

CATS-HV Saturated Load and Transmission Study

A Transmission Option to
Serve Saturated Loads
in Pinal County, Arizona

APPENDIX C Land Use & Electric Assumptions



CATS HV SATURATED LOAD 2005

Blue Text = Formulas

Demand Assignment Categories

Black Text = entered data

Demand Types		Demand Value	Unit
Commercial			
Heavy	(45kW/acre *640acre/sq mile)	28800	kW/sq mile
Medium	(30kW/acre *640acre/sq mile)	19200	kW/sq mile
Light	(14kW/acre *640acre/sq mile)	8960	kW/sq mile
Government	(use light Commercial)	8960	kW/sq mile
Residential			
Assumes 4kW per dwelling unit			
Avg d.u./acre			
0.05	0.2 kW/acre	128	kW/sq mile
0.2	0.8 kW/acre	512	kW/sq mile
0.25	1 kW/acre	640	kW/sq mile
0.50	2 kW/acre	1280	kW/sq mile
1	4 kW/acre	2560	kW/sq mile
1.5	6 kW/acre	3840	kW/sq mile
2	8 kW/acre	5120	kW/sq mile
2.5	10 kW/acre	6400	kW/sq mile
3	12 kW/acre	7680	kW/sq mile
3.5	14 kW/acre	8960	kW/sq mile
4	16 kW/acre	10240	kW/sq mile
4.5	18 kW/acre	11520	kW/sq mile
5	20 kW/acre	12800	kW/sq mile
5.5	22 kW/acre	14080	kW/sq mile
6	24 kW/acre	15360	kW/sq mile
6.5	26 kW/acre	16640	kW/sq mile
7	28 kW/acre	17920	kW/sq mile
7.5	30 kW/acre	19200	kW/sq mile
8	32 kW/acre	20480	kW/sq mile
8.5	34 kW/acre	21760	kW/sq mile
9	36 kW/acre	23040	kW/sq mile
9.5	38 kW/acre	24320	kW/sq mile
10	40 kW/acre	25600	kW/sq mile
10.5	42 kW/acre	26880	kW/sq mile
11	44 kW/acre	28160	kW/sq mile
11.5	46 kW/acre	29440	kW/sq mile
12	48 kW/acre	30720	kW/sq mile
12.5	50 kW/acre	32000	kW/sq mile
13	52 kW/acre	33280	kW/sq mile
13.5	54 kW/acre	34560	kW/sq mile
14	56 kW/acre	35840	kW/sq mile
14.5	58 kW/acre	37120	kW/sq mile
15	60 kW/acre	38400	kW/sq mile
15.5	62 kW/acre	39680	kW/sq mile
16	64 kW/acre	40960	kW/sq mile
16.5	66 kW/acre	42240	kW/sq mile
17	68 kW/acre	43520	kW/sq mile
17.5	70 kW/acre	44800	kW/sq mile
18	72 kW/acre	46080	kW/sq mile
18.5	74 kW/acre	47360	kW/sq mile
19	76 kW/acre	48640	kW/sq mile
19.5	78 kW/acre	49920	kW/sq mile
20	80 kW/acre	51200	kW/sq mile
20.5	82 kW/acre	52480	kW/sq mile
21	84 kW/acre	53760	kW/sq mile
21.5	86 kW/acre	55040	kW/sq mile
22	88 kW/acre	56320	kW/sq mile
22.5	90 kW/acre	57600	kW/sq mile
23	92 kW/acre	58880	kW/sq mile
23.5	94 kW/acre	60160	kW/sq mile
24	96 kW/acre	61440	kW/sq mile
Other Uses			
Parks		500	kW/sq mile
State Land		0	kW/sq mile
Reservation Land (with resorts/industrial parks)		500	kW/sq mile
Reservation Land		100	kW/sq mile
Existing ROW/Roads		0	kW/sq mile
Agriculture		1000	kW/sq mile
Schools	(use Medium Commercial Value)	19200	kW/sq mile

CATS Area Loads

Bus #	Substation Load	Full Load MW	75%	Half load MW
19045	Coolidge 230	455	341	227
19068	Test Track 230kV (formerly SR230)	455	341	227
19057	Oracle	0	0	0
17012	Marana 115kV	220	165	110
14225	Saguaro 230kV	520	390	260
14203	Casa Grande APS 230kV	401	301	201
19210	Rattlesnake 115kV	172	129	86
16000	Tortolita 500kV	516	387	258
			0	
90001	CATSHV01	514	386	257
90002	CATSHV02	523	392	262
90003	CATSHV03	495	372	248
90004	CATSHV04 (Empire)	528	396	264
90005	CATSHV05 (ED5)	463	347	231
90006	CATSHV06 (ED4)	483	362	241
90007	CATSHV07 (Pinal South)	512	384	256
19410	Sundance (Formerly CATSHV08)	498	373	249
90009	CATSHV09 (Florence)	490	367	245
90010	CATSHV10	498	374	249
90011	CATSHV11	399	299	200
90012	CATSHV12 (Marana)	528	396	264
90013	CATSHV13 (Oracle Junction)	476	357	238
90014	CATSHV14 (Pinal West)	377	283	189
90015	CATSHV15	437	328	219
90016	CATSHV16	437	328	219
		10398	7799	5199

