

Control Circuits in acc. with UL508A

- Definition of Control Circuits
- Disconnecting Means
- Protection of Control Circuits
- Dimensioning of the wires and cables
- Loads in the Control Circuit

Definition of Control Circuits

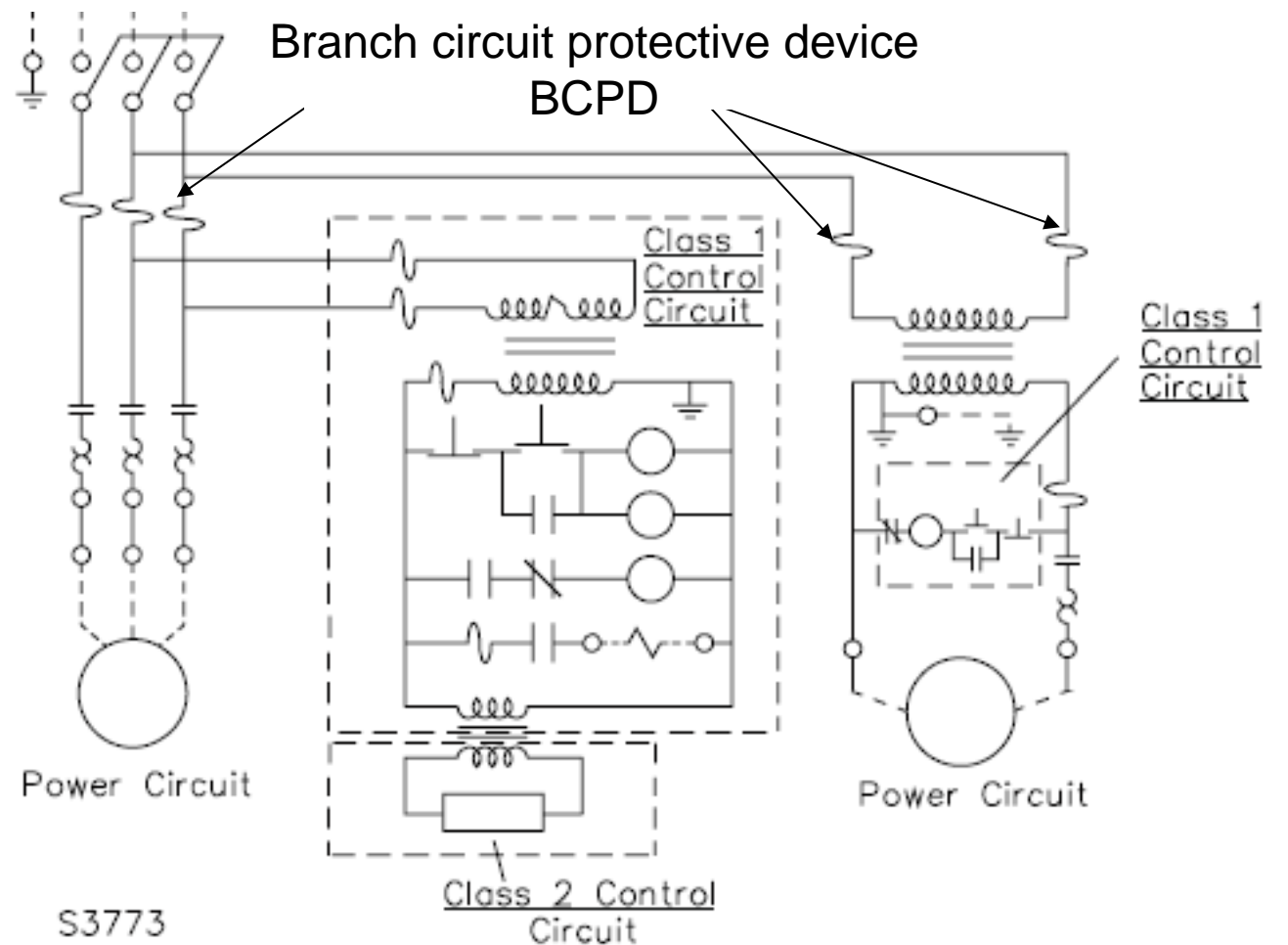
Definition of a Control Circuit: (UL508A)

A circuit that carries the electric signals directing the performance of a controller, and which does not carry the main power circuit. A control circuit is, in most cases, **limited to 15 amperes**.

