VALVE REGULATED SEALED LEAD ACID BATTERY

Acme-F Range

(Front access design)

OPERATION MANUAL

Version 3.4

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Contents

Important Safety Instructions

Please read this operation manual carefully. It offers very important safety instructions, installation and operation guide, and ensure your equipment with best performance and prolong the service life of your equipment.

- For the sake of your safety, please do not attempt to remove the components of the battery. The maintenance of the battery can only be carried out by service engineers specially trained by the principal.
- Considering the potential harm of the lead component to the health and environment, the battery can be replaced only by the service center authorized by the manufacturer. To replace the battery or maintenance equipment, please call the after-sales service hotline for information of the nearest service center.
- Please check the local regulations on the correct way of dealing with battery disposal or send the battery to the authorized service center for replacement.
- Battery replacement should be operated or supervised by engineers who are experienced and aware of the preventive measures on the potential harm of the battery.
- Warning - Do not smoke and refrain having fire near the battery.
- Warning - Do not use any organic solvent to clean the battery.
- Warning - Do not have fire near the battery or it may explode.
- Warning - Do not remove the components of the battery as it contains electrolyte that may cause injury to the human body.
- Warning - Battery may cause short circuit. Please remove any watches and jewelry during replacement of the battery, and operate with tools with insulated materials.

				
Warning	Electricity danger	Protecting your eye	Watch Short-circuits	With adults custody
				
Read the manual	Fire forbidden	Circle use	Do not put batteries into dustbin	The product has past the UL Safe authentication

Chapter One Product Introduction

1. Features

1.1 Long life

1.1.1 4BS paste technology

1.1.2 Special paste prescription

1.1.3 Special patent grid alloy

1.1.4 Thick plate design

1.2 Reliable seal performance, no acid spillage to cause equipment erosion.

1.2.1 Reliable seal performance, recombination efficiency reach 99%

1.2.2 Patented post sealing structure

1.2.3 Whole valve design ensure the precision

1.3 Excellent high rate discharge performance

1.3.1 Cross-wall welding between each cell, this construction made internal resistance very low

1.3.2 Superior grid radiates style design; raise the high rate discharge performance.

1.3.3 Patent paste technology

1.3.4 Copper core cable, copper bar as optional

1.4 Unique Rack line dimension Design Created by Narada in China

1.4.1 Long and narrow construction design, good at heat dispersing ability

1.4.2 Both positive and negative posts are in one side of the battery, easy for monitoring and maintenance.

1.4.3 Flexible connectors to be fit together according to client demand

1.4.4 Patent gas collecting system

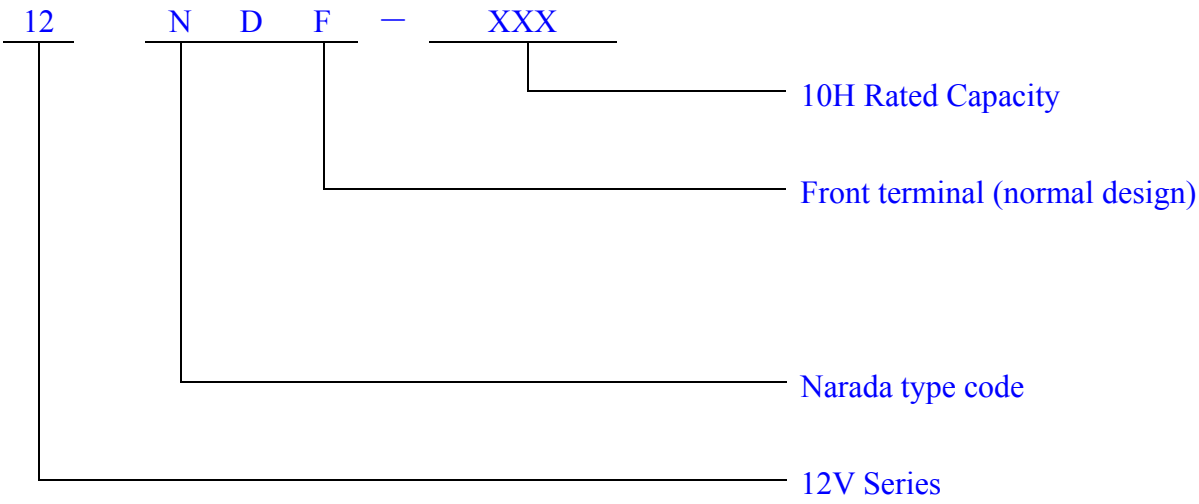
2. Main application fields

2.1 Telecom standby system

2.2 UPS system

2.3 Power system

3. Indication of Type

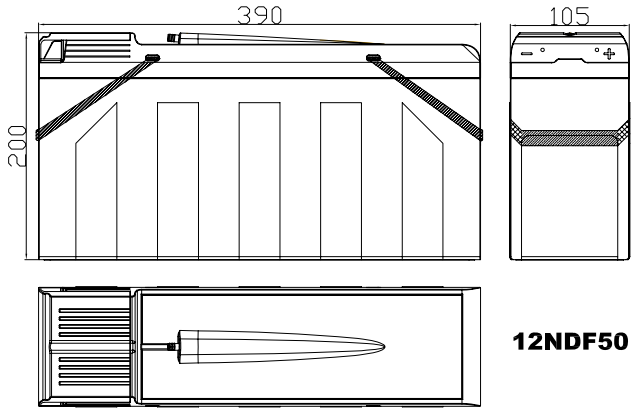


4. Types & Dimensions

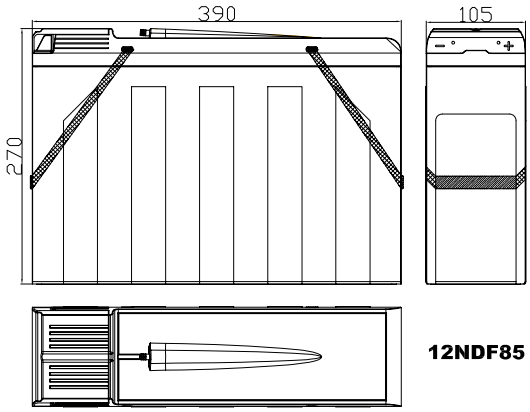
Table 1-1 Narada Acme series battery specification

Type	Normal Voltage (V)	Rated Capacity C_{10}(Ah)	Dimensions(mm)			Weight (Kg)
			Length	Width	Height	
12NDT26	12	26	250	97	148.5	9.3
12NDF50	12	50	390	105	200	21.0
12NDF85	12	85	390	105	270	31.0
12NDT95	12	95	390	105	287	36.0
12NDF100	12	100	390	105	287	33.0
12NDT100A	12	100	390	105	287	32.5
12NDF125	12	125	558	125	270	45.0
12NDF155	12	155	558	125	270	52.5
12NDT180	12	180	558	125	316	60.0
12NDT190	12	190	558	125	316	60.5