**CATS HV SATURATED LOAD STUDY
GENERATION DISPATCH**

		2015 Base			CATS_SAT Load Cases			
					50%	75%	100%	TOTAL
Existing GENERATION								
#	Name	MW	MWmax	Avail	288	0	0	288
19411-20	Sundance	450	600	150	150	-	-	
14987-89	DBG	519	597	78	78	-	-	
14941-45	SaguaroCTs 1-2-3	399	399	0	-	-	-	
16518	Springerville3	420	450	30	30	-	-	
16519	Springerville4	420	450	30	30	-	-	
14800-11	Gila CT&ST	2220	2220	0	-	-	-	
15157-162	HGC CT&ST	1128	1128	0	-	-	-	
15164-169	MES CT&ST	1382	1382	0	-	-	-	
14931-33	Palo Verde	4332	4332	0	-	-	-	
14974-77	RED CT&ST	984	984	0	-	-	-	
15145-7	ARL-CT&ST	699	699	0	-	-	-	
Expansion of Existing Generation								
#	Name	MW						1600
	19410 Sundance2	0	600	600	-	600	-	
	14237 DBG2	0	600	600	-	600	-	
	14225 Saguaro2	0	400	400	-	400	-	
Proposed Generation								
#	Name	MW						8726
	90100 Winchester 500(NM WIND)	0	1500	1500	950	0	200	1150
	80345 Toltec	0	1096	1096	-	1000	96	1096
16530-35	Bowie	0	1080	1080	1080	-	-	1080
14001 (FC BUS)	Desert Rock (coal)	0	1500	1500	-	-	1300	1300
SWAT 14001	Four Corners (coal)	0	1500	1500	900	-	300	1200
SWAT+15021	PV HUB (CTs)	0	1500	1500	950	-	500	1450
SWAT+15021	PV HUB (CCs)	0	1200	1200	-	-	600	600
SWAT 14001	Four Corners (wind)	0	1500	1500	850	-	-	850
Generation Dispatched					5018	2600	2996	10614
CATSHV LOAD								
CATSHV LOAD					5199.5	7799	10399	
Existing LOAD (turned off)					457			
Total New LOAD (CATS-Existing)					4742.5	7799	10399	
Resource Summary								
		MW						
Existing Generation								
Existing (natural gas)		288						
Proposed Generation								
Wind (NM at Winchester & Four Corners)		2000						
Coal (Four Corners)		2500						
Natural Gas (CT&CC)		4226						
Expansion of Existing (natural gas)		1600						
Total		10614						
Resources-Internal vs External								
		MW						
Internal (existing, expansion, Toltec)		2984						
External (PV, FC, Bowie, Winchester)		7630						
Total		10614						

CATS HV Saturated Load Study

As modeled:

Input the Size of Conductor:
1272 or 954

Size	Conductor	voltage	Bundled	# Wires in Bundle	Length	R	X	B	RTG (AMPS)	MVA
1272	ACSS- Bittern	230	NO	1	1 mile	0.000161	0.001429	0.003027	2144	854
2156	ACSR (from IVGS study)	500	Yes	2	1 mile	0.000010907	0.000244	0.0176	1804	3124

PSLF Line Parameters

Modeled lines: (calculated from 1-mile line segments)

