

SAUDI ARABIAN OIL COMPANY



BI-10-01575-0003

REPLACE 56" ABQAIQ YANBU PIPELINE - SECTION-7

AY-1L PIPELINE

**SOLAR SYSTEM
SIZING CALCULATION**

OCTOBER 2025

PREPARED BY:



REVISION CERTIFICATION		EDSD VERIFICATION	
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SOLAR SYSTEM SIZING CALCULATION		DWG. TYPE DOC	PLANT NO.	INDEX	DRAWING NO.	SHT.NO.	REV.NO.
REPLACE 56" ABQAIQ YANBU PIPELINE SECTION 7 AY-1L PIPELINE			K18	A	VE-200705	001 OF 017	B
YANBU	SAUDI ARABIA	JO / EWO:	10-01575-0003				

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A	07/15/25	10-01575- 0003	FFA	LAK	AAB	AAB
B	10/19/25	10-01575- 0003	FFA	LAK	AAB	AAB
DISCIPLINE ENGINEER FFA						
DATE: 10/19/25						
PROJECT ENGINEER AAI						
DATE: 10/19/25						
CERTIFIED LAK						
DATE: 10/19/25						
CONSTRUCTION AGENCY KHI						
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1.0 INTRODUCTION

The objective of this SOLAR system sizing calculation is to get the estimated size of batteries, Photovoltaic array and controller sizes along with the applications of certain factors as shown in the respective clause herein attached.

2.0 OBJECTIVE

The purpose of this SOLAR System Sizing Calculation is to calculate the adequate battery size & Photovoltaic array sizing to verify the applicable capacity of DC equipment.

3.0 REFERENCES

The calculations are performed conforming to National Electrical Code (NFPA-70) and SAUDI ARAMCO Standards, referred herein:

3.1 SAUDI ARAMCO Engineering Standards (Cut-off Date: May, 2023)

- | | |
|--------------|--|
| SAES-P-100 | - Basic Power System Design Criteria |
| SAES-P-103 | - UPS and DC Systems |
| SAES-P-128 | - Off-Grid Solar Photovoltaic (PV) System with Battery Storage |
| 17-SAMSS-511 | - Stationary Storage Batteries |

3.2 OTHER INDUSTRY STANDARDS

- | | |
|----------|--|
| NFPA-70 | - National Electrical Code |
| NEMA 250 | - Enclosures for Electrical Equipment (1000 VOLTS MAXIMUM) |
| IEEE | - Institute of Electrical and Electronics Engineers |
| ANSI-C2 | - National Electrical Safety Code |

4.0 METHODOLOGY / ASSUMPTIONS

4.1 CONNECTED LOADS

The provided power rating of the equipment is not final, since Vendor load awaited; loads are subject to change based on actual load from vendor.

4.2 DESIGN CONSIDERATIONS FOR PHOTOVOLTAIC SYSTEM CALCULATIONS

- Total Battery back-up time should be 120 hours as per SAES-P-128, para.12.3.
- Battery sizing for Nickel Cadmium batteries shall be in accordance with SAES-P-103 and 17-SAMSS-511.
- The minimum allowed DC system voltage shall be 91.5% of Nominal Voltage for Photovoltaic systems as per SAES-P103, para 5.3.14, Notes-2
- Number of cells are calculated as per SAES-P-103, section 5.3.16, equation (4), considering End of Discharge within the range (1.14 VPC to 1.2 VPC) as specified in SAES-P-103, section 5.3.17, Table 3.
- The provided power rating of the equipment is not final, since Vendor load data is awaited; loads are subject to change based on actual load from vendor.

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DISCIPLINE	ENGINEER	DESCRIPTION	ENGG	CERT
	FFA	ISSUED FOR 60% DETAILED DESIGN	LAK	
	B	10/19/25	FFA	LAK
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- f. Charge controller and inverter shall be rated for the maximum array current plus at least 10% design margin as per SAES-P-128, para 12.4.
- g. The solar array shall be sized to fully recharge the battery to 95% state of charge in 30 days as per SAES-P-128, para. 12.5.1.
- h. The array shall be sized based on 5 effective sun hours for all on-shore installations in Saudi Arabia as per SAES-P-128, para. 12.5.2.
- i. The array sizing shall include additional 10% capacity for future growth as per SAES-P-128, para. 12.5.3.
- j. The array size shall be de-rated 10% for aging over the array expected useful life as per SAES-P-128, para. 12.5.4.
- k. The array size shall be de-rated 20% for dust accumulation as per SAES-P-128, para. 12.5.5.
- l. The solar power supply arrangement at each of the installations is based on one (1) solar power array system rated to cater for 100% of the total load including the following at each location.
- 1 x 100% rated Photovoltaic (PV) module array.
 - 1 x 100% rated battery charging controllers / regulators.
 - 1 x 100% rated maintenance free, long-life, Nickel-Cadmium batteries with five days (i.e., 120 hours) autonomy time. Vendor to submit the cost evaluation of batteries for COMPANY review.
- m. HOLD: For the photovoltaic system the number and specification of photovoltaic modules, charger controller size and battery capacity are preliminary and shall be updated once all the Vendor final loads are received.
- n. Vendor to perform sizing and design of the entire photovoltaic system.

5.0 FORMULAS and CALCULATIONS

5.1 Battery Sizing

For applications of constant current consumption loads, the battery ampere-hour capacity shall be computed by equation (1) as follows:

$$\text{Battery Ah Capacity @ CBT} = L \times BT \times TC \times AF \times DF \quad \text{equation (1)}$$

Where:

Battery Ah Capacity @ CBT - Ah capacity of battery at required backup time

L - Continuous load current (DC amperes)

BT - Battery back-up time (hours)

AF - Aging factor (use 1.25 for all batteries) as per SAES-P-103, para 5.3.3

DF - Design factor (use DF = 1.1 for all types of batteries) as per SAES-P-103, para 5.3.3

TC - Temperature compensation factor (cell size correction factor):

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		10-01575-0003	LAK	LAK
DISCIPLINE ENGINEER FFA <hr/> PROJECT ENGINEER AAI <hr/> CERTIFIED LAK <hr/> CONSTRUCTION AGENCY KHI <hr/> OPERATIONS AAB <hr/> EDSD VERIFICATION CONTROL NUMBER BY: DATE: REVISION CERTIFICATION THIS INDICATES THAT REV. NO. B OF THIS DRAWING IS COVERED FOR ALL APPROVAL/CERTIFICATION REQUIREMENTS, BY DRAWING COMPLETION CERTIFICATE (DCO) NO. 				