With UL, the control circuits are usually connected to the load side of the branch circuit protective device (BCPD).

The circuit itself is not considered as branch.

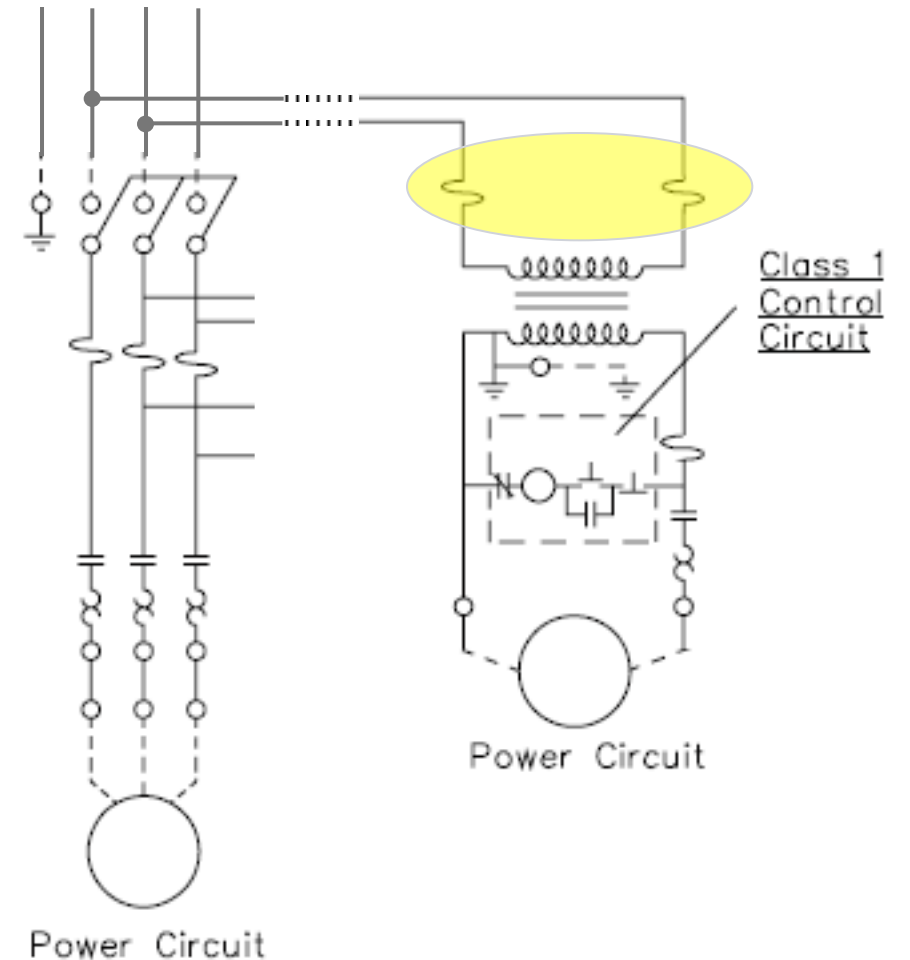
If connected to the line side of the BCPD a separate BCPD is required.