From #	From Name	To #	To Name	voltage	Ckt ID	Length	R	X	B	MVA	Comment
14226	Santa Rosa	90001	CATSHV01	230	1	10.8	0.001739	0.015432	0.032686	854	new 230kV following 500kV line
14226	Santa Rosa	90001	CATSHV01	230	2	10.8	0.002205	0.016120	0.031074	287	Loop-in existing SR-TATmomli-Saguaro 230kV line
90001	CATSHV01	14229	Tatmomli	230	1	17.7	0.003615	0.026420	0.050926	287	Loop-in existing SR-TATmomli-Saguaro 230kV line
14237	Desert Basin	90003	CATSHV03 (CG)	230	1	5	0.000805	0.007145	0.015133	854	
19055	Lone Butte	90002	CATSHV02	230	1	32	0.005153	0.045725	0.096848	854	Loop-in existing LB-Coolidge 230kV line
90002	CATSHV02	19410	Sundance	230	1	15.8	0.002544	0.022577	0.047819	854	formerly to CATs02-Coolidge, changed end to Sundance
90003	CATSHV03 (CG)	90007	CATSHV07(PS)	230	1	10.3	0.001659	0.014718	0.031173	854	
90004	CATSHV04 (EM)	90005	CATSHV05(ED5)	230	1	12.1	0.001948	0.017290	0.036621	854	
90003	CATSHV03 (CG)	90006	CATSHV06(ED4)	230	1	18.6	0.002995	0.026578	0.056293	854	Status zero
90007	CATSHV07 (PS)	90006	CATSHV06(ED4)	230	1	9.2	0.001481	0.013146	0.027844	854	
90005	CATSHV05 (ED5)	90006	CATSHV06(ED4)	230	1	8.5	0.001369	0.012146	0.025725	854	
90005	CATSHV05 (ED5)	14225	Saguaro	230	1	15.3	0.002464	0.021862	0.046305	854	
90007	CATSHV07(PS)	19410	Sundance	230	1	4.5	0.000725	0.006430	0.013619	854	formerly to CATS 08. Removed CATS 08 bus = Sundance
90009	CATSHV09 (FL)	15210	SEV	230	1	26.5	0.004267	0.037866	0.080202	854	formerly CATS09 to Browning
15222	Browning	15210	SEV	230	1					854	in case
90007	CATSHV07 (PS)	90009	CATSHV09 (FL)	230	1	18.7	0.003011	0.026720	0.056596	854	
19045	Coolidge	90010	CATSHV10	230	1	11.2	0.001803	0.016004	0.033897	854	
14225	Saguaro	90012	CATSHV12(MA)	230	1	8	0.001288	0.011431	0.024212	854	
14225	Saguaro	90013	CATSHV13(OJ)	230	1	17.3	0.002786	0.024720	0.052358	854	
90007	CATSHV07	90011	CATSHV11	230	1	11	0.001771	0.015718	0.033292	854	
90011	CATSHV11	90016	CATSHV16	230	1	12.7	0.002045	0.018147	0.038437	854	
90016	CATSHV16	14225	Saguaro	230	1	14.5	0.002335	0.020719	0.043884	854	
90015	CATSHV15	90016	CATSHV16	230	1	8.7	0.001401	0.012431	0.026331	854	
90001	CATSHV01	90003	CATSHV03 (CG)	230	1	14.5	0.002335	0.020719	0.043884	854	
90010	CATSHV10	90015	CATSHV15	230	1	15	0.002415	0.021434	0.045398	854	
90015	CATSHV15	90013	CATSHV13(OJ)	230	1	15.7	0.002528	0.022434	0.047516	854	
90100	Winchester	90013	CATSHV13(OJ)	500	1	75	0.000818	0.018278	1.320000	3124	
90100	Winchester	90013	CATSHV13(OJ)	500	1	series cap	0.000000	-0.009832	0.000000	3124	
90013	CATSHV13	90007	CATSHV07 (PS)	500	1	40.3	0.000440	0.009822	0.709280	3124	
15090	HASSYAMPA	79264	PINAL WEST	500	1*	51.8	0.00048	0.01105	1.0374	4290	1780KCM ACSR Chukar tri-bundle
79264	PINAL WEST	14015	SANTA ROSA	500	1*	13.8	0.00013	0.00295	0.27612	4290	1780 ACSR
14015	SANTA ROSA	90007	CATSHV07 (PS)	500	1*	36.9	0.000340	0.007880	0.738640	4290	1780 ACSR
90007	CATSHV07 (PS)	15992	SEV	500	1*	31.3	0.000290	0.006680	0.626460	4290	1780 ACSR
15992	SEV	15051	Browning	500	1*	18	0.000170	0.003850	0.360180	4290	1780 ACSR
14203	Casagrande APS	19218	CASA GRANDE WAPA	230	1	jmp	0.000000	0.000290	0.000000	600	jumper
19218	CASA GRANDE WAPA	90004	CATSHV04(EM)	230	1	12.5	0.002013	0.017861	0.037831	854	
14203	Casagrande APS	90006	CATSHV06(ED4)	230	1	18	0.002898	0.025720	0.054477	854	
90006	CATSHV06	14225	Saguaro	230	1	23.8	0.003832	0.034008	0.072031	854	
90012	CATSHV12(MA)	90207	Nloop	230	1	8	0.001288	0.011431	0.024212	854	
90013	CATSHV13(OJ)	90207	Nloop	230	1	24	0.003864	0.034294	0.072636	854	
80000	REDMSA_E	81000	Four Corners	500	1	183	0.001996	0.044599	3.220800	3124	
80000	REDMSA_E	81000	Four Corners	500	1	series cap	0.000000	-0.015610	0.000000	3124	
14003	Navajo	80000	Red Mesa E	500	1	sec1	0.000141	0.003162	0.245665	2147	split existing line
14002	Moenkopi	80000	Red Mesa E	500	1	61	0.000659	0.014838	1.152735	2147	
Lines to add Toltec Project											
26114	PINAL WEST	16103	South	345kV	1	calc 104	0.004730	0.049470	0.927800	925	in case
16114	Pinal West	80345	Toltec	345	1	25	0.001137	0.011892	0.223029		
80345	Toltec	16103	South	345kV	1	79	0.003593	0.037578	0.704771		
						sumcheck	0.004730	0.049470	0.927800		
80500	Toltec	14004	Saguaro	500	1	17	0.000185	0.004143	0.299200		