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- a) For Lead Acid Batteries refer, the table as per SAES-P-103, para 5.3.3.
- b) For Nickel Cadmium Batteries, consult battery manufacturers for TC Values.

5.2 Photovoltaic Array Sizing

Photovoltaic array sizing and charger controller sizing are calculated in line with SAES-P-128 Attachment-1 calculation procedure.

TABLE-1: Solar Photovoltaic Equipment Summary

PKG (A)	SLNO. (B)	LOCATION (C)	EQUIPMENT (D)	DESCRIPTION (E)	RATING (F)		
					Charger (A)	Batt. (C5 Ah)	Parallel Modules
AY-1L SEC-7	1	MLIV-1 AT KM 3.40	BATTERY	4 parallel sets of 19 cells, Ni-Cd Batt., 120Hr Backup time	-	1400	-
			CHARGER CONTROLLER	Output 24 V DC, Outdoor	400	-	-
			PV MODULE	460 MS High Power PV Modules	-	-	30
	2	MLIV-3 AT KM 34.00	BATTERY	4 parallel sets of 19 cells, Ni-Cd Batt., 120Hr Backup time	-	1400	-
			CHARGER CONTROLLER	Output 24 V DC, Outdoor	400	-	-
			PV MODULE	460 MS High Power PV Modules	-	-	30
	3	MLIV-2 AT KM 19.400	BATTERY	1 parallel set of 19 cells, Ni-Cd Batt., 120Hr Backup time	-	325	-
			CHARGER CONTROLLER	Output 24 V DC, Outdoor	30	-	-
			PV MODULE	460 MS High Power PV Modules	-	-	2

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DISCIPLINE
ENGINEER
FFA
DATE: 10/19/25

PROJECT
ENGINEER
AAI
DATE: 10/19/25

CERTIFIED
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CONSTRUCTION
AGENCY
KHI
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6.0 EQUIPMENT LIST & PHOTOVOLTAIC SYSTEM CALCULATION

6.1 MLIV-1 AT KM 3.40:
EQUIPMENT LIST - LOAD RATINGS FED FROM PHOTOVOLTAIC SYSTEM

Equipment	Power (W)	Voltage (V)	Load current (A)	Runtime (HRs)	Avg. Daily Power (Wh/Day)
K18-RTU-740	400	24	16.67	24	9600
Communication Equip.	400	24	16.67	24	9600
RTU CABINET LTG.	50	24	2.08	5	250
HOV	1500	24	62.50	0.16	240

NOTES:

1. Battery / Controller installation shall be outdoor, natural ventilated in Reinforced fiberglass enclosure.
2. For equipment tag numbers and locations, refer to Electrical One Line Diagram number VA-077561.
3. HOLD: Final Ah & Charger rating on HOLD awaiting vendor load.
4. Battery charger vendor shall perform the sizing and submit calculation for review as per actual load.

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**6.1 MLIV-1 AT KM 3.40:
PHOTOVOLTAIC SYSTEM CALCULATION**

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BATTERY CALCULATION K18-(SP-001)-SB-0001	
System Voltage (Volts DC)	24
Description of the loads (Wh/Day):	-
K18-RTU-740	9600
Communication Equip.	9600
RTU CABINET LTG.	250
HOV	240
Estimated Load (Wh/day)	19690.00
Estimated Load (Wh)	820.42
Load current (A)	34.18
Assumed future expansion (10%)	3.42
Load current + future	37.60
Battery type	Ni-Cd
Constants:	-
Battery Back-up Time (BT)	120
Aging Factor (AF)	1.25
Design Factor (DF)	1.1
TC value for Ni-Cd	1
Computed capacity of battery (Amp Hour) at C120	6204.4
Minimum allowed DC System Voltage (91.5%)	21.96
Selected End of Discharge Voltage per cell	1.2
Calculated Number of Cell	19
Required capacity of battery (Amp Hour) at C120 (4 parallel set)	1520
Selected capacity of battery (Amp Hour) at C5 (4 parallel set)	1400
Assumed daily night duration (Hours)	19

*Note1

*Note1 As per Battery vendor's database (enclosed)

*Note2

*Note2 Conversion from C120 to C5 done as per Saft
Battery catalogue (enclosed)

Photovoltaic Modules K18-(SP-001)-PV-0001	
Selected Module	460MS
Max Current (A)	11.09
Aging Factor	1.1
Dust Factor	1.2
Future Factor	1.1
Daily Peak Hours/day	5
Load Current (A)	34.18
Total Daily Power (Load Current (A) x 24 (H))	820.4
Adjusted Daily Power (Ah)	1191.2
Load Daily Power from PV (Ah)	248.18
Load Daily Power from Battery (Ah)	943.07
Daily Battery Required Recharging Ah for Load x BIF	1084.5
Recharge Time When Battery Fully Depleted to 95% Ah	30 days
Recharge Hours	150
Battery Ah with BIF	6440
Daily Battery Recharging Ah	214.67
Total Daily Battery Recharging Ah	1299.2
Daily Total Required Ah	1547.4
Peak PV Module Output (A)	11.09
Daily Peak Module Output	55.45
No. of Parallel Modules (Min)	27.9
No. of Parallel Modules Selected	30

Charger Controller K18-(SP-001)-BC-0001	
B.C. Output Current (Max Module Amp. X No. of Parallel Modules Selected)	332.7
Charger Controller Amp. + 10% Safety Factor	365.97
Selected charger controller size (Amp.)	400

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6.2 MLIV-3 AT KM 34.00:
EQUIPMENT LIST - LOAD RATINGS FED FROM PHOTOVOLTAIC SYSTEM

Equipment	Power (W)	Voltage (V)	Load current (A)	Runtime (HRs)	Avg. Daily Power (Wh/Day)
K18-RTU-750	400	24	16.67	24	9600
Communication Equip.	400	24	16.67	24	9600
RTU CABINET LTG.	50	24	2.08	5	250
HOV	1500	24	62.50	0.16	240

NOTES:

1. Battery / Controller installation shall be outdoor, natural ventilated in Reinforced fiberglass enclosure.
2. For equipment tag numbers and locations, refer to Electrical One Line Diagram number VA-077576.
3. HOLD: Final Ah & Charger rating on HOLD awaiting vendor load.
4. Battery charger vendor shall perform the sizing and submit calculation for review as per actual load.

