

PowerSafe[®]

Sustainable solutions













PowerSafe[®] TS

Operation Guide for Solar Applications

EnerSys[®]

Power/Full Solutions

<p>Safety precautions Batteries give off explosive gasses. They are filled with dilute sulphuric acid, which is very corrosive. When working with sulphuric acid, always wear protective clothing and glasses. Exposed metal parts of the battery always carry a voltage and are electrically live (risk of short circuits). Avoid electrostatic charge. The protective measures according to EN 50272-2 must be observed.</p>		
 <p>Note operating instructions.</p>	 <p>Danger. Cells are heavy. Make sure they are safely installed. Only use suitable transport and lifting equipment.</p>	 <p>Risk of explosion or fire. Avoid short circuits.</p>
 <p>When working on batteries, wear safety glasses and protective clothing.</p>	 <p>Electrical hazard.</p>	 <p>Wash all acid splash in eyes or on skin with plenty of clean water and seek immediate medical assistance</p>
 <p>No smoking. Do not allow naked flames, hot objects or sparks near the battery, due to the risk of explosion or fire.</p>	 <p>Electrolyte is highly corrosive.</p>	
<p>Recycling and disposal of used batterie Used batteries contain valuable recyclable materials. They must not be disposed of with the domestic waste but as special waste. Modes of return and recycling shall conform to the prevailing regulations in operation at the site where the battery is located.</p>		
		
<p>Warranty Any of the following actions will invalidate the warranty - Non-adherence to the Installation, Operating and Maintenance instructions. Repairs carried out with non-approved spare parts. Application of additives to the electrolyte. Unauthorised interference with the battery.</p>		
<p>Handling TS batteries are supplied in a fully charged state and must be unpacked carefully to avoid short-circuit between terminals of opposite polarity. The cells are heavy and must be lifted with appropriate equipment</p>	<p>Keep Flames Away Discharge any possible static electricity from clothes by touching an earth connected part.</p>	<p>Tools Use tools with insulated handles. Do not place or drop metal objects onto the battery. Remove rings, wristwatch and metal articles of clothing that might come into contact with the battery terminals.</p>

Specific Abilities

The specific abilities of this type of battery for renewable energy applications are as follows.

- **Cycling** (one “cycle” consists of a discharge, of any depth, followed by a recharge)
- **Overcharge ability**
- **Cycling in state of discharge**
- **Low rate of self-discharge**
- **Large electrolyte reserve**

PowerSafe® TS cells are designed for applications where the battery must undergo repeated cycling with daily depths of discharge of up to 35% of capacity C_{120} (such as rural settlements, communications systems and lighting systems etc.).

Cell Design

The PowerSafe® TS range offers a high-performance, long-life solution for renewable energy applications.

PowerSafe® TS cells are based on conventional, vented technology and designed for renewable energy applications that require maximum cycle life with the highest level of reliability. They are particularly suitable for use in solar energy installations, ensuring a continuity of electrical supply during the hours of darkness or during periods of reduced sunshine.

Reduced maintenance is achieved through the use of additional electrolyte, which means cells only have to be topped-up once a year. This helps to keep down maintenance costs and makes them an ideal solution for many remote or unman-ned locations.

Tubular positive plates are widely used in batteries for particularly demanding applications. In the TS range they have been optimised to give an extended cycle life and increased capacity.

Features & Benefits

- **Capacities from 300Ah to 4580Ah at the 120 hour rate (C_{120})**
- **Products available in flooded or dry charged versions**
- **Up to 5200 cycles to 25% depth of discharge**
- **Topping up required only once a year**
- **Minimal mainenance required**
- **Excellent operational safety including fully insulated connectors and terminals, acid-proof flame arrestor plug for each cell and protection of polarities during transport**

Capacity

Capacity is the number of Ah a battery can supply for a well-defined current and an end of discharge voltage. Capacity varies with the discharge time, discharge rate and temperature.