*RXB - Data for these elements provided by SRP

Lines added 4-4-06

14016	Pinnacle Peak APS	14001	Four Corners	500	1	sec1	series cap	0	-0.012120	0.000000	1567.5/2182.calc as % of FC-Moenkopi line 179 miles, data from APS3/23/06
14016	Pinnacle Peak APS	14001	Four Corners	500	1	sec2	289	0.002906	0.069260	5.399000	1732.12182.4
14016	Pinnacle Peak APS	14001	Four Corners	500	1	sec3	series cap	0	-0.012120	0.000000	1567.5/2182.4
90007	CATSHV07 (PS)	19045	Coolidge	230	1	11.25	0.001811	0.016075	0.034048	854	

CATS HV Saturated Load Study

As modeled:

Input the Size of Conductor:
1272 or 954

Size	Conductor	voltage	Bundled	# Wires in Bundle	Length
1272		230	NO	1	1 mile
2156		500	Yes	2	1 mile

Distance Calculations (new, upgraded, 230kV/500kV)

Upgrade New Existing

Modeled lines:

(calculated from 1-mile line segments)

From #	From Name	To #	To Name	voltage	Ckt ID	Length			
14226	Santa Rosa	90001	CATSHV01	230	2	10.8			E
90001	CATSHV01	14229	Tatmomli	230	1	17.7			E
19055	Lone Butte	90002	CATSHV02	230	1	32			E
90002	CATSHV02	19410	Sundance	230	1	15.8			E
	TATmomli		Saguaro	230	-	40			E
90100	Winchester	90013	CATSHV13(OJ)	500	1	75			N
90100	Winchester	90013	CATSHV13(OJ)	500	1	series cap			N
90013	CATSHV13	90007	CATSHV07 (PS)	500	1	40.3			N
15090	HASSYAMPA	79264	PINAL WEST	500	1*	51.8			N
79264	PINAL WEST	14015	SANTA ROSA	500	1*	13.8			N
14015	SANTA ROSA	90007	CATSHV07 (PS)	500	1*	36.9			N
90007	CATSHV07 (PS)	15992	SEV	500	1*	31.3			N
15992	SEV	15051	Browning	500	1*	18			N
14226	Santa Rosa	90001	CATSHV01	230	1	10.8			N
14237	Desert Basin	90003	CATSHV03 (CG)	230	1	5			N
90003	CATSHV03 (CG)	90007	CATSHV07(PS)	230	1	10.3			N
90003	CATSHV03 (CG)	90006	CATSHV06(ED4)	230	1	18.6			N
90007	CATSHV07(PS)	19410	Sundance	230	1	4.5			N
90009	CATSHV09 (FL)	15210	SEV	230	1	26.5			N
15222	Browning	15210	SEV	230	1				N
90007	CATSHV07 (PS)	90009	CATSHV09 (FL)	230	1	18.7			N
14225	Saguaro	90012	CATSHV12(MA)	230	1	8			N
90011	CATSHV11	90016	CATSHV16	230	1	12.7			N
90016	CATSHV16	14225	Saguaro	230	1	14.5			N
90015	CATSHV15	90016	CATSHV16	230	1	8.7			N
90001	CATSHV01	90003	CATSHV03 (CG)	230	1	14.5			N
14203	Casagrande APS	19218	CASA GRANDE WAPA	230	1	jmp			N
90012	CATSHV12(MA)	90207	Nloop	230	1	8			N
90013	CATSHV13(OJ)	90207	Nloop	230	1	24			N
90007	CATSHV07 (PS)	19045	Coolidge	230	1	11	Upgrade		
90007	CATSHV07 (PS)	90006	CATSHV06(ED4)	230	1	9.2	Upgrade		
90005	CATSHV05 (ED5)	90006	CATSHV06(ED4)	230	1	8.5	Upgrade		
90004	CATSHV04 (EM)	90005	CATSHV05(ED5)	230	1	12.1	Upgrade		
90005	CATSHV05 (ED5)	14225	Saguaro	230	1	15.3	Upgrade		
19045	Coolidge	90010	CATSHV10	230	1	11.2	Upgrade		
14225	Saguaro	90013	CATSHV13(OJ)	230	1	17.3	Upgrade		
90007	CATSHV07	90011	CATSHV11	230	1	11	Upgrade		
90010	CATSHV10	90015	CATSHV15	230	1	15	Upgrade		
90015	CATSHV15	90013	CATSHV13(OJ)	230	1	15.7	Upgrade		
19218	CASA GRANDE WAPA	90004	CATSHV04(EM)	230	1	12.5	Upgrade		
14203	Casagrande APS	90006	CATSHV06(ED4)	230	1	18	Upgrade		
90006	CATSHV06	14225	Saguaro	230	1	23.8	Upgrade		
									Total Existing
									116.3
									Total 500 New
									267.1
									Total 230kV New
									184.8
									Total 115kV upgrade
									180.6