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**6.2 MLIV-3 AT KM 34.00:
PHOTOVOLTAIC SYSTEM CALCULATION**

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BATTERY CALCULATION K18-(SP-003)-SB-0001	
System Voltage (Volts DC)	24
Description of the loads (Wh/Day):	-
K18-RTU-750	9600
Communication Equip.	9600
RTU CABINET LTG.	250
HOV	240
Estimated Load (Wh/day)	19690.00
Estimated Load (Wh)	820.42
Load current (A)	34.18
Assumed future expansion (10%)	3.42
Load current + future	37.60
Battery type	Ni-Cd
Constants:	-
Battery Back-up Time (BT)	120
Aging Factor (AF)	1.25
Design Factor (DF)	1.1
TC value for Ni-Cd	1
Computed capacity of battery (Amp Hour) at C120	6204.4
Minimum allowed DC System Voltage (91.5%)	21.96
Selected End of Discharge Voltage per cell	1.2
Calculated Number of Cell	19
Required capacity of battery (Amp Hour) at C120 (4 parallel set)	1520
Selected capacity of battery (Amp Hour) at C5 (4 parallel set)	1400
Assumed daily night duration (Hours)	19

*Note1

*Note2

*Note1 As per Battery vendor's database (enclosed)

*Note2 Conversion from C120 to C5 done as per Saft Battery catalogue (enclosed)

Photovoltaic Modules K18-(SP-003)-PV-0001	
Selected Module	460MS
Max Current (A)	11.09
Aging Factor	1.1
Dust Factor	1.2
Future Factor	1.1
Daily Peak Hours/day	5
Load Current (A)	34.18
Total Daily Power (Load Current (A) x 24 (H))	820.4
Adjusted Daily Power (Ah)	1191.2
Load Daily Power from PV (Ah)	248.18
Load Daily Power from Battery (Ah)	943.07
Daily Battery Required Recharging Ah for Load x BIF	1084.5
Recharge Time When Battery Fully Depleted to 95% Ah	30 days
Recharge Hours	150
Battery Ah with BIF	6440
Daily Battery Recharging Ah	214.67
Total Daily Battery Recharging Ah	1299.2
Daily Total Required Ah	1547.4
Peak PV Module Output (A)	11.09
Daily Peak Module Output	55.45
No. of Parallel Modules (Min)	27.9
No. of Parallel Modules Selected	30

Charger Controller K18-(SP-003)-BC-0001	
B.C. Output Current (Max Module Amp. X No. of Parallel Modules Selected)	332.7
Charger Controller Amp. + 10% Safety Factor	365.97
Selected charger controller size (Amp.)	400

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**6.3 MLIV-2 AT KM 19.400:
EQUIPMENT LIST - LOAD RATINGS FED FROM PHOTOVOLTAIC SYSTEM**

Equipment	Power (W)	Voltage (V)	Load current (A)	Runtime (HRs)	Avg. Daily Power (Wh/Day)
K18-DIT-00912	30	24	1.25	24	720
K18-U-0004 (Surge relief Skid)	50	24	2.08	0.25	12.5
HOV	2500	24	104.17	0.16	400

NOTES:

1. Battery / Controller installation shall be outdoor, natural ventilated in Reinforced fiberglass enclosure.
2. For equipment tag numbers and locations, refer to Electrical One Line Diagram number VA-077546.
3. HOLD: Final Ah & Charger rating on HOLD awaiting vendor load.
4. Battery charger vendor shall perform the sizing and submit calculation for review as per actual load.

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CONTROL NUMBER	BY:	DATE:	_____
DATE: _____			
DISCIPLINE ENGINEER FFA			
DATE 10/19/25			
PROJECT ENGINEER AAI			
DATE 10/19/25			
CERTIFIED			
LAK			
DATE 10/19/25			
CONSTRUCTION AGENCY KHI			
DATE 10/19/25			
OPERATIONS			
AAB			
DATE 10/19/25			
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VERIFICATION			
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ENGINEER	FFA	PROJECT ENGINEER	AAI	CERTIFIED	DATE	10/19/25	CONSTRUCTION AGENCY	KHI	OPERATIONS	AAB	
DATE	10/19/25	DATE	10/19/25	DATE	10/19/25	DATE	10/19/25	DATE	10/19/25	DATE	10/19/25
CONTROL NUMBER	BY:	DATE:									

6.3 MLIV-2 AT KM 19.400:

PHOTOVOLTAIC SYSTEM CALCULATION

BATTERY CALCULATION K18-(SP-002)-SB-0001	
System Voltage (Volts DC)	24
Description of the loads (Wh/Day):	-
K18-DIT-00912	720
K18-U-000 (Surge relief) Skid	12.5
HOV	400
Estimated Load (Wh/day)	1132.5
Estimated Load (Wh)	47.19
Load current (A)	1.97
Assumed future expansion (10%)	0.20
Load current + future	2.16
Battery type	Ni-Cd
Constants:	-
Battery Back-up Time (BT)	120
Aging Factor (AF)	1.25
Design Factor (DF)	1.1
TC value for Ni-Cd	1
Computed capacity of battery (Amp Hour) at C120	356.9
Minimum allowed DC System Voltage (91.5%)	21.96
Selected End of Discharge Voltage per cell	1.2
Calculated Number of Cell	19
Required capacity of battery (Amp Hour) at C120 (1 set)	355
Selected capacity of battery (Amp Hour) at C5 (1 set)	325
Assumed daily night duration (Hours)	19

*Note1 As per Battery vendor's database (enclosed)

*Note2 Conversion from C120 to C5 done as per Saft
Battery catalogue (enclosed)

Photovoltaic Modules K18-(SP-002)-PV-0001	
Selected Module	460MS
Max Current (A)	11.09
Aging Factor	1.1
Dust Factor	1.2
Future Factor	1.1
Daily Peak Hours/day	5
Load Current (A)	1.97
Total Daily Power (Load Current (A) x 24 (H))	47.2
Adjusted Daily Power (Ah)	68.516
Load Daily Power from PV (Ah)	14.274
Load Daily Power from Battery (Ah)	54.242
Daily Battery Required Recharging Ah for Load x BIF	62.378
Recharge Time When Battery Fully Depleted to 95% Ah	30 day
Recharge Hours	150
Battery Ah with BIF	373.75
Daily Battery Recharging Ah	12.458
Total Daily Battery Recharging Ah	74.837
Daily Total Required Ah	89.111
Peak PV Module Output (A)	11.09
Daily Peak Module Output	55.45
No. of Parallel Modules (Min)	1.6
No. of Parallel Modules Selected	2

Charger Controller K18-(SP-002)-BC-0001	
B.C. Output Current (Max Module Amp. X No. of Parallel Modules Selected)	22.18
Charger Controller Amp. + 10% Safety Factor	24.398
Selected charger controller size (Amp.)	30