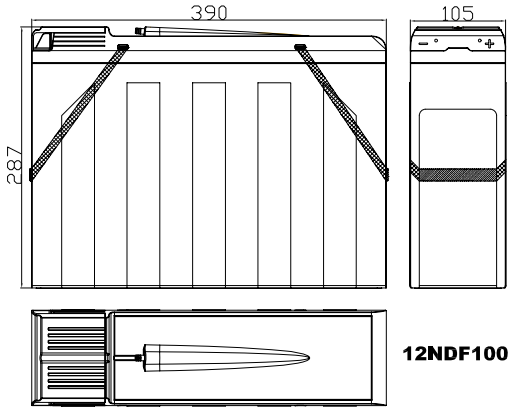
5. Dimension and sketch map



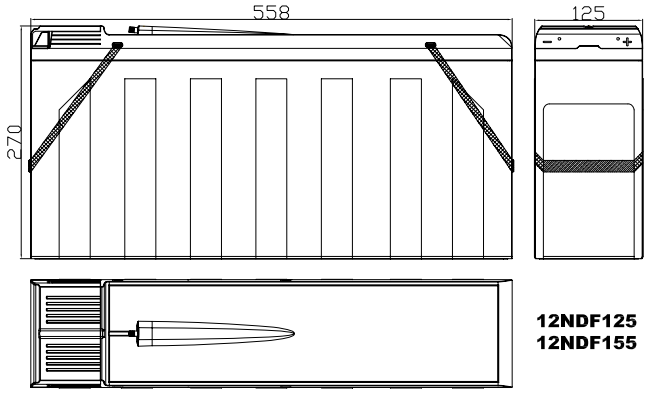
12NDF50



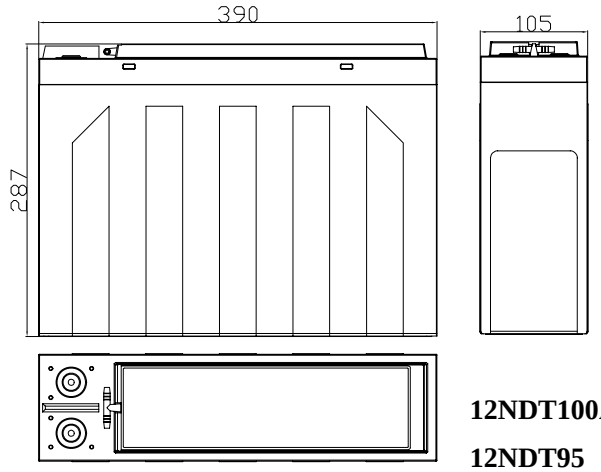
12NDF85



12NDF100

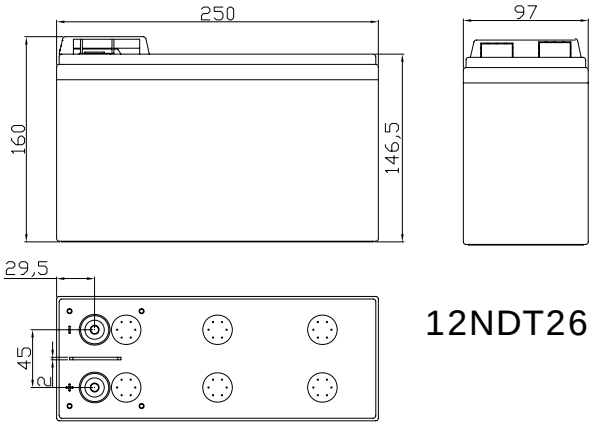


12NDF125
12NDF155

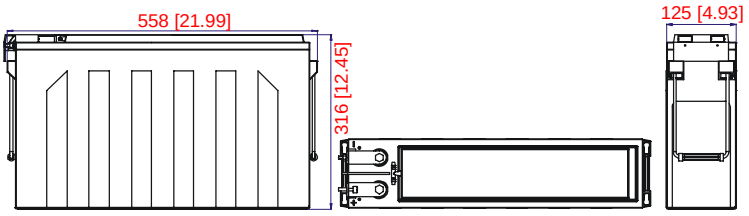


12NDT100A

12NDT95

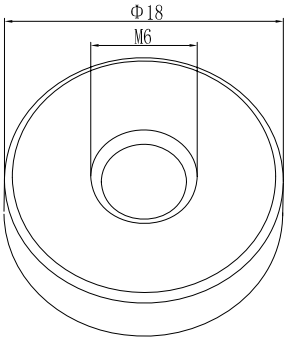


12NDT26



12NDT180/12NDT190

6. Terminals sketch map



12NDF50、12NDF85、12NDF100
12NDF125、12NDF155、12NDT100A

7. Working principle

The chemical reaction-taking place in lead acid battery is as follows:

$$Pb+PbO_2+2H_2SO_4 \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} 2PbSO_4+2H_2O$$

Following by-reaction ① takes place in ordinary lead acid battery:

$$2H_2O \longrightarrow 2H_2\uparrow +O_2\uparrow \qquad ①$$

This by-reaction makes water loss gradually and pure water need to be added regularly to keep the battery operate normally.

Acme series battery adopts design of barren-liquor and utilizes AGM separator. Thus there is a path existing between the positive and the negative. Also special alloy grid is chosen to increase vent hydrogen over-potential gassing on the negative plate, which prevents generation of Hydrogen. Otherwise, the oxygen generated from positive diffuses through separator to the negative and the oxygen gas reacts quickly and is recombined into water. The reactions are as follows:：

$$2Pb+O_2 \longrightarrow 2PbO \qquad ②$$

$$PbO+H_2SO_4 \longrightarrow PbSO_4+H_2O \qquad ③$$

So it is possible to build Acme series battery in sealed structure.

Chapter Two Technical Characteristics

1. Discharge Performance

Fig.2-1, 2-2 are the discharge performance curves at different current（$0.1C_{10}$~$1.0C_{10}$）at 25℃. The end voltage is 10.5V.

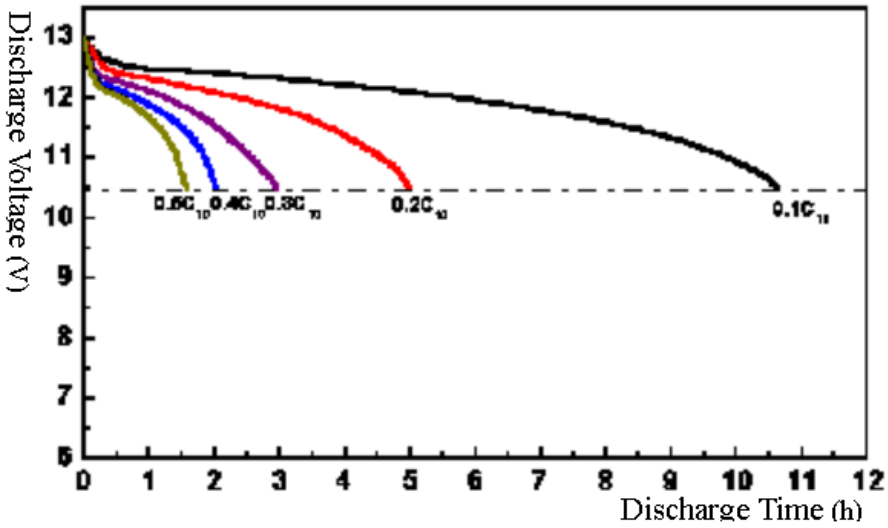


Fig. 2-1Discharge Curve with the current of 0.1 C_{10}~0.5 C_{10}A（25℃）

Explanation for fig. 2-1：let us make 12NDF100 battery as an example. The C_{10} of 12NDF100 is 100Ah，so when discharge at $0.2C_{10}$, i.e.0.2×100＝20A，The discharge voltage and discharge time is shown by $0.2C_{10}$ curve.