Synchronous Condensers added to 75% and 100% cases

#	Name	kV	ID	Status	pgen	pmax	75% Load	100% Load	qmax	qmin
							qgen (MVARs)	qgen (MVARs)		
90015	CATSHV15	230	sc	1	0	0	109	113	200	-100
90010	CATSHV10	230	sc	1	0	0	30	96	100	-100
90207	NLOOP230	230	sc	1	0	0	13	83	100	-100
17666	BOPP	115	sc	1	0	0	0	38.9	100	-100
19214	SNYDHILL	115	sc	1	0	0	0	46	100	-100
90009	CATSHV09	230	sc	1	0	0	0	106	200	-100
90002	CATSHV02	230	sc	1	0	0	0	84	200	-100
90005	CATSHV05	230	sc	1	0	0	0	149	200	-100
90011	CATSHV11	230	sc	1	0	0	0	131	200	-100
90001	CATSHV01	230	sc	1	0	0	0	229	300	-100
90013	CATSHV13	230	sc	1	0	0	0	128	200	-100
TOTAL							152	1203.9		

**Original
Interim Report**

Synchronous Condensers added to 75% and 100% cases

#	Name	kV	ID	Status	pgen	pmax	75% Load	100% Load	qmax	qmin	
							qgen (MVARs)	qgen (MVARs)			
90015	CATSHV15	230	sc	1	0	0	93.7	104.9	200	-100	
90010	CATSHV10	230	sc	1	0	0	25	85.6	100	-100	
90207	NLOOP230	230	sc	1	0	0	0	57.3	100	-100	
17666	BOPP	115	sc	1	0	0	0	36.3	100	-100	
19214	SNYDHILL	115	sc	1	0	0	0	44.1	100	-100	
90009	CATSHV09	230	sc	1	0	0	0	90.6	200	-100	
90002	CATSHV02	230	sc	1	0	0	0	69.2	200	-100	
90005	CATSHV05	230	sc	1	0	0	0	131.4	200	-100	
90011	CATSHV11	230	sc	1	0	0	0	114.5	200	-100	
90001	CATSHV01	230	sc	1	0	0	0	213.3	300	-100	
90013	CATSHV13	230	sc	1	0	0	0	116.1	200	-100	
TOTAL							118.7	1063.3			
							for report	118.7	1063.3		

Final Report

Shunts Added to CATS HV 50% load case

BUS NAME	KV	ID	STATUS	MVARs	VSCHED	-V-ACT-
CATSHV02	230	CT	1	50	1	1.0028
CATSHV09	230	CT	1	50	1	1.0017
CATSHV12	230	CT	1	50	1	1.004
CATSHV05	230	CT	1	50	1	1.0057
CATSHV04	230	CT	1	50	1	1.0058
CATSHV11	230	CT	1	50	1	1.0015
CATSHV06	230	CT	1	50	1	1.0042
CATSHV10	230	CT	1	50	1	0.999
ORME	230	CT	1	100	1	0.9812
THUNDRST	230	CT	1	100	1	0.9789
GOLDFELD	230	CT	1	50	1	0.9875
ROGERS	230	CT	1	50	1	0.9832
SUNYSLOP	230	CT	1	50	1	0.97
TOTAL				750		