Example Capacities for PowerSafe TYS 5 cell are as follows:

Discharge time	10 h	120h	240h
End voltage	1.80Vpc	1.85Vpc	1.90Vpc
Capacity at 25°C	590Ah	802Ah	768Ah

The nominal capacity of PowerSafe® TS cells for renewable energy applications is given as follows:

Capacity Ah	Current A	Discharge period h	End voltage V/cell
C_{120}	I_{120}	120	1.85V

Discharge Rate: Is the ratio of discharge current divided by battery capacity

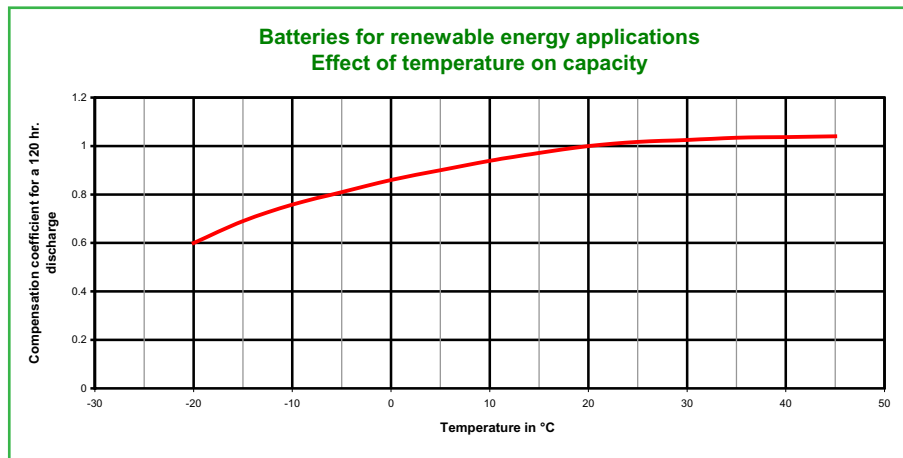
Depth of Discharge (DOD): Capacity removed from the battery compared to total capacity. It is expressed as a percentage.

Daily cycle: The battery is normally used with a daily cycle as follows: Charge during the day hours and discharge during night hours.

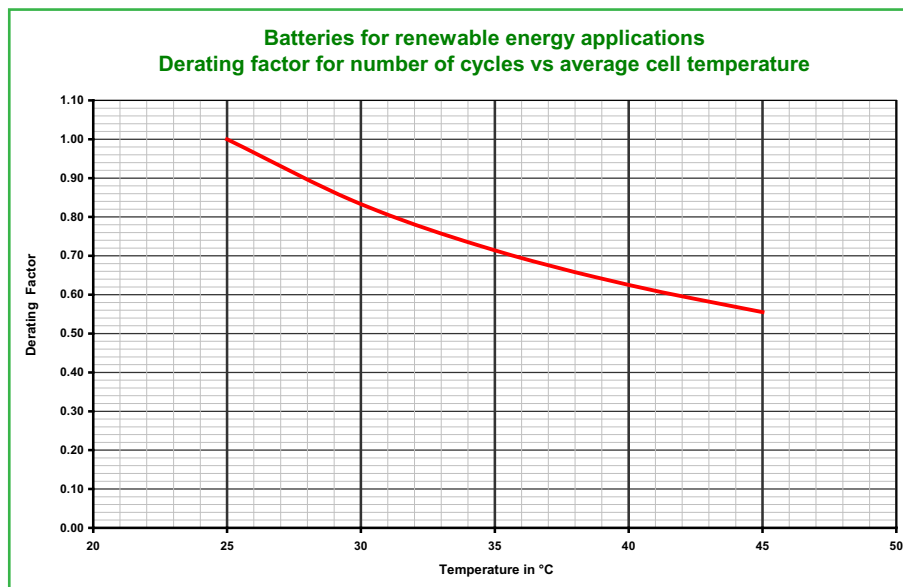
Typically daily use is between 2 to 20% DOD.

Effect of Temperature

On capacity: Correction factors of the capacity, according to the temperature are shown in the curve below. If the temperature is other than 25°C, the correction factors must be applied to the installation rating in order to secure an optimum service life.



On the number of cycles: A rise in temperature brings about a decrease in the number of cycles (see below).



Charge Efficiency

The charge efficiency is the ratio between the quantity of Ah delivered during the discharge and the quantity of Ah necessary to restore the initial state of charge.

State of Charge (SOC)	Ah Efficiency
90	> 85
75	> 90
<50	> 95

1 GENERAL OPERATING INSTRUCTIONS

1.1 Operating Temperature Range

The recommended operating temperature range for PowerSafe® TS technology is -15°C to 40°C (Humidity <90%). Optimum life and performance is attained at +25°C. All technical data relates to the rated temperature of +25°C.