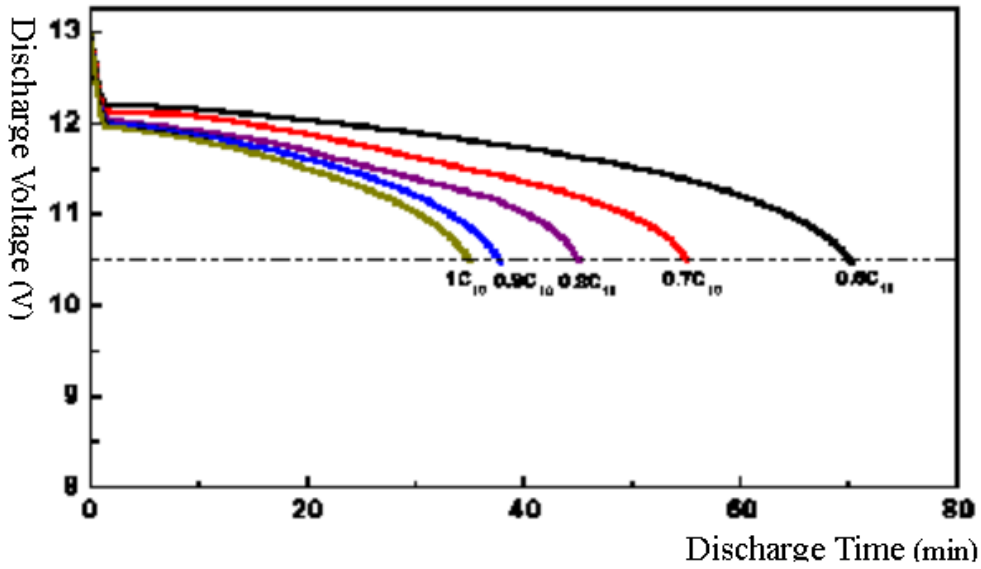


Fig. 2-2 Discharge Curve with the current of 0.6 C_{10}～1.0 C_{10}A（25℃）

Explanation for fig. 2-2：let us make 12NDF100 battery as an example. The C_{10} of 12NDF100 is 100Ah，so when discharge at $0.8C_{10}$, i.e.0.8×100＝80A，The discharge voltage and discharge time is shown by $0.8C_{10}$ curve.

Fig.2-3 are the curves at different discharge rate (20～50 hours rate) at 25℃. The end voltage is 11.1V and 10.8V

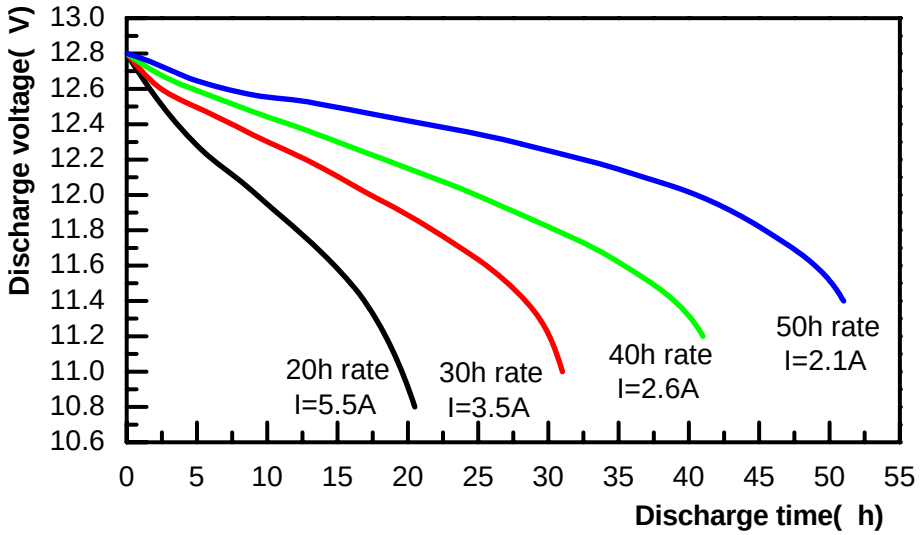


Fig.2-3 Discharge Curve at 20～50 hours rate（25℃）

Fig.2-4 are the discharge time curves at different discharge current (10A~5A) at -15℃. The end voltage is 10.5V.

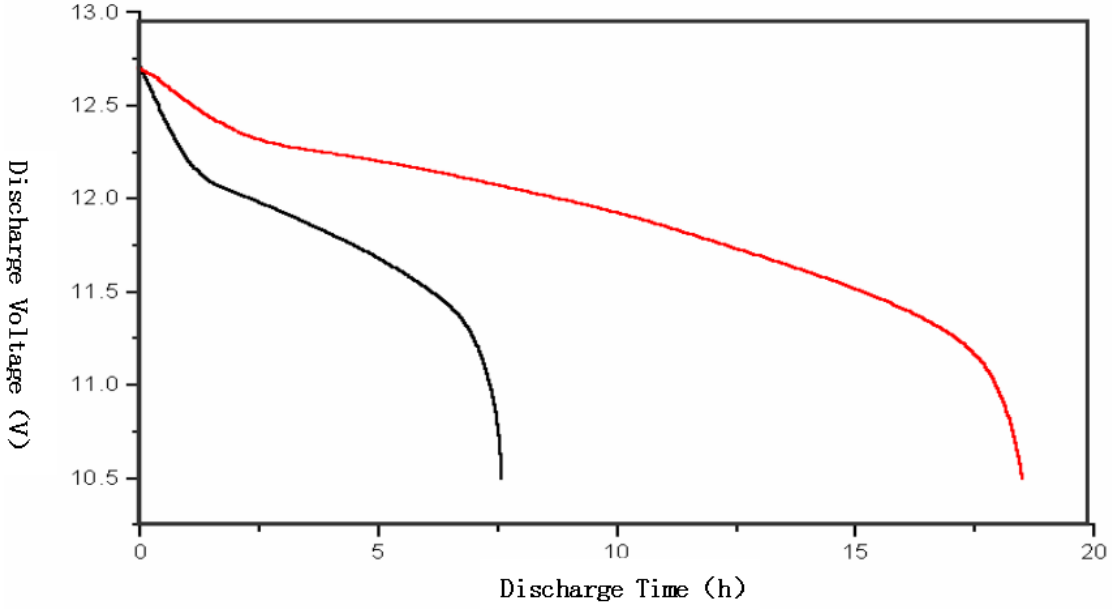


Fig.2-4. Discharge Curves with Current of 5A, 10A at low temperature（-15℃）

2. Constant current and constant power data sheet

Table 2-1 constant current discharge data (Amperes, 25℃)

