6.049
	5(OPE)	282	227	-1303	239	-11	249	0.244	3.247	-7.683
	6(OPE)	-566	109	-948	51	1057	359	1.431	4.165	-10.061
	7(SUS)	-70	-47	-2144	372	56	5	-0.031	-0.084	-0.029
	8(SUS)	-70	-47	-2144	372	56	5	-0.031	-0.084	-0.029
	9(SUS)	-70	-47	-2144	372	56	5	-0.031	-0.084	-0.029
650		TYPE=Rigid ANC;								
	4(OPE)	-576	-272	-1947	-444	1009	-297	-0.000	-0.000	0.220
	5(OPE)	-654	-311	-2242	-598	1223	-363	-0.000	-0.000	0.220
	6(OPE)	-799	-373	-2596	-764	1493	-424	-0.000	-0.000	0.220
	7(SUS)	14	79	-507	23	88	113	0.000	0.000	-0.000
	8(SUS)	14	79	-507	23	88	113	0.000	0.000	-0.000
	9(SUS)	14	79	-507	23	88	113	0.000	0.000	-0.000
700		TYPE=VSH Redesign;								
	4(OPE)	0	0	-8012	0	0	0	-0.761	0.147	-6.934
	5(OPE)	0	0	-8138	0	0	0	-1.573	0.282	-8.697
	6(OPE)	0	0	-8413	0	0	0	-3.280	0.965	-12.577
	7(SUS)	0	0	-7520	0	0	0	-0.015	-0.072	0.003
	8(SUS)	0	0	-7520	0	0	0	-0.015	-0.072	0.003
	9(SUS)	0	0	-7520	0	0	0	-0.015	-0.072	0.003
710		TYPE=VSH Redesign;								
	4(OPE)	0	0	-9216	0	0	0	-0.107	0.147	-5.935
	5(OPE)	0	0	-9322	0	0	0	-0.766	0.282	-7.434

Node	Load Case	FX N	FY N	FZ N	MX Nm	MY Nm	MZ Nm	DX mm	DY mm	DZ mm
	6(OPE)	0	0	-9578	0	0	0	-2.432	0.965	-11.034
	7(SUS)	0	0	-8795	0	0	0	-0.011	-0.072	-0.000
	8(SUS)	0	0	-8795	0	0	0	-0.011	-0.072	-0.000
	9(SUS)	0	0	-8795	0	0	0	-0.011	-0.072	-0.000
720		TYPE=VSH Redesign;								
	4(OPE)	0	0	-7901	0	0	0	-0.917	1.473	-6.414
	5(OPE)	0	0	-8035	0	0	0	-0.473	1.895	-8.309
	6(OPE)	0	0	-8224	0	0	0	1.012	2.593	-10.963
	7(SUS)	0	0	-7445	0	0	0	0.016	-0.077	0.002
	8(SUS)	0	0	-7445	0	0	0	0.016	-0.077	0.002
	9(SUS)	0	0	-7445	0	0	0	0.016	-0.077	0.002
730		TYPE=VSH Redesign;								
	4(OPE)	0	0	-9479	0	0	0	-0.243	1.473	-5.441
	5(OPE)	0	0	-9595	0	0	0	0.334	1.895	-7.076
	6(OPE)	0	0	-9764	0	0	0	1.796	2.593	-9.456
	7(SUS)	0	0	-9093	0	0	0	0.007	-0.077	-0.002
	8(SUS)	0	0	-9093	0	0	0	0.007	-0.077	-0.002
	9(SUS)	0	0	-9093	0	0	0	0.007	-0.077	-0.002