SOLAR SYSTEM SIZING CALCULATION	DWG. TYPE	PLANT NO.	INDEX	DRAWING NO.	SHT NO.	REV NO.
REPLACE 56" ABQAIQ YANBU PIPELINE -SECTION 7	DOC	K18	A	VE-200705	011	
AY-1L PIPELINE					OF	B
YANBU		SAUDI ARABIA	JO NO.	10-01575-0003	017	

SAUDI ARABIAN OIL COMPANY

7.0 ATTACHMENTS

Attachment- 7.1: KUMAX CANDIAN SOLAR

ATTACHMENT#1

**HiKu****HIGH POWER MONO PERC MODULE****435 W ~ 460 W****CS3W-435 | 440 | 445 | 450 | 455 | 460MS****MORE POWER**

26 % more power than conventional modules

Up to 4.5 % lower LCOE
Up to 2.7 % lower system costLow NMOT: 42 ± 3 °C
Low temperature coefficient (Pmax):
-0.35 % / °C

Better shading tolerance

**12 Years** Enhanced Product Warranty on Materials and Workmanship***25 Years** Linear Power Performance Warranty***1st year power degradation no more than 2%****Subsequent annual power degradation no more than 0.55%**

*According to the applicable Canadian Solar Limited Warranty Statement.

MANAGEMENT SYSTEM CERTIFICATES*ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
ISO 45001: 2018 / International standards for occupational health & safety**PRODUCT CERTIFICATES***IEC 61215 / IEC 61730 / CE / MCS / INMETRO
FSEC (US Florida) / UL 61730 / IEC 61701 / IEC 62716
UNI 9177 Reaction to Fire: Class 1 / Take-e-way

* The specific certificates applicable to different module types and markets will vary, and therefore not all of the certifications listed herein will simultaneously apply to the products you order or use. Please contact your local Canadian Solar sales representative to confirm the specific certificates available for your product and applicable in the regions in which the products will be used.

CSI Solar Co., Ltd. is committed to providing high quality solar products, solar system solutions and services to customers around the world. Canadian Solar was recognized as the No. 1 module supplier for quality and performance/price ratio in the IHS Module Customer Insight Survey, and is a leading PV project developer and manufacturer of solar modules, with over 50 GW deployed around the world since 2001.

* For detailed information, please refer to Installation Manual.

CSI Solar Co., Ltd.
199 Lushan Road, SND, Suzhou, Jiangsu, China, 215129, www.csisolar.com, support@csisolar.com

REVISION CERTIFICATION	EDSD VERIFICATION	CONTROL NUMBER	THIS INDICATES THAT REV. NO. <u>B</u> FOR ALL APPROVAL/CERTIFICATION REQUIREMENTS BY DRAWING COMPLETION CERTIFICATE (DCC) NO. <u></u>			
			BY: <u></u>	DATE: <u></u>	BY: <u></u>	DATE: <u></u>

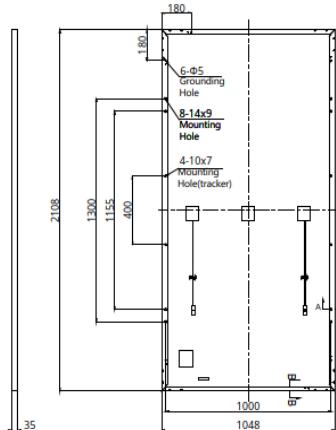
SOLAR SYSTEM SIZING CALCULATION	DWG. TYPE	PLANT NO.	INDEX	DRAWING NO.	SHT NO.	REV NO.
REPLACE 56" ABQAIQ YANBU PIPELINE -SECTION 7	DOC	K18	A	VE-200705	012 OF	B
AY-1L PIPELINE						
YANBU		SAUDI ARABIA	JO NO.	10-01575-0003	017	

SAUDI ARABIAN OIL COMPANY

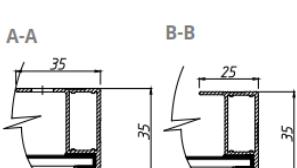
		ENGG CERT	PMT	OPRNS	AAB	AAB
		FFA	LAK			
DESCRIPTION						
ISSUED FOR 60% DETAILED DESIGN						
ISSUED FOR 90% DETAILED DESIGN						
REV. NO.	DATE	JO/EWO				
A	07/15/25	10-01575-0003				
B	10/19/25	10-01575-0003				
DISCIPLINE						
ENGINEER						
FFA						
DATE	10/19/25					
PROJECT						
ENGINEER						
AAI						
DATE	10/19/25					
CERTIFIED						
LAK						
DATE	10/19/25					
CONSTRUCTION						
AGENCY						
KHI						
DATE	10/19/25					
OPERATIONS						
AAB						
DATE	10/19/25					
EDSD	VERIFICATION					
B	CONTROL NUMBER					
BY:						
DATE:						
REVISION CERTIFICATION						
This indicates that Rev. No. B of this drawing is covered for all approval/certification requirements by drawing completion certificate DDCI No. 0003.						

ENGINEERING DRAWING (mm)

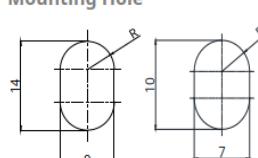
Rear View



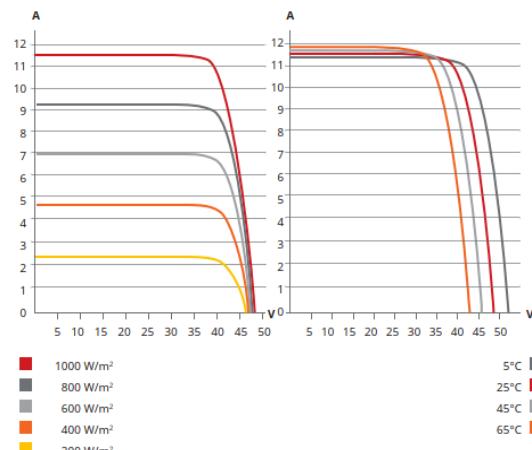
Frame Cross Section



Mounting Hole



CS3W-435MS / I-V CURVES



ELECTRICAL DATA | STC*

CS3W	435MS	440MS	445MS	450MS	455MS	460MS
Nominal Max. Power (Pmax)	435 W	440 W	445 W	450 W	455 W	460 W
Opt. Operating Voltage (Vmp)	40.5 V	40.7 V	40.9 V	41.1 V	41.3 V	41.5 V
Opt. Operating Current (Imp)	10.75 A	10.82 A	10.89 A	10.96 A	11.02 A	11.09 A
Open Circuit Voltage (Voc)	48.5 V	48.7 V	48.9 V	49.1 V	49.3 V	49.5 V
Short Circuit Current (Isc)	11.42 A	11.48 A	11.54 A	11.60 A	11.66 A	11.72 A
Module Efficiency	19.7%	19.9%	20.1%	20.4%	20.6%	20.8%
Operating Temperature	-40°C ~ +85°C					
Max. System Voltage	1500V (IEC/UL) or 1000V (IEC/UL)					
Module Fire Performance	TYPE 1 (UL 61730 1500V) or TYPE 2 (UL 61730 1000V) or CLASS C (IEC 61730)					
Max. Series Fuse Rating	20 A					
Application Classification	Class A					
Power Tolerance	0 ~ + 10 W					

* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

ELECTRICAL DATA | NMOT*

CS3W	435MS	440MS	445MS	450MS	455MS	460MS
Nominal Max. Power (Pmax)	325 W	328 W	332 W	336 W	339 W	343 W
Opt. Operating Voltage (Vmp)	37.8 V	37.9 V	38.1 V	38.3 V	38.5 V	38.7 V
Opt. Operating Current (Imp)	8.59 A	8.65 A	8.71 A	8.76 A	8.82 A	8.87 A
Open Circuit Voltage (Voc)	45.6 V	45.8 V	46.0 V	46.2 V	46.4 V	46.6 V
Short Circuit Current (Isc)	9.21 A	9.26 A	9.31 A	9.36 A	9.41 A	9.45 A

* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m², spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

MECHANICAL DATA

Specification	Data
Cell Type	Mono-crystalline
Cell Arrangement	144 [2 X (12 X 6)]
Dimensions	2108 X 1048 X 35 mm (83.0 X 41.3 X 1.38 in)
Weight	24.3 kg (53.6 lbs)
Front Cover	3.2 mm tempered glass
Frame	Anodized aluminium alloy
J-Box	IP68, 3 bypass diodes
Cable	4 mm² (IEC), 12 AWG (UL)
Cable Length	500 mm (19.7 in) (+) / 350 mm (13.8 in) (-) or customized length*
Connector	T4 series or H4 UTX or MC4-EVO2
Per Pallet	30 pieces
Per Container (40' HQ)	660 pieces

* For detailed information, please contact your local Canadian Solar sales and technical representatives.

TEMPERATURE CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.35 % / °C
Temperature Coefficient (Voc)	-0.27 % / °C
Temperature Coefficient (Isc)	0.05 % / °C
Nominal Module Operating Temperature	42 ± 3°C

PARTNER SECTION

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* The specifications and key features contained in this datasheet may deviate slightly from our actual products due to the on-going innovation and product enhancement. CSI Solar Co., Ltd. reserves the right to make necessary adjustment to the information described herein at any time without further notice.

Please be kindly advised that PV modules should be handled and installed by qualified people who have professional skills and please carefully read the safety and installation instructions before using our PV modules.

CSI Solar Co., Ltd.
199 Lushan Road, SND, Suzhou, Jiangsu, China, 215129, www.csisolar.com, support@csisolar.com

SOLAR SYSTEM SIZING CALCULATION	DWG. TYPE	PLANT NO.	INDEX	DRAWING NO.	SHT NO.	REV NO.
REPLACE 56" ABQAQIY YANBU PIPELINE -SECTION 7	DOC	K18	A	VE-200705	013	
AY-1L PIPELINE					OF	
YANBU		SAUDI ARABIA	JO NO.	10-01575-0003	017	B

SAUDI ARABIAN OIL COMPANY

Attachment- 7.2: SAFT Ni-Cd Batteries



(3)

		DESCRIPTION		ENGG CERT	PMT	OPRNS
REV. NO.	DATE	JO/EWO	DATE	FFA	LAK	AAB
A	07/15/25	10-01575-0003				
B	10/19/25	10-01575-0003				

DISCIPLINE
ENGINEER
FFA

DATE 10/19/25

PROJECT
ENGINEER
AAI

DATE 10/19/25**CERTIFIED**

LAK

DATE 10/19/25

CONSTRUCTION
AGENCY
KHI

10/19/25**OPERATIONS**

AAB

DATE 10/19/25

EDSD	VERIFICATION	CONTROL NUMBER	BY:	DATE:
B				

REVISION CERTIFICATION
THIS INDICATES THAT REV. NO.
OF THIS DRAWING IS COVERED FOR ALL
APPROVAL/CERTIFICATION REQUIREMENTS
BY DRAWING COMPLETION CERTIFICATE
DCI NO.

Protective cover

- to prevent external short-circuits
- in line with EN 50272-2 / IEC 62485-2 (safety) with IP2 level

Flame arresting vent plug**Handles****Block concept**

up to 6 cells

Cell container

made of tough polypropylene

Automated integral water filling system

SAFT's automated integral water filling system is available as an option for Sunica.plus cell range



(3) Sunica.plus installed on an off-grid telecom installation in Africa.

Sunica.plus – Physical properties

Cell type	Capacity	Capacity	Height	
	C ₁₀₀ 120 h 1.0 V Ah	C ₅ 5 h 1.0 V Ah		
SUN+ 100	100	95	421	16,6
SUN+ 150	150	140	421	16,6
SUN+ 200	200	185	421	16,6
SUN+ 250	250	235	421	16,6
SUN+ 305	305	280	421	16,6
SUN+ 355	355	325	421	16,6
SUN+ 405	405	375	421	16,6
SUN+ 455	455	420	421	16,6
SUN+ 505	505	470	421	16,6
SUN+ 555	555	515	405	15,9
SUN+ 610	610	560	405	15,9
SUN+ 660	660	610	405	15,9
SUN+ 710	710	650	405	15,9
SUN+ 760	760	700	405	15,9
SUN+ 810	810	750	405	15,9
SUN+ 860	860	800	405	15,9
SUN+ 910	910	840	405	15,9
SUN+ 960	960	890	405	15,9
SUN+ 1015	1015	940	405	15,9
SUN+ 1065	1065	980	405	15,9
SUN+ 1115	1115	1030	405	15,9
SUN+ 1170	1170	1080	405	15,9
SUN+ 1215	1215	1120	405	15,9
SUN+ 1270	1270	1170	405	15,9
SUN+ 1320	1320	1220	405	15,9
SUN+ 1370	1370	1260	405	15,9
SUN+ 1420	1420	1300	405	15,9
SUN+ 1470	1470	1350	405	15,9
SUN+ 1520	1520	1400	405	15,9
SUN+ 1570	1570	1450	405	15,9
SUN+ 1620	1620	1500	405	15,9
SUN+ 1670	1670	1550	405	15,9
SUN+ 1720	1720	1600	405	15,9
SUN+ 1775	1775	1650	405	15,9
SUN+ 1830	1830	1700	405	15,9