End Voltage	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
12NDF26															
1.60V	97.8	52.5	31.8	23.0	18.6	10.7	7.75	6.08	5.14	4.41	3.39	2.68	2.35	1.47	1.23
1.67V	91.5	50.6	31.3	22.9	18.5	10.6	7.59	6.03	5.11	4.37	3.35	2.64	2.35	1.46	1.22
1.70V	91.0	49.8	30.8	22.7	18.4	10.6	7.59	6.03	5.03	4.34	3.31	2.64	2.32	1.46	1.22
1.75V	83.2	48.2	30.5	22.6	18.1	10.3	7.49	5.93	5.00	4.31	3.29	2.63	2.32	1.45	1.22
1.80V	74.9	44.9	29.2	21.6	17.6	10.2	7.44	5.93	4.90	4.22	3.25	2.60	2.30	1.44	1.21
1.83V	71.2	41.2	28.7	20.9	16.9	10.1	7.18	5.64	4.74	4.07	3.21	2.51	2.19	1.44	1.20
1.85V	67.1	39.9	26.7	20.1	16.4	9.70	6.97	5.56	4.62	3.98	3.11	2.49	2.16	1.40	1.19
12NDF50															
1.60V	188	101	61.2	44.3	35.8	20.6	14.9	11.7	9.88	8.49	6.51	5.36	4.52	2.83	2.36
1.67V	176	97.4	60.1	44.0	35.6	20.4	14.6	11.6	9.83	8.41	6.47	5.28	4.51	2.80	2.34
1.70V	175	95.7	59.3	43.7	35.4	20.3	14.6	11.6	9.67	8.35	6.44	5.28	4.46	2.80	2.34
1.75V	160	92.7	58.7	43.4	34.8	19.8	14.4	11.4	9.62	8.28	6.37	5.25	4.46	2.79	2.34
1.80V	144	86.4	56.2	41.6	33.9	19.6	14.3	11.4	9.42	8.11	6.33	5.20	4.43	2.76	2.33
1.83V	137	79.2	55.2	40.2	32.5	19.4	13.8	10.9	9.11	7.83	6.18	5.01	4.21	2.76	2.30
1.85V	129	76.7	51.3	38.6	31.5	18.6	13.4	10.7	8.89	7.66	5.98	4.97	4.16	2.70	2.28
12NDF85															
1.60V	307	165	100	72.5	58.6	33.6	24.4	19.1	16.2	13.9	10.6	8.76	7.38	4.62	3.86
1.67V	288	159	98.3	71.9	58.2	33.4	23.9	19.0	16.1	13.7	10.6	8.67	7.37	4.58	3.83
1.70V	286	156	96.9	71.4	57.8	33.2	23.8	18.9	15.8	13.6	10.5	8.63	7.30	4.57	3.83
1.75V	262	151	96.0	70.9	57.0	32.3	23.5	18.7	15.7	13.5	10.4	8.58	7.29	4.56	3.82
1.80V	235	141	91.9	68.0	55.5	32.0	23.4	18.6	15.4	13.3	10.4	8.50	7.23	4.52	3.82
1.83V	224	129	90.2	65.7	53.1	31.6	22.6	17.8	14.9	12.8	10.1	8.18	6.88	4.51	3.75
1.85V	210	125	83.8	63.1	51.4	30.5	22.0	17.6	14.5	12.5	9.78	8.12	6.80	4.42	3.72
End Voltage	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
12NDT95															
1.60V	343	184	112	81.0	65.5	34.1	24.9	21.4	18.1	15.5	11.9	9.79	8.25	5.17	4.31
1.67V	322	178	110	80.4	65.1	33.9	24.4	21.3	18.0	15.4	11.8	9.69	8.24	5.12	4.28
1.70V	319	175	108	79.8	64.6	35.2	24.2	21.2	17.7	15.2	11.8	9.69	8.15	5.11	4.28
1.75V	294	169	107	79.2	63.7	32.9	24.1	20.9	17.6	15.1	11.7	9.60	8.15	5.10	4.28
1.80V	263	158	103	76.0	62.0	32.6	23.8	20.8	17.2	14.8	11.6	9.50	8.08	5.04	4.27
1.83V	251	144	101	73.4	59.3	32.1	23.0	19.9	16.6	14.3	11.3	9.15	7.69	5.04	4.20
1.85V	235	141	93.7	70.6	57.5	30.9	22.4	19.7	16.2	14.0	10.9	9.07	7.60	4.94	4.16
12NDF100															
1.60V	361	194	118	85.3	68.9	39.5	28.7	22.5	19.0	16.3	12.5	10.3	8.68	5.44	4.54
1.67V	339	187	116	84.6	68.5	39.3	28.2	22.4	18.9	16.2	12.4	10.2	8.67	5.39	4.50
1.70V	336	184	114	84.0	68.0	39.0	28.0	22.3	18.6	16.0	12.4	10.2	8.58	5.38	4.50
1.75V	309	178	113	83.4	67.0	38.0	27.7	22.0	18.5	15.9	12.3	10.1	8.58	5.37	4.50
1.80V	277	166	108	80.0	65.3	37.7	27.5	21.9	18.1	15.6	12.2	10.0	8.51	5.31	4.49
1.83V	264	152	106	77.3	62.4	37.2	26.6	20.9	17.5	15.1	11.9	9.63	8.09	5.30	4.42
1.85V	247	148	98.6	74.3	60.5	35.8	25.9	20.7	17.1	14.7	11.5	9.55	8.00	5.20	4.38
End Voltage	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
12NDF125															
1.60V	410	220	133	96.7	78.2	44.8	32.5	26.9	23.5	20.3	15.8	13.0	11.0	6.85	5.73
1.67V	385	212	131	96.0	77.7	44.6	31.9	26.8	23.3	20.2	15.6	12.8	10.9	6.79	5.67
1.70V	381	209	129	95.3	77.1	44.2	31.8	26.6	23.8	20.2	15.6	12.8	10.8	6.78	5.67
1.75V	350	202	128	94.6	76.0	43.1	31.4	26.3	23.4	20.1	15.4	12.7	10.8	6.76	5.67
1.80V	314	188	123	90.7	74.0	42.7	31.2	26.3	22.8	19.7	15.3	12.6	10.7	6.70	5.66
1.83V	299	173	120	87.7	70.8	42.2	30.1	25.0	22.1	19.0	15.0	12.1	10.2	6.68	5.57
1.85V	281	167	112	84.2	68.6	40.6	29.3	24.7	21.5	18.6	14.5	12.0	10.2	6.55	5.52