1.2 Storage

Store the battery at a dry, clean and preferably cool and frost-free location. Do not expose the cells to direct sunlight, otherwise defects on container and cover may occur.

Limit values for storage conditions: Temperature range of -20°C to +45°C, Humidity <90%

Self-discharge:

It is the capacity loss that results when the battery is left at rest (without charge) for a given period of time.

The self discharge will increase:

- With natural ageing of the cell
- Following faulty use such as excessive over-discharge, bad maintenance, by non-demineralised water topping-up
- Temperature rise

The self-discharge rate of PowerSafe® TS batteries with the temperature:

Temperature	25°C	30°C	40°C
Monthly self-discharge rate	3%	4.5%	10%

PowerSafe® TS technology has a shelf life of 5 months when stored at 25°C. Higher temperatures increase the rate of self discharge and therefore reduce storage life.

This table gives the **maximum** storage period before refresh, at the given average storage ambient temperature:

Average storage ambient temperature	Maximum storage time
20°C	6 months
25°C	5 months
30°C	4 months
40°C	2 months

PowerSafe® TS batteries must be given a refreshing charge:

- when maximum storage time is reached, or
- when the OCV approaches 2.10Volts/cell whichever occurs first

If the batteries are supplied dry-charged, the storage time shall not exceed 2 years. For filling see special instructions on filling and commissioning dry-charged batteries.

1.3 Freshening Charge

The refresh charge should be conducted using constant voltage (adjusted to the temperature) eg. 2.23Vpc at 20-25°C with 0.1 C₁₀ Amps current limit for a minimum period of 96h.

1.4 Commissioning

Safety, installation & ventilation

The battery room should be well ventilated in order to remove gases produced during charging. The gases (mixture of oxygen and hydrogen) liberated by the cells when on charge may cause an explosion, and therefore, care must be taken not to produce SPARKS: NAKED LIGHTS must be not allowed, and remember NO SMOKING.

Following precautions must also be taken:

- Do not wear clothing likely to create static electricity (nylon) during maintenance operations
- Do not use a portable apparatus linked to an electric plug

The electrical protective measures and the accommodation and ventilation of the battery installation must be in accordance with the applicable “local” national standards, rules and regulations. Specifically EN 50272-2 standard applies. Low ventilation requirement according to EN 50272-2.

The battery should be installed in a clean, dry area.

Avoid placing the battery in a hot place or in front of a window (no direct sunlight). Battery racks are recommended for proper installation. Place the cells on the rack and arrange the positive and the negative terminals for connection according the wiring diagram.

Check that all contact surfaces are clean. Tighten terminal screws, taking care to use the correct torque loading.

Terminal screw	Torque
M10 - Female	23 - 25 Nm

Torque loadings for terminal screws

Follow the polarity to avoid short circuiting of cell groups. A loose connector can cause trouble in adjusting the system, erratic battery performance, and possible damage to the battery and/or personal injury.

Commissioning

The initial charge is extremely important as it will condition the battery service life. So the battery must be fully recharged to ensure that it is in an optimum state of charge.

Case 1: Using a constant voltage charger.

Cells here will need to be recharged at a constant voltage of between 2.35 and 2.40 Vpc at 25°C for a minimum of 48h and a maximum of 72h with a current limited to 0.10C₁₀.

Case 2: With no external source available for recharging.

Connect the battery to the solar panel regulator and leave at rest for 1 to 2 weeks.

For this charge, set the regulator to the following values:

	T°C	Voltage
Low charge-restart voltage	0 to 20°C	2.30V
	20 to 40°C	2.30V
High charge-disconnect voltage	0 to 20°C	2.50V
	20 to 40°C	2.45V