* Rigid connector included

SOLAR SYSTEM SIZING CALCULATION		DWG. TYPE	PLANT NO.	INDEX	DRAWING NO.	SHT NO.	REV NO.
REPLACE 56" ABQAIQ YANBU PIPELINE -SECTION 7	DOC	K18	A	VE-200705	014	OF	
AY-1L PIPELINE							
YANBU		SAUDI ARABIA	JO NO.	10-01575-0003		017	B

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REVISION CERTIFICATION		EDSD	VERIFICATION
		<u>B</u>	<u>CONTROL NUMBER</u>
THIS INDICATES THAT REV. NO. <u>B</u> OF THIS DRAWING IS COVERED FOR ALL APPROVAL/CERTIFICATION REQUIREMENTS BY DRAWING COMPLETION CERTIFICATE DCC1 NO.		BY: _____	DATE: _____

Width mm in	Length per block												Approx. weight per cell kg lb	Internal resistance* mOhm	Cell connection bolt per pole			
	1 cell		2 cells		3 cells		4 cells		5 cells		6 cells							
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in						
195	7,7	-	-	85	3,9	121	4,8	156	6,1	192	7,6	228	9,0	4,9	10,8	2,55 M8		
195	7,7	-	-	109	4,3	157	6,2	204	8,0	252	9,9	300	11,8	6,7	14,7	1,73 M10		
195	7,7	-	-	133	5,2	193	7,6	252	9,9	312	12,2	372	14,6	8,4	18,5	1,31 M10		
195	7,7	-	-	159	6,3	232	9,1	304	11,9	377	14,8	450	17,7	9,9	21,8	1,03 M10		
195	7,7	-	-	183	7,2	268	10,6	352	13,8	437	17,2	522	20,5	11,5	25,3	0,86 M10		
195	7,7	-	-	228	9,0	336	13,2	-	-	-	-	-	-	15,1	33,2	0,74 2xM10		
195	7,7	-	-	252	9,9	372	14,6	-	-	-	-	-	-	16,8	37,0	0,65 2xM10		
195	7,7	-	-	278	10,9	411	16,1	-	-	-	-	-	-	18,3	40,3	0,58 2xM10		
195	7,7	-	-	304	11,9	450	17,7	-	-	-	-	-	-	19,8	43,6	0,51 2xM10		
195	7,7	171	6,7	-	-	-	-	-	-	-	-	-	-	21,4	47,1	0,47 2xM10		
195	7,7	183	7,2	-	-	-	-	-	-	-	-	-	-	23,0	50,7	0,43 2xM10		
195	7,7	207	8,1	-	-	-	-	-	-	-	-	-	-	26,5	58,4	0,40 3xM10		
195	7,7	219	8,6	-	-	-	-	-	-	-	-	-	-	28,2	62,1	0,37 3xM10		
195	7,7	232	9,1	-	-	-	-	-	-	-	-	-	-	29,7	65,4	0,35 3xM10		
195	7,7	243	9,6	-	-	-	-	-	-	-	-	-	-	31,4	69,2	0,32 3xM10		
195	7,7	256	10,0	-	-	-	-	-	-	-	-	-	-	32,9	72,5	0,30 3xM10		
195	7,7	268	10,5	-	-	-	-	-	-	-	-	-	-	34,5	76,0	0,29 3xM10		
195	7,7	291	11,4	-	-	-	-	-	-	-	-	-	-	38,1	83,9	0,27 4xM10		
195	7,7	304	11,9	-	-	-	-	-	-	-	-	-	-	39,6	87,3	0,26 4xM10		
195	7,7	315	12,4	-	-	-	-	-	-	-	-	-	-	41,2	90,8	0,25 4xM10		
195	7,7	327	12,8	-	-	-	-	-	-	-	-	-	-	42,9	94,5	0,23 4xM10		
195	7,7	352	13,8	-	-	-	-	-	-	-	-	-	-	46,3	102,0	0,22 4xM10		
195	7,7	352	13,8	-	-	-	-	-	-	-	-	-	-	46,0	101,4	0,22 4xM10		
195	7,7	352	13,8	-	-	-	-	-	-	-	-	-	-	49,5	109,0	0,21 5xM10		
195	7,7	387	15,2	-	-	-	-	-	-	-	-	-	-	51,3	113,0	0,20 5xM10		
195	7,7	400	15,7	-	-	-	-	-	-	-	-	-	-	52,7	116,0	0,19 5xM10		
195	7,7	412	16,2	-	-	-	-	-	-	-	-	-	-	54,4	119,9	0,19 5xM10		
195	7,7	425	16,7	-	-	-	-	-	-	-	-	-	-	55,9	123,0	0,18 5xM10		
195	7,7	437	17,2	-	-	-	-	-	-	-	-	-	-	57,5	126,7	0,17 5xM10		
195	7,7	462	18,2	-	-	-	-	-	-	-	-	-	-	61,0	134,0	0,17 5xM10		
195	7,7	472	18,5	-	-	-	-	-	-	-	-	-	-	62,8	138,4	0,16 6xM10		
195	7,7	485	19,1	-	-	-	-	-	-	-	-	-	-	64,2	142,0	0,16 6xM10		
195	7,7	497	19,5	-	-	-	-	-	-	-	-	-	-	65,9	145,2	0,15 6xM10		
195	7,7	510	20,1	-	-	-	-	-	-	-	-	-	-	67,4	149,0	0,15 6xM10		
195	7,7	522	20,5	-	-	-	-	-	-	-	-	-	-	69,0	152,1	0,14 6xM10		

SUN+ 100 to SUN+ 505: standard mounted on racks – SUN+ 555 to SUN+ 830: crosswise mounted on racks

REVISION CERTIFICATION	EDSD	VERIFICATION
	<u>B</u>	<u>CONTROL NUMBER</u>
THIS INDICATES THAT REV. NO. <u>B</u> OF THIS DRAWING IS COVERED FOR ALL APPROVAL/CERTIFICATION REQUIREMENTS BY DRAWING COMPLETION CERTIFICATE DCC1 NO.	BY: _____	DATE: _____

SOLAR SYSTEM SIZING CALCULATION			DWG. TYPE	PLANT NO.	INDEX	DRAWING NO.	SHT NO.	REV NO.
REPLACE 56" ABQAIQ YANBU PIPELINE -SECTION 7	DOC	K18	A	VE-200705	015 OF 017			
AY-1L PIPELINE								
YANBU				SAUDI ARABIA	JO NO.	10-01575-0003		B