End Voltage	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
12NDF155															
1.60V	507	273	165	120	96.8	55.5	40.2	33.3	29.1	25.1	19.5	16.1	13.7	8.48	7.09
1.67V	476	263	162	119	96.2	55.2	39.5	33.2	28.9	25.0	19.3	15.8	13.5	8.41	7.02
1.70V	472	258	160	118	95.5	54.8	39.3	33.0	29.5	25.0	19.3	15.9	13.4	8.39	7.02
1.75V	433	250	159	117	94.1	53.4	38.8	32.6	29.0	24.8	19.1	15.8	13.4	8.37	7.02
1.80V	389	233	152	112	91.6	52.9	38.6	32.5	28.2	24.3	19.0	15.6	13.3	8.29	7.00
1.83V	371	214	149	109	87.6	52.2	37.3	31.0	27.3	23.5	18.5	15.0	12.6	8.27	6.89
1.85V	347	207	138	104	84.9	50.3	36.3	30.6	26.7	23.0	17.9	14.9	12.7	8.11	6.83
12NDT180															
1.60V	504	316	208	153	125	72.4	51.3	40.5	34.4	29.1	23.0	18.5	15.9	10.0	8.26
1.67V	472	311	205	153	124	71.7	51.1	40.5	34.2	28.8	22.8	18.4	15.8	9.85	8.19
1.70V	455	305	202	152	123	71.4	50.9	40.4	34.1	28.7	22.7	18.3	15.7	9.76	8.15
1.75V	432	292	194	149	122	70.8	50.6	40.2	33.9	28.4	22.5	18.1	15.6	9.66	8.08
1.80V	388	268	183	142	118	69.3	49.8	39.8	33.3	27.9	22.4	18.0	15.5	9.66	8.04
1.83V	354	251	174	136	116	67.5	48.9	39.3	32.6	27.2	22.1	17.9	15.4	9.57	8.00
1.85V	336	239	170	131	113	65.7	48.0	38.8	32.1	26.9	21.8	17.8	15.3	9.57	7.95
12NDT190															
1.60V	532	334	220	162	132	76.4	54.2	42.8	36.3	30.7	24.3	19.5	16.8	10.5	8.72
1.67V	498	328	216	162	131	75.7	53.9	42.8	36.1	30.4	24.1	19.4	16.7	10.3	8.64
1.70V	480	322	213	160	130	75.4	53.7	42.6	36.0	30.3	24.0	19.3	16.6	10.3	8.60
1.75V	456	308	205	157	129	74.7	53.4	42.4	35.8	30.0	23.8	19.1	16.5	10.1	8.53
1.80V	410	283	193	150	125	73.2	52.6	42.0	35.2	29.5	23.6	19.0	16.4	10.1	8.49
1.83V	374	265	184	144	122	71.3	51.6	41.5	34.4	28.7	23.3	18.9	16.3	10.1	8.44
1.85V	355	252	179	138	119	69.4	50.7	41.0	33.9	28.4	23.0	18.8	16.2	10.1	8.39
End Voltage	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
12NDT100A															
1.60V	361	194	118	85.3	68.9	39.5	28.7	22.5	19.0	16.3	12.5	10.3	8.68	5.44	4.54
1.67V	339	187	116	84.6	68.5	39.3	28.2	22.4	18.9	16.2	12.4	10.2	8.67	5.39	4.50
1.70V	336	184	114	84.0	68.0	39.0	28.0	22.3	18.6	16.0	12.4	10.2	8.58	5.38	4.50
1.75V	309	178	113	83.4	67.0	38.0	27.7	22.0	18.5	15.9	12.3	10.1	8.58	5.37	4.50
1.80V	277	166	108	80.0	65.3	37.7	27.5	21.9	18.1	15.6	12.2	10.0	8.51	5.31	4.49
1.83V	264	152	106	77.3	62.4	37.2	26.6	20.9	17.5	15.1	11.9	9.63	8.09	5.30	4.42
1.85V	247	148	98.6	74.3	60.5	35.8	25.9	20.7	17.1	14.7	11.5	9.55	8.00	5.20	4.38

Table 2-1 Constant power discharge data (Watts per cell, 25℃)

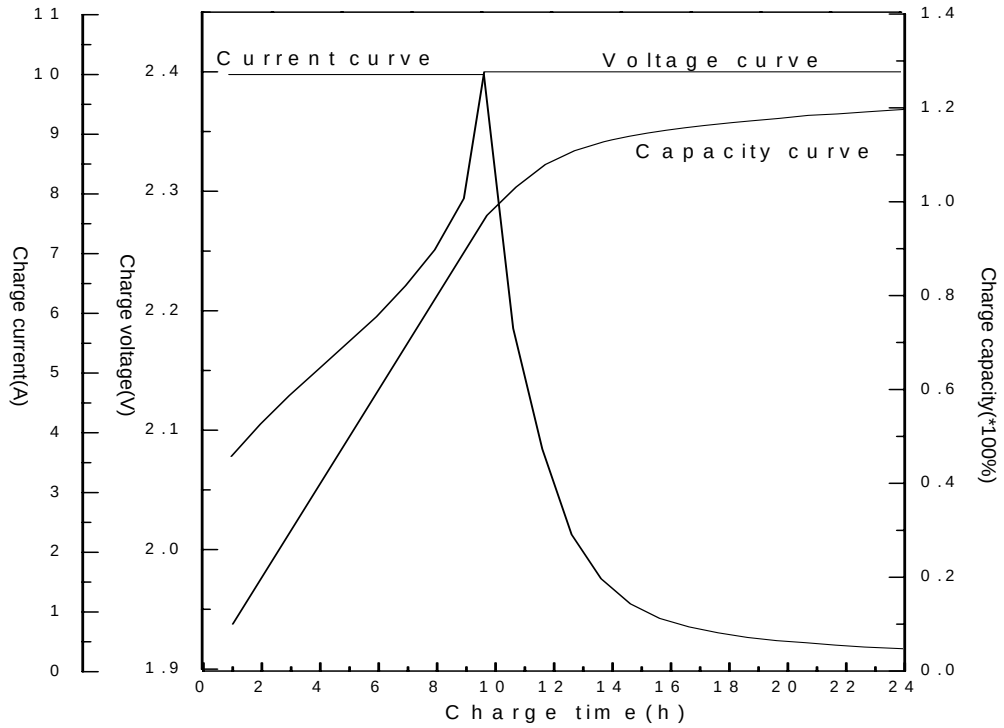
End Voltage	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
12NDF26															
1.60V	163.3	92.0	57.7	43.3	35.0	20.2	14.7	11.7	9.83	8.48	6.55	5.41	4.54	2.91	2.44
1.67V	157.0	90.5	57.2	43.0	34.8	20.1	14.6	11.6	9.83	8.42	6.55	5.36	4.54	2.90	2.44
1.70V	156.5	89.4	57.2	43.0	34.7	20.0	14.6	11.6	9.72	8.37	6.50	5.30	4.50	2.90	2.43
1.75V	145.6	88.9	56.7	42.8	34.2	19.9	14.4	11.6	9.72	8.37	6.45	5.30	4.50	2.89	2.43
1.80V	133.6	84.2	55.6	41.8	34.2	19.9	14.4	11.5	9.52	8.27	6.40	5.30	4.49	2.89	2.43
1.83V	127.9	77.0	54.6	40.6	32.8	19.6	14.0	11.1	9.31	8.01	6.34	5.15	4.35	2.88	2.41
1.85V	119.6	74.9	50.9	38.9	31.7	19.0	13.6	11.0	9.10	7.85	6.14	5.11	4.31	2.83	2.39
12NDF50															
1.60V	314	177	111	83.2	67.4	38.8	28.3	22.5	18.9	16.3	12.6	10.4	8.74	5.60	4.69
1.67V	302	174	110	82.7	67.0	38.7	28.0	22.4	18.9	16.2	12.6	10.3	8.74	5.58	4.69
1.70V	301	172	110	82.6	66.8	38.5	28.0	22.3	18.7	16.1	12.5	10.2	8.66	5.57	4.68
1.75V	280	171	109	82.4	65.8	38.3	27.7	22.3	18.7	16.1	12.4	10.2	8.66	5.55	4.68