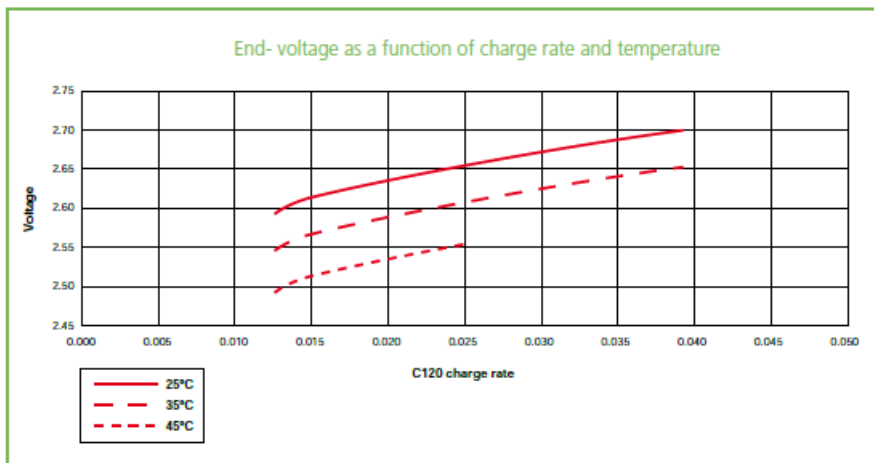
End-of-charge

End-of-charge is when all cell voltages and electrolyte specific gravities (corrected to 25°C) cease to rise for three consecutive hourly readings.

Continue charging until the specific gravity of electrolyte for all cells rise to nominal specific gravity at maximum level.

Cell voltages:

Charging RateC: Capacity	Minimum voltage in volts per cell for:			
	15°C	25°C	35°C	45°C
C/20	2.75 V	2.70 V	2.65 V	2.60 V
C/30	2.70 V	2.65 V	2.60 V	2.55 V
C/45	2.67 V	2.62 V	2.57 V	2.52 V
C/60	2.64 V	2.59 V	2.54 V	2.49 V



Electrolyte specific gravities:

- Measure the specific gravity with a hydrometer
- After reading, squirt the solution back into the cell from which it was drawn
- The nominal specific gravity at the end of the charge at the specified level is for a temperature of 25°C
- If temperature is above or below 25°C, specific gravity reading must be adjusted using the table hereunder.

15°C Specific gravity	20°C Specific gravity	25°C Specific gravity	35°C Specific gravity	45°C Specific gravity
1.147	1.144	1.142	1.138	1.131
1.167	1.164	1.162	1.157	1.149
1.186	1.183	1.180	1.176	1.168
1.206	1.203	1.200	1.194	1.187
1.217	1.213	1.210	1.204	1.197
1.227	1.223	1.220	1.214	1.207
1.237	1.233	1.230	1.224	1.216
1.244	1.240	1.237	1.231	1.223
1.248	1.244	1.241	1.234	1.226
1.254	1.250	1.247	1.240	1.232
1.259	1.255	1.252	1.245	1.236
1.270	1.266	1.263	1.256	1.247

Nominal electrolyte specific gravity of PowerSafe® TS cells at maximum level = 1.240 at 25°C
 Values according to electrolyte level at 25°C:

Type	Minumum	Medium	Maximum
TLS, TVS & TYS	1.280	1.260	1.240
TZS	1.265	1.250	1.240

1.5 Disposal

Lead acid PowerSafe® TS batteries are recyclable. End of life batteries must be packaged and transported according to prevailing transportation rules and regulations. End of life batteries must be disposed of in compliance with local and national laws by a licensed battery recycler.