SAUDI ARABIAN OIL COMPANY

Performance for fully charged cells by a constant current charge according to IEC 62259 standard
Available Amperes at $+ 20^\circ\text{C} \pm 5^\circ\text{C}$ ($+ 68^\circ\text{F} \pm 9^\circ\text{F}$)

Final voltage: 1.18 V/cell

Cell type	Capacity C ₁₂₀ 1.0 V Ah	DESCRIPTION									
		2 days 48 hours	3 days 72 hours	4 days 96 hours	5 days 120 hours	6 days 144 hours	7 days 168 hours	8 days 192 hours	9 days 216 hours	10 days 240 hours	
SUN+ 100	100	1,92	1,33	1,02	0,83	0,70	0,60	0,53	0,47	0,43	
SUN+ 150	150	2,88	2,00	1,53	1,24	1,05	0,90	0,79	0,71	0,64	
SUN+ 200	200	3,84	2,66	2,03	1,66	1,39	1,21	1,05	0,95	0,85	
SUN+ 250	250	4,79	3,33	2,54	2,07	1,74	1,51	1,32	1,18	1,07	
SUN+ 305	305	5,85	4,06	3,10	2,53	2,13	1,84	1,61	1,44	1,30	
SUN+ 355	355	6,81	4,73	3,61	2,94	2,48	2,14	1,87	1,68	1,52	
SUN+ 405	405	7,77	5,39	4,12	3,36	2,82	2,44	2,14	1,92	1,73	
SUN+ 455	455	8,73	6,06	4,63	3,77	3,17	2,74	2,40	2,15	1,94	
SUN+ 505	505	9,7	6,72	5,14	4,18	3,52	3,05	2,66	2,39	2,16	
SUN+ 555	555	10,6	7,39	5,64	4,60	3,87	3,35	2,93	2,63	2,37	
SUN+ 610	610	11,7	8,12	6,20	5,05	4,25	3,68	3,22	2,89	2,60	
SUN+ 660	660	12,7	8,79	6,71	5,47	4,60	3,98	3,48	3,12	2,82	
SUN+ 710	710	13,6	9,45	7,22	5,88	4,95	4,28	3,74	3,36	3,03	
SUN+ 760	760	14,6	10,1	7,73	6,30	5,30	4,58	4,01	3,60	3,24	
SUN+ 810	810	15,5	10,8	8,24	6,71	5,65	4,89	4,27	3,83	3,46	
SUN+ 860	860	16,5	11,4	8,75	7,13	6,00	5,19	4,54	4,07	3,67	
SUN+ 910	910	17,5	12,1	9,25	7,54	6,35	5,49	4,80	4,31	3,88	
SUN+ 960	960	18,4	12,8	9,76	7,95	6,69	5,79	5,06	4,54	4,10	
SUN+ 1015	1015	19,5	13,5	10,3	8,41	7,08	6,12	5,35	4,80	4,33	
SUN+ 1065	1065	20,4	14,2	10,8	8,83	7,43	6,42	5,62	5,04	4,55	
SUN+ 1115	1115	21,4	14,8	11,3	9,24	7,78	6,73	5,88	5,28	4,76	
SUN+ 1170	1170	22,4	15,6	11,9	9,70	8,16	7,06	6,17	5,54	4,99	
SUN+ 1215	1215	23,3	16,2	12,4	10,1	8,47	7,33	6,41	5,75	5,19	
SUN+ 1270	1270	24,4	16,9	12,9	10,5	8,86	7,66	6,70	6,01	5,42	
SUN+ 1320	1320	25,3	17,6	13,4	10,9	9,21	7,96	6,96	6,25	5,63	
SUN+ 1370	1370	26,3	18,2	13,9	11,4	9,55	8,26	7,23	6,48	5,85	
SUN+ 1420	1420	27,2	18,9	14,4	11,8	9,9	8,56	7,49	6,72	6,06	
SUN+ 1470	1470	28,2	19,6	14,9	12,2	10,3	8,87	7,75	6,96	6,27	
SUN+ 1520	1520	29,2	20,2	15,5	12,6	10,6	9,17	8,02	7,19	6,49	
SUN+ 1570	1570	30,1	20,9	16,0	13,0	10,9	9,47	8,28	7,43	6,70	
SUN+ 1620	1620	31,1	21,6	16,5	13,4	11,3	9,77	8,54	7,67	6,92	
SUN+ 1670	1670	32,0	22,2	17,0	13,8	11,6	10,1	8,81	7,90	7,13	
SUN+ 1720	1720	33,0	22,9	17,5	14,3	12,0	10,4	9,07	8,14	7,34	
SUN+ 1775	1775	34,0	23,6	18,0	14,7	12,4	10,7	9,36	8,40	7,58	
SUN+ 1830	1830	35,1	24,4	18,6	15,2	12,8	11,0	9,65	8,66	7,81	