1.80V	257	162	107	80.4	65.7	38.2	27.6	22.2	18.3	15.9	12.3	10.2	8.63	5.55	4.67
1.83V	246	148	105	78.0	63.0	37.7	27.0	21.4	17.9	15.4	12.2	9.91	8.37	5.54	4.64
1.85V	230	144	97.9	74.9	61.0	36.5	26.2	21.1	17.5	15.1	11.8	9.83	8.28	5.44	4.60
12NDF85															
1.60V	513	290	181	136	110	63.4	46.3	36.7	31.0	26.7	20.7	17.0	14.3	9.15	7.67
1.67V	494	285	179	135	109	63.3	45.7	36.6	31.0	26.5	20.5	16.9	14.3	9.12	7.66
1.70V	491	282	179	135	109	63.0	45.7	36.5	30.5	26.3	20.4	16.7	14.2	9.10	7.65
1.75V	464	279	179	135	108	62.7	45.2	36.5	30.5	26.2	20.2	16.7	14.2	9.08	7.65
1.80V	426	264	174	131	107	62.5	45.1	36.4	30.0	26.0	20.2	16.6	14.1	9.08	7.64
1.83V	413	242	172	128	103	61.7	44.1	35.0	29.3	25.2	20.0	16.2	13.7	9.06	7.58
1.85V	391	236	160	122	100	59.7	42.9	34.6	28.6	24.7	19.4	16.1	13.5	8.88	7.52
End Voltage	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
12NDT95															
1.60V	574	324	202	152	124	70.9	51.8	41	34.6	29.8	23.1	19	16	10.3	8.57
1.67V	552	318	200	151	123	70.7	51.1	40.9	34.6	29.6	23	18.8	16	10.2	8.57
1.70V	549	314	200	151	123	70.4	51.1	40.8	34.1	29.5	22.8	18.6	15.9	10.2	8.55
1.75V	512	313	200	150	121	70	50.5	40.8	34.1	29.4	22.6	18.6	15.8	10.2	8.55
1.80V	470	295	195	147	120	69.8	50.4	40.7	33.5	29.1	22.5	18.6	15.8	10.2	8.53
1.83V	449	271	193	143	115	69	49.2	39.1	32.8	28.2	22.3	18.1	15.3	10.2	8.47
1.85V	420	264	179	137	111	66.7	47.9	38.7	32	27.6	21.7	18	15.1	9.98	8.41
12NDF100															
1.60V	604	341	213	160	130	74.6	54.5	43.2	36.4	31.4	24.3	20.0	16.8	10.8	9.02
1.67V	581	335	211	159	129	74.4	53.8	43.1	36.4	31.2	24.2	19.8	16.8	10.7	9.02
1.70V	578	331	211	159	129	74.1	53.8	42.9	35.9	31.0	24.0	19.6	16.7	10.7	9.00
1.75V	539	329	210	158	127	73.7	53.2	42.9	35.9	30.9	23.8	19.6	16.6	10.7	9.00
1.80V	495	311	205	155	126	73.5	53.1	42.8	35.3	30.6	23.7	19.6	16.6	10.7	8.98
1.83V	473	285	203	150	121	72.6	51.8	41.2	34.5	29.7	23.5	19.1	16.1	10.7	8.92
1.85V	442	278	188	144	117	70.2	50.4	40.7	33.7	29.1	22.8	18.9	15.9	10.5	8.85
End Voltage	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
12NDF125															
1.60V	685	387	241	181	147	84.6	61.8	51.7	45.1	39.0	30.6	25.2	21.3	13.6	11.4
1.67V	659	380	239	180	146	84.4	61.0	51.6	45.0	39.0	30.3	25.0	21.2	13.5	11.4
1.70V	655	376	239	180	146	84.0	61.0	51.4	46.0	39.0	30.2	24.8	21.0	13.5	11.3
1.75V	612	373	238	180	144	83.6	60.3	51.4	45.5	38.9	29.9	24.7	21.0	13.5	11.3
1.80V	561	352	233	175	143	83.3	60.2	51.2	44.4	38.5	29.9	24.6	20.9	13.5	11.3
1.83V	536	323	230	170	137	82.3	58.8	49.3	43.5	37.4	29.6	24.0	20.3	13.4	11.2
1.85V	501	315	213	163	133	79.6	57.2	48.7	42.4	36.6	28.7	23.8	20.4	13.2	11.1
12NDF155															
1.60V	848	479	299	225	182	105	76.5	64.0	55.8	48.3	37.9	31.1	26.4	16.8	14.1
1.67V	816	470	296	223	181	104	75.5	63.9	55.7	48.3	37.5	30.9	26.2	16.7	14.1
1.70V	811	465	296	223	180	104	75.5	63.6	56.9	48.3	37.5	30.7	26.0	16.7	14.0
1.75V	757	461	295	222	178	104	74.7	63.6	56.3	48.2	37.1	30.6	26.0	16.7	14.0
1.80V	695	436	288	217	177	103	74.5	63.4	55.0	47.7	37.0	30.5	25.9	16.7	14.0
1.83V	663	400	284	211	170	102	72.8	61.1	53.8	46.3	36.7	29.7	25.1	16.6	13.9
1.85V	621	390	264	202	165	98.6	70.8	60.3	52.5	45.4	35.5	29.5	25.2	16.3	13.8
12NDT180															
1.60V	879	584	374	300	255	151	107	83.5	70.3	59.8	45.9	39.4	34.1	20.9	17.4
1.67V	831	568	371	298	254	151	107	83.2	70.0	59.6	45.8	39.3	34.0	20.7	17.3
1.70V	801	557	369	297	253	150	106	83.0	69.7	59.5	45.7	39.3	33.9	20.6	17.3
1.75V	740	536	362	293	249	149	106	82.5	69.3	59.2	45.4	39.2	33.8	20.4	17.2
1.80V	680	507	351	284	243	146	104	81.5	68.3	58.7	45.1	39.0	33.6	20.1	17.2

1.83V	660	480	340	276	236	142	102	80.5	67.3	58.1	44.9	38.7	33.4	19.9	17.1
1.85V	647	458	333	270	231	139	100	79.5	66.1	57.4	44.6	38.6	33.2	19.6	17.1
12NDT190															
1.60V	928	616	395	317	269	159	113	88.1	74.2	63.1	48.5	41.6	36.0	22.0	18.4
1.67V	877	600	392	315	268	159	113	87.8	73.9	62.9	48.3	41.5	35.9	21.9	18.3
1.70V	846	588	390	314	267	158	112	87.6	73.6	62.8	48.2	41.5	35.8	21.7	18.3
1.75V	781	566	382	309	263	157	112	87.1	73.2	62.5	47.9	41.4	35.7	21.5	18.2
1.80V	718	535	371	300	257	154	110	86.0	72.1	62.0	47.6	41.2	35.5	21.2	18.2
1.83V	697	507	359	291	249	150	108	85.0	71.0	61.3	47.4	40.9	35.3	21.0	18.1
1.85V	683	483	352	285	244	147	105	83.9	69.8	60.6	47.1	40.7	35.0	20.7	18.1
End Voltage	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
12NDT100A															
1.60V	604	341	213	160	130	74.6	54.5	43.2	36.4	31.4	24.3	20.0	16.8	10.8	9.02
1.67V	581	335	211	159	129	74.4	53.8	43.1	36.4	31.2	24.2	19.8	16.8	10.7	9.02
1.70V	578	331	211	159	129	74.1	53.8	42.9	35.9	31.0	24.0	19.6	16.7	10.7	9.00
1.75V	539	329	210	158	127	73.7	53.2	42.9	35.9	30.9	23.8	19.6	16.6	10.7	9.00
1.80V	495	311	205	155	126	73.5	53.1	42.8	35.3	30.6	23.7	19.6	16.6	10.7	8.98
1.83V	473	285	203	150	121	72.6	51.8	41.2	34.5	29.7	23.5	19.1	16.1	10.7	8.92
1.85V	442	278	188	144	117	70.2	50.4	40.7	33.7	29.1	22.8	18.9	15.9	10.5	8.85

3. Charge Performance Curve

Following chart is 12NDF100 battery after 100% DOD discharge, charged with $0.1C_{10}A$ current, constant 14.4V/block(25℃) charging curve, battery after completely charging, the capacity can reach above 120%.



4. Internal resistance and short circuit current

The internal resistance of the battery is a dynamic nonlinear parameter that is continuously changed along with the temperature and discharge state. The internal resistance is the lowest when battery is fully charged. The table 2-4 shows the internal resistance and short circuit current of Narada battery in fully charged state according to the IEC60896-21/22 standard.