1.6 Products Covered by this Guide

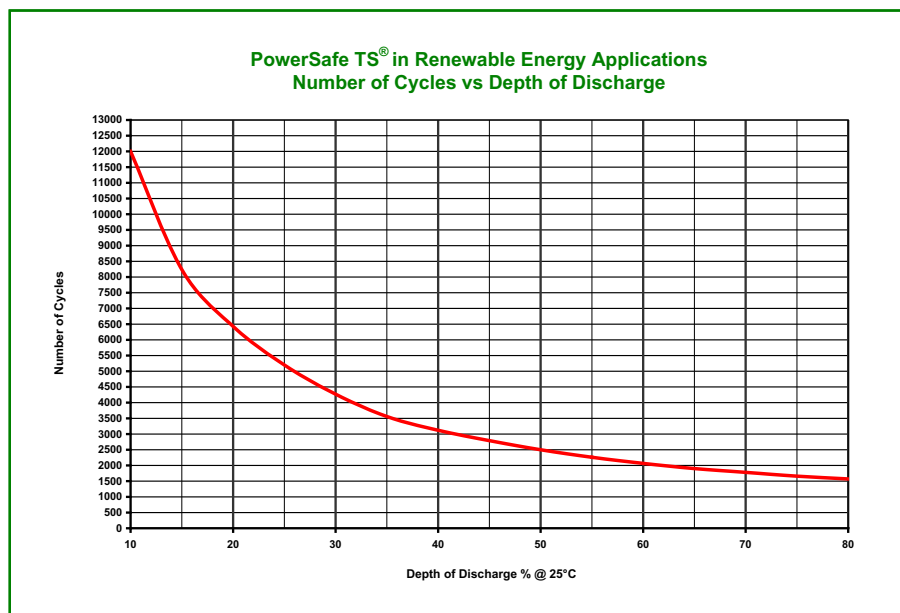
Type	Nominal Voltage (V)	Number of Terminals	Nominal Capacity (Ah)		Nominal Dimensions						Typical Weight Dry charged		Typical Weight Acid Filled		Electrolyte Volume		Short Circuit Current (A)	Internal Resistance (mΩ)
			10 hr rate to 1.80Vpc @20°C	120 hr rate to 1.85Vpc @25°C	Length mm	in	Width mm	in	Height mm	in	kg	lbs	kg	lbs	Litres	US Gal		
TLS 4	2	2	220	300	103	4.06	206	8.12	389	15.33	13.0	28.6	18.0	39.8	3.9	1.0	2059	1.02
TLS 5	2	2	270	367	124	4.89	206	8.12	389	15.33	15.5	34.2	21.9	48.2	4.9	1.3	2625	0.8
TLS 6	2	2	323	440	145	5.71	206	8.12	389	15.33	18.1	39.8	25.6	56.5	5.8	1.5	3000	0.7
TVS 4	2	2	340	460	124	4.89	206	8.12	505	19.9	18.4	40.6	27.3	60.3	6.9	1.8	2838	0.74
TVS 5	2	2	390	530	124	4.89	206	8.12	505	19.9	21.5	47.3	30.0	66.2	6.6	1.7	3281	0.64
TVS 6	2	2	470	640	145	5.71	206	8.12	505	19.9	25.1	55.3	35.4	78.0	7.9	2.1	3750	0.56
TVS 7	2	2	550	745	166	6.54	206	8.12	505	19.9	28.7	63.2	40.7	89.7	9.2	2.4	4200	0.5
TYS 5	2	2	590	802	145	5.71	206	8.12	684	26.95	29.8	65.8	44.6	98.3	11.3	3.0	3621	0.58
TYS 6	2	2	670	912	145	5.71	206	8.12	684	26.95	34.0	75.0	48.4	106.7	11.0	2.9	4200	0.5
TYS 7	2	2	816	1120	191	7.53	210	8.27	684	26.95	40.5	89.2	59.6	131.3	14.8	3.9	5147	0.41
TYS 8	2	2	900	1220	191	7.53	210	8.27	684	26.95	44.6	98.4	63.2	139.4	14.5	3.8	5676	0.37
TYS 9	2	2	1040	1415	233	9.18	210	8.27	684	26.95	50.2	110.8	73.9	163.0	18.3	4.8	6625	0.32
TYS 10	2	2	1120	1523	233	9.18	210	8.27	684	26.95	54.4	119.9	77.8	171.6	18.0	4.8	7000	0.3
TYS 11	2	2	1260	1714	275	10.84	210	8.27	684	26.95	60.0	132.2	88.4	194.8	21.9	5.8	8108	0.26
TYS 12	2	2	1340	1825	275	10.84	210	8.27	684	26.95	64.1	141.4	92.3	203.5	21.6	5.7	8824	0.24
TZS 11	2	4	1560	2130	275	10.84	210	8.27	829	32.66	76.5	168.6	112.3	247.6	27.5	7.3	7554	0.28
TZS 12	2	4	1710	2335	275	10.84	210	8.27	829	32.66	81.7	180.0	117.0	257.9	27.1	7.2	8400	0.25
TZS 13	2	6	1940	2640	399	15.72	214	8.43	813	32.03	94.9	209.2	146.6	323.2	39.7	10.5	8936	0.24
TZS 14	2	6	2040	2775	399	15.72	214	8.43	813	32.03	101.8	224.5	153.4	338.2	39.6	10.5	9589	0.22
TZS 15	2	6	2150	2925	399	15.72	214	8.43	813	32.03	105.4	232.4	156.0	343.9	38.9	10.3	10294	0.2
TZS 16	2	6	2240	3050	399	15.72	214	8.43	813	32.03	110.3	243.2	160.9	354.7	38.9	10.3	11053	0.19
TZS 17	2	8	2430	3310	487	19.19	212	8.35	813	32.03	122.0	269.0	182.2	401.6	48.5	12.8	11667	0.18
TZS 18	2	8	2555	3480	487	19.19	212	8.35	813	32.03	127.6	281.3	186.7	411.7	47.8	12.6	12353	0.17
TZS 20	2	8	2800	3810	487	19.19	212	8.35	813	32.03	137.8	303.8	199.8	440.5	47.6	12.6	14000	0.15
TZS 22	2	8	3090	4210	576	22.69	212	8.35	813	32.03	151.9	335.0	223.5	492.7	57.7	15.2	11053	0.14
TZS 24	2	8	3360	4580	576	22.69	212	8.35	813	32.03	162.6	358.4	235.8	519.9	56.3	14.9	16154	0.13