Final voltage: 1.20 V/cell

Cell type	Capacity C ₁₂₀ 1.0 V Ah	DESCRIPTION									
		2 days 48 hours	3 days 72 hours	4 days 96 hours	5 days 120 hours	6 days 144 hours	7 days 168 hours	8 days 192 hours	9 days 216 hours	10 days 240 hours	
SUN+ 100	100	1,76	1,24	0,94	0,78	0,67	0,58	0,51	0,46	0,41	
SUN+ 150	150	2,65	1,86	1,41	1,16	1,00	0,86	0,76	0,68	0,62	
SUN+ 200	200	3,53	2,48	1,88	1,55	1,33	1,15	1,02	0,91	0,82	
SUN+ 250	250	4,41	3,10	2,35	1,94	1,66	1,44	1,27	1,14	1,03	
SUN+ 305	305	5,38	3,78	2,86	2,37	2,03	1,76	1,55	1,39	1,25	
SUN+ 355	355	6,26	4,40	3,33	2,75	2,36	2,05	1,81	1,62	1,46	
SUN+ 405	405	7,14	5,02	3,80	3,14	2,70	2,33	2,06	1,85	1,67	
SUN+ 455	455	8,02	5,64	4,27	3,53	3,03	2,62	2,32	2,08	1,87	
SUN+ 505	505	8,9	6,26	4,74	3,92	3,36	2,91	2,57	2,31	2,08	
SUN+ 555	555	9,8	6,88	5,21	4,30	3,69	3,20	2,82	2,53	2,28	
SUN+ 610	610	10,8	7,56	5,73	4,73	4,06	3,52	3,10	2,79	2,51	
SUN+ 660	660	11,6	8,18	6,20	5,12	4,39	3,80	3,36	3,01	2,72	
SUN+ 710	710	12,5	8,80	6,67	5,51	4,73	4,09	3,61	3,24	2,92	
SUN+ 760	760	13,4	9,4	7,14	5,89	5,06	4,38	3,87	3,47	3,13	
SUN+ 810	810	14,3	10,0	7,61	6,28	5,39	4,67	4,12	3,70	3,33	
SUN+ 860	860	15,2	10,7	8,08	6,67	5,73	4,96	4,38	3,93	3,54	
SUN+ 910	910	16,0	11,3	8,55	7,06	6,06	5,24	4,63	4,15	3,74	
SUN+ 960	960	16,9	11,9	9,01	7,44	6,39	5,53	4,88	4,38	3,95	
SUN+ 1015	1015	17,9	12,6	9,5	7,87	6,76	5,85	5,16	4,63	4,18	
SUN+ 1065	1065	18,8	13,2	10,0	8,26	7,09	6,14	5,42	4,86	4,38	
SUN+ 1115	1115	19,7	13,8	10,5	8,65	7,42	6,43	5,67	5,09	4,59	
SUN+ 1170	1170	20,6	14,5	11,0	9,07	7,79	6,74	5,95	5,34	4,81	
SUN+ 1215	1215	21,4	15,1	11,4	9,4	8,09	7,00	6,18	5,55	5,00	
SUN+ 1270	1270	22,4	15,7	11,9	9,8	8,45	7,32	6,44	5,80	5,23	
SUN+ 1320	1320	23,3	16,4	12,4	10,2	8,79	7,61	6,72	6,03	5,43	
SUN+ 1370	1370	24,2	17,0	12,9	10,6	9,12	7,89	6,97	6,26	5,64	
SUN+ 1420	1420	25,0	17,6	13,3	11,0	9,5	8,18	7,23	6,48	5,84	
SUN+ 1470	1470	25,9	18,2	13,8	11,4	9,8	8,47	7,48	6,71	6,05	
SUN+ 1520	1520	26,8	18,8	14,3	11,8	10,1	8,76	7,73	6,94	6,25	
SUN+ 1570	1570	27,7	19,5	14,7	12,2	10,5	9,05	7,99	7,17	6,46	
SUN+ 1620	1620	28,6	20,1	15,2	12,6	10,8	9,34	8,24	7,40	6,67	
SUN+ 1670	1670	29,5	20,7	15,7	12,9	11,1	9,6	8,50	7,63	6,87	
SUN+ 1720	1720	30,3	21,3	16,2	13,3	11,5	9,9	8,75	7,85	7,08	
SUN+ 1775	1775	31,3	22,0	16,7	13,8	11,8	10,2	9,03	8,10	7,30	
SUN+ 1830	1830	32,3	22,7	17,2	14,2	12,2	10,5	9,31	8,36	7,53	

SOLAR SYSTEM SIZING CALCULATION

REPLACE 56" ABQAQI YANBU PIPELINE -SECTION 7

AY-1L PIPELINE

YANBU

DWG. TYPE

DOC

PLANT NO.

K18

INDEX

A

DRAWING NO.

VE-200705

SHT NO.

016

OF

017

REV NO.

B

REV.
NO.

A

07115/25

003

10-01575-

003

10/19/25

003

DISCIPLINE

ENGINEER

FFA

DATE

10/19/25

PROJECT

ENGINEER

AAI

DATE

10/19/25

CERTIFIED

LAK

DATE

10/19/25

CONSTRUCTION

AGENCY

KHI

DATE

10/19/25

OPERATIONS

AAB

DATE

10/19/25

EDSD

VERIFICATION

BY:

DATE:

THIS INDICATES THAT REV. NO.

OF THIS DRAWING IS COVERED FOR ALL

APPROVAL/CERTIFICATION REQUIREMENTS

BY DRAWING COMPLETION CERTIFICATE

DCI NO.

SAUDI ARABIAN OIL COMPANY

REVISION CERTIFICATION	EDSD VERIFICATION	CONTROL NUMBER <u>B</u>	THIS INDICATES THAT REV. NO. OF THIS DRAWING IS COVERED FOR ALL APPROVAL/CERTIFICATION REQUIREMENTS BY DRAWING COMPLETION CERTIFICATE DOC# NO.				
SOLAR SYSTEM SIZING CALCULATION REPLACE 56" ABQAIQ YANBU PIPELINE -SECTION 7 AY-1L PIPELINE YANBU							
		DWG. TYPE <u>DOC</u>	PLANT NO. <u>K18</u>	INDEX <u>A</u>	DRAWING NO. <u>VE-200705</u>	SHT NO. <u>017</u>	REV NO. <u>B</u>
			SAUDI ARABIA	JO NO. 10-01575-0003			

5.4. Affect of temperature on performance

Variations in ambient temperature affects the performance of Sunica and this must be allowed for in the battery engineering.

Low temperature operation has the effect of reducing the performance but the higher temperature characteristics are similar to those of normal temperatures. The effect of temperature is more marked at higher rates of discharge.

The factors which are required in sizing a battery to compensate for temperature variations are given in a graphical form in Figure 1 for operating temperatures from -40°C to $+60^{\circ}\text{C}$.

The Sunica battery with conventional bolted assembly connections will withstand a short circuit current of this magnitude for many minutes without damage.

5.5. Short circuit values

The typical short circuit value in amperes for a Sunica cell is approximately 15 times the ampere-hour capacity.

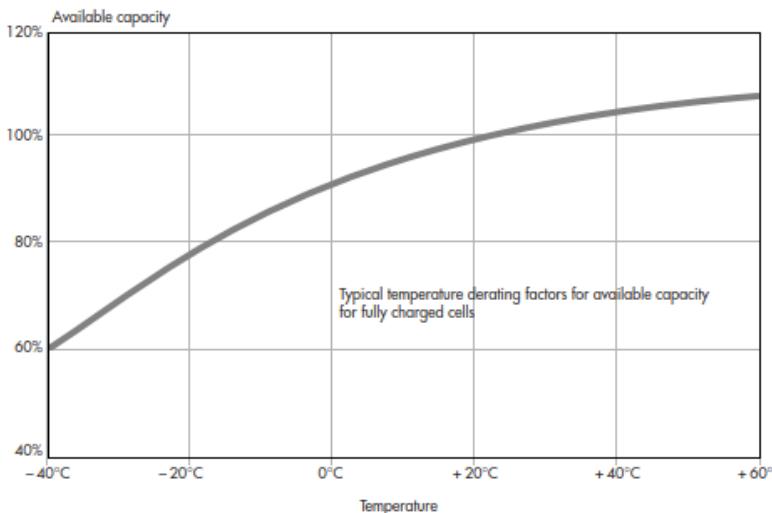


Figure 1: Typical capacity derating factors versus temperature