Table 2-4. Internal resistance and short circuit current (25℃)

Type	Internal resistance (mΩ)	Short circuit current (A)
12NDT26	10.3	1218
12NDF50	8.87	1407
12NDF85	6.47	1864
12NDT95	6.25	2100
12NDF100	6.31	1979
12NDF125	5.70	2229
12NDF155	4.27	2906
12NDT180	3.88	3200
12NDT190	3.88	3200
12NDT100A	6.31	1979

Note: Short circuit current will decrease the voltage of the battery to 0V, and damage the internal components of the battery.

Chapter Three Operation and Maintenance

1. Operation Conditions

Ambient temperature: Acme series optimum temperature is 15℃～25℃, the higher and lower temperatures will impact battery performance

Operation temperature range

Operate status	Temperature range	Optimum temperature
Discharge	-40℃～50℃	15℃～25℃
Charge	-20℃～50℃	15℃～25℃
Storage	-20℃～40℃	15℃～25℃

Ambient humidity：≤95％

Cabinet ventilation conditions: meet the standard EN 50272-2:2001

2. Capacity and influence factors

2.1 The capacity of battery is the capacity that battery can be discharged under certain conditions, expressed as signal C. The usual unit of capacity is ampere-hour, shortened as Ah.

The capacity can be expressed in Rated Capacity or Actual Capacity. The Rated Capacity please see Table 1-1. The Actual Capacity is the product of the discharge current and the discharge time, the unit is Ah.

2.2 The Influence Factor of Actual Capacity

The actual capacity is mainly related with the battery's construction, manufacturing process and operation circumstance. During operation, the factors that influence the actual capacity are discharge rate, end voltage, ambient temperature and discharge time.

2.3 Discharge Rate

If the discharge rate (hour rate) is smaller, the discharge current is larger, and the discharge time is shorter, then the capacity, which can be discharged, is less. For example, the discharge current of 3 hours rate is larger than that of 10 hours rate; and the capacity of 3 hours rate is smaller than that of 10 hours rate.

2.4 End Voltage

The end voltage is the lowest working voltage below which the battery cannot be

discharged any more. Usually the end voltage of Acme range battery is 10.8V per block. The capacity cannot be discharged more even if the end voltage drops, because of the characteristics of lead acid battery. The lower end voltage will harm the battery, especially when the voltage drops to 0V and the battery cannot be recharged in time. This will shorten life of the battery greatly.

Table 3-1 discharge end voltage at different current

Discharge current (A)	Discharge end voltage (V/block)
I＜0.2C	10.8
0.2C≤I＜0.5C	10.2
0.5C≤I＜1.0C	9.30
I≥1.0C	7.80

3. Ambient Temperature, Capacity and Life

3.1 Relation of Ambient Temperature and Capacity

VRLA batteries can be used in very low or high temperature (below-15℃ or above 45℃). Yet all standard data (such as capacity, life, floating voltage) are measured under standard temperature of 20℃-25℃. The capacity will decrease under lower temperature as Fig. 3-1:

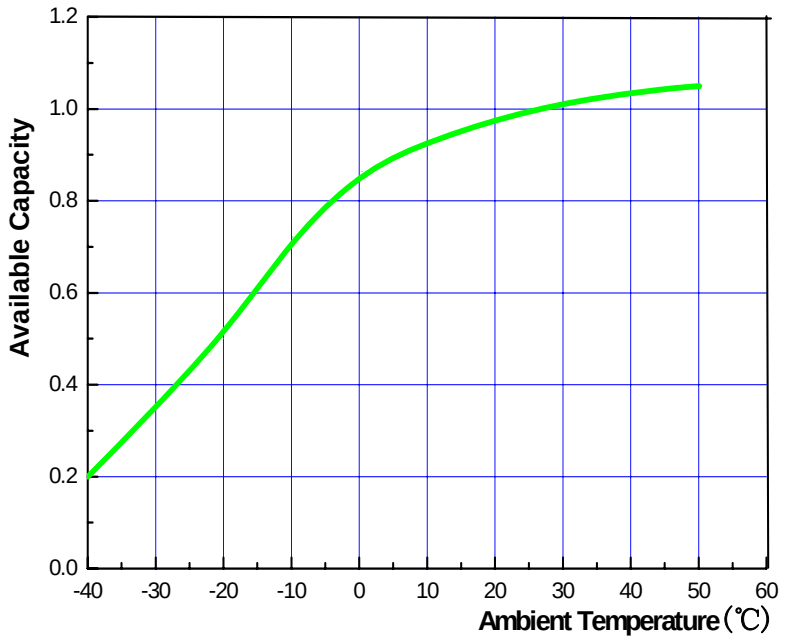


Fig.3-1：Ambient Temperature VS Available Capacity

We may see that the capacity will decrease if the temperature is too low. For example, if the temperature decrease 20℃, the capacity will decrease 16%. Meanwhile, the low

temperature will make the battery always in a less-charged state, then it may cause the battery fail to discharge and the active material in negative plates sulfation.

The capacity will increase when the temperature increases. The capacity will increase 6% when the temperature increase 10℃. However, the high temperature will accelerate the corrosion of the grid and cause water loss inside the battery, thus shorten the life of the battery

So it is important to strictly control the ambient temperature. Please keep the room ventilate and use air-condition when the temperature is too high.

3.2 Floating Operation

To choose given floating voltage is to make the battery operate under the best condition. If the floating voltage is too high, the battery floating current will get larger and expedite the grid erode speed, and cut down the service life of battery; if the floating voltage too low, battery can not maintain full charged condition, can cause sulphate, and reduce the capacity, and will also cut down the service life of battery. Under 25℃， the floating voltage of Narada Acme range battery is 13.5V/block, temperature compensate factor is -18mV/℃/block.

Floating calculating formula under different temperature is:

V_T=13.5-(T-25)×0.003×6

V_T—Floating voltage under T temperature

Table 3-2 gives floating voltage under different temperature

Ambient temperature(℃)	Floating voltage (V/cell)	Floating voltage (V/block)
≤5	2.31	13.86
10	2.295	13.77
15	2.28	13.68
20	2.265	13.59
25	2.25	13.50
30	2.235	13.41
35	2.22	13.32
≥40	2.205	13.23

Note: If ambient temperature below 5℃ or above 40℃, temperature compensate is no longer go on.

3.3 Equalization Charge

VRLA battery need Equalization Charge regularly to ensure the battery operating normally, under 25℃ condition，Narada Acme series battery each block equalization voltage is 14.4V/block. The same, equalization voltage need to adjusted according to the ambient temperature, temperature compensate factor is -30mV/℃/block,

Equalization voltage calculating formula under different temperature is:

V_T=14.4-(T-25)×0.005×6

V_T—equalization voltage under T temperature

Table 3-3 gives Equalization voltage under different temperature

Ambient temperature(℃)	Equalization voltage (V/cell)	Equalization voltage (V/block)
≤5	2.50	15.00
10	2.475	14.85
15	2.45	14.70
20	2.425	14.55
25	2.40	14.40
30	2.375	14.25
35	2.350	14.10
≥40	2.325	13.95

Note: If ambient temperature below 5℃ or above 40℃, temperature compensate is no longer go on.