Notes: The electrical values shown in the table relate to performance from a fully charged condition at ambient temperature of +25°C.
 Height shown is overall height, including connectors and shrouds.

2 CYCLIC OPERATION

2.1 Cyclic Performance

The graph below shows cycling capability of Powersafe® TS products (25°C):



2.2 Discharging (low voltage urgent and non-urgent alarm)

As a rule, installations will be equipped with a regulator whose voltage threshold values will protect against deep discharge:

	Discharge time		
	10h	120h	240h
Low voltage alarm	1.92V	1.92V	1.95V
Disconnect voltage	1.80V	1.85V	1.90V

2.3 Setting Charging Voltages (solar charge on and solar charge off voltages)

In order to ensure optimum recharge, the following setting charge disconnect and restart voltages can be applied:

	Temperature			
	-20 to 0°C	0 to 20°C	20 to 35°C	> 35°C
Low recharge-restart voltage (Vpc)	2.35V	2.30V	2.30V	2.25V
High recharge-disconnect voltage (Vpc)	2.50V	2.45V	2.40V	2.35V

For a battery discharged to 80% of its rated capacity within 120 hours, in optimum sunshine it will take around fifteen days to recharge the cells and a further fifteen days to equalize their specific gravity.

3 SERVICE LIFE

Under normal operating conditions, the battery lifetime largely depends on the temperature and depths of discharge.

Influence of temperature

See curve page 3.

Example of an Powersafe® TS battery cycling with 25% daily:

Average temperature of cells	Number of cycles at 25°C	Compensation coefficient	Estimated average number of cycles at average temperature
25°C	5200	1	5200
30°C	5200	0.83	4316
35°C	5200	0.71	3692

Influence of depth of discharge

See curve (item 2.1), relative to number of cycles according to DOD at 25°C.

Example of an Powersafe® TS battery at 25°C:

Daily depth of discharge	Number of cycles at 25°C	Estimated service life at 25°C
25	5200	> 14

4 MAINTENANCE CHECKS DATA RECORDING

Flooded batteries require maintenance watering.

Water consumption depends on the charging current at a given temperature.

Example for a battery fully charged with a constant voltage of 2.35Vpc:

	Temperature		
	25°C	35°C	45°C
Charging current mA/Ah	1	4	9
Water consumption ml/Ah/year	2	10	25

Because there is a large electrolyte reserve, water may be added just once a year.

Exact watering frequency will be determined by climate conditions and the battery location.

Top up the electrolyte level (only with demineralised water) to the nominal level, without exceeding the “max” mark.

5 CHECKS DATA RECORDING

- The containers and lids should be kept dry and free from dust. Cleaning must be undertaken with a dampened cotton cloth without additives and without manmade fibres or addition of cleaning agents, never use abrasives or solvents. Avoid electrostatic charging.
- Every 6 months, check total voltage at battery terminals, cell voltages & electrolyte specific gravity (electrolyte level & temperature) of pilot cells, the cells surface temperature and battery room temperature.
- Once a year, take readings of individual cell voltages too.
- Keep a logbook in which the measured values can be noted as well as time and date of each event like commissioning date, water consumption, discharge tests, topping-up dates etc.

**“We shall be the best in the industry by being
easy to do business with, while supplying
the highest quality products and services
on time and in the most cost-effective manner.”**



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