3.4 Ambient Temperature and Life

Temperature raise can destroy battery, and reduce the service life .when the ambient temperature exceed 25℃，the service life reduce half for each raised 10℃, for example, the battery design service life is 10 years under 25℃, But if operated under 35℃, the service life can only be 5 years, there is a formulas follows:

$t_{25}=t_T\times 2^{(T-25)/10}$

wherein: T actual ambient temperature；

t_T design life under T;

t_{25}design life under 25℃ condition

So that the ambient temperature should be controlled, the heat dispersing of VRLA battery is not quite good, when the temperature run up to some extent can destroy the battery and cause heat lose control phenomenon. If the temperature inside reach too

high some measures should taken to control it and the distance should not less than 10mm, and meanwhile adjust the floating voltage and equalization charging voltage according to the manual request.

4. Charging request

4.1 Equalization charging

Following situation should take equalization charging:

a. There are more than two batteries which voltage is under 13.0V in one group

b. More than three months after floating operation

Equalization charging is recommend as follows: charge the battery group with constant current not exceed $0.2C_{10}A$ till the average voltage go up to 14.4V/block(25℃)，then change into constant voltage of 14.4V/block charging, Equalization charging time is 24 hours.

4.2 Battery charging

Under following situation the battery group need charged method as equalization charging:

a. The batteries should be recharged in time after discharge.

b. After battery system installed

c. Battery storage period exceed three month or open circuit voltage lower than 12.6V/block

- Battery charging is recommended as follows:

  The batteries should first be charged on the constant current of $0.10C_{10}A$ till the average voltage of the batteries increases to 14.4V/block, then the batteries should be charged with constant voltage of 14.4V/block till the charging has completed.

- On some occasions, the batteries have to be fully charged immediately, then fast charging could be adopted. The value of limit current should not be larger than $0.2C_{10}A$, and the charge voltage should be 14.4V/block (25ºC).

Whether the batteries are fully charged can be decided according to any one of two standards as follows:

a. After charging 18～24hours(can be shorter if not deep discharged, for example 20% DOD, the charging time can be shorten into 10 hours)；

b. Under condition of constant voltage, the value of charge current hasn't varied for continuous three hours.

5. Storage

All lead acid batteries experience self-discharge in open circuit. The result is that the voltage of open circuit is decreased, and the capacity also decreased. During storage period, please note:

5.1 The self-discharge rate is related with ambient temperature. The self-discharge degree is smaller when the ambient temperature is lower, otherwise is larger. The requirement temperature of Narada batteries' storage environment is from 5℃ to 30℃. The storage place must be clean, ventilated and dry.

5.2 An important parameter in storage is open circuit voltage, which is related with density of electrolyte. In order to avoid permanent damage to the plate caused by self-discharge, the batteries should be supplemental charged as storage period shown in following table. The equalization charge method should be adopted.

Storage temperature	Max. Storage period
Above 30℃	3 months
Below 30℃	6 months

5.3 During storage, if the open circuit voltage is lower than 12.6V/block, the batteries should be refreshing charged before use. The equalization charge method should be adopted.

5.4 All batteries, which are ready to store, should be fully charged before storage. It's suggested record the storage time in the periodic maintenance record and note the time when next necessary supplemental charge should be made.

Fig.3-2 is the curve of Acme series batteries storage time vs. capacity under different temperature

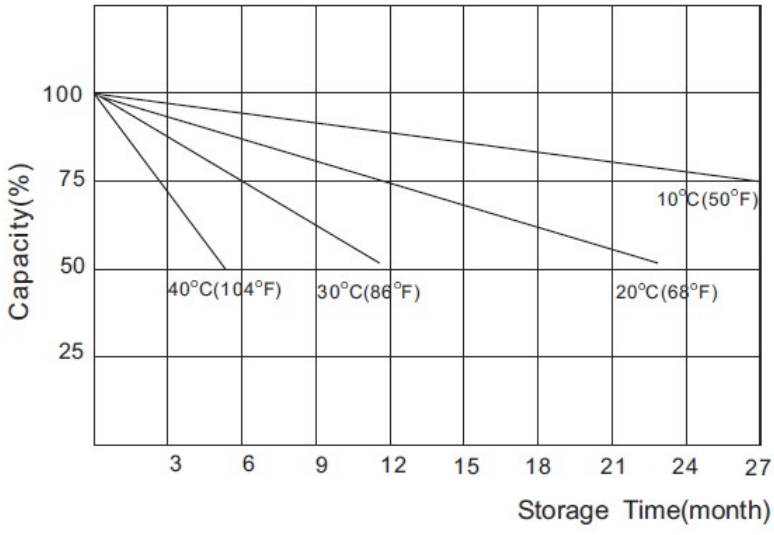


Fig.3-2 self-discharge curve

Chapter four Maintenance

1. Regulated Maintenance

1.1 Instruments and tools needed:

1.1.1 Digital Voltage Meter

1.1.2 Insulated wrench

1.1.3 Internal resistance, conductive, instant loading experiment instruments

1.2 Monthly Maintenance

- Keep the battery-room clean.
- Measure and record the ambient temperature of the battery-room.
- Check each battery's cleanness; check damage and overheating trace of the terminal, container and lid.
- Measure and record the total voltage and floating current of the battery system.

1.3 Quarterly Maintenance

- Repeat monthly inspection.
- Measure and record floating voltage of every on-line battery. If more than one battery's voltage is lower than 13.1V after temperature adjustment, the batteries need to be equalization charged. If the problem still exists after adopting above-mentioned measures, the batteries need yearly maintenance or even three years' maintenance. If all methods are ineffective, please contact us.

1.4 Yearly Maintenance

- Repeat quarterly maintenance and inspection.
- Check whether connectors are loose or not every year.
- Make a discharge test to check with exact load every year, discharge 30-40% of rated capacity.

1.5 Three-year Maintenance

- Make a capacity test every three years and every year after six years' operation. If the capacity of the battery decreases to lower than 80% of rated capacity, the battery should be replaced.

2. Precautions

2.1 Insufficient Charge

If the floating voltage is not set correctly (too low or not amend according to temperature), the battery system will in an insufficient charge state for a long period of time. When the electricity is cut, the battery may not be able to work because the active material is sulfated and the capacity is decreased.

2.2 Over Charge

Please do not neglect the performance of rectify to transfer floating charge to equalization charge. If the rectify cannot transfer charge modes because of its wrong performance or no adjustment, the battery system is always in an equalization charge state. Thus may cause serious problems for battery, such as water loss, life decrease, heat out of control, deformation, etc.

2.3 Too low or too high temperature

We have mentioned that too low temperature will affect the capacity of battery. While too high temperature will also cause problems, such as water loss, life decrease, heat out of control, deformation, etc.

2.4 Too low end voltage

The end voltage is also an important parameter for battery. The battery shall stop discharge when reach a certain voltage (The normal end voltage is 10.5V, in some special causes, is 9.6V). If the end voltage is too low, it will be difficult to recharge the battery and decrease the charge efficiency, thus reduce the life of battery.

2.5 Charge the battery immediately after discharge.

If the battery is put aside without charge for a long time (2 hours above) after discharge, it will affect the capacity and life of the battery. Because some large size $PbSO_4$ will create in the negative which are difficult to transfer to active Pb.

After-sale services

Narada Power Source Co., Ltd.
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Annex 1

VRLA Battery Regular Maintenance Record

Type		Place	
Status		Number of battery	
Total Voltage（V）	Current (A)	Temperature	
No.	Voltage（V）	No.	Voltage（V）
1		13	
2		14	
3		15	
4		16	
5		17	
6		18	
7		19	
8		20	
9		21	
10		22	
11		23	
12		24	
Check by sight			
Result：			
Tester:		Date:	