Disconnecting Means

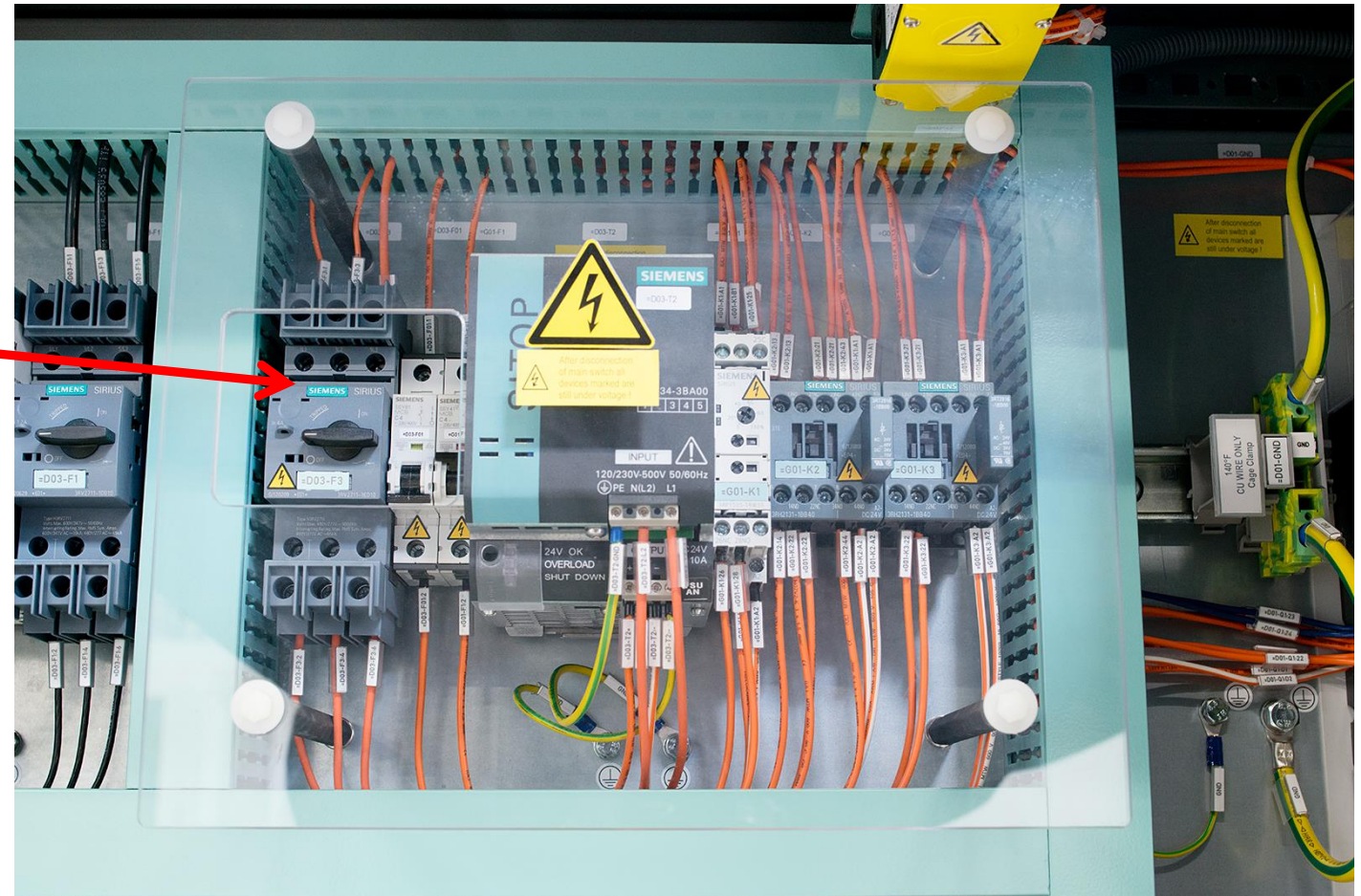
UL508A §39

- Control circuits connected to the line side of the main disconnecting means need to have their own main disconnecting means
- Possible are all devices which can be used as main disconnecting means for the power circuits
UL508A; §30
- Door interlocking mechanism is not required



Branch circuit protection and disconnecting means provided via a UL489 C.B.

Door interlocking mechanism is not required!



Definition of Control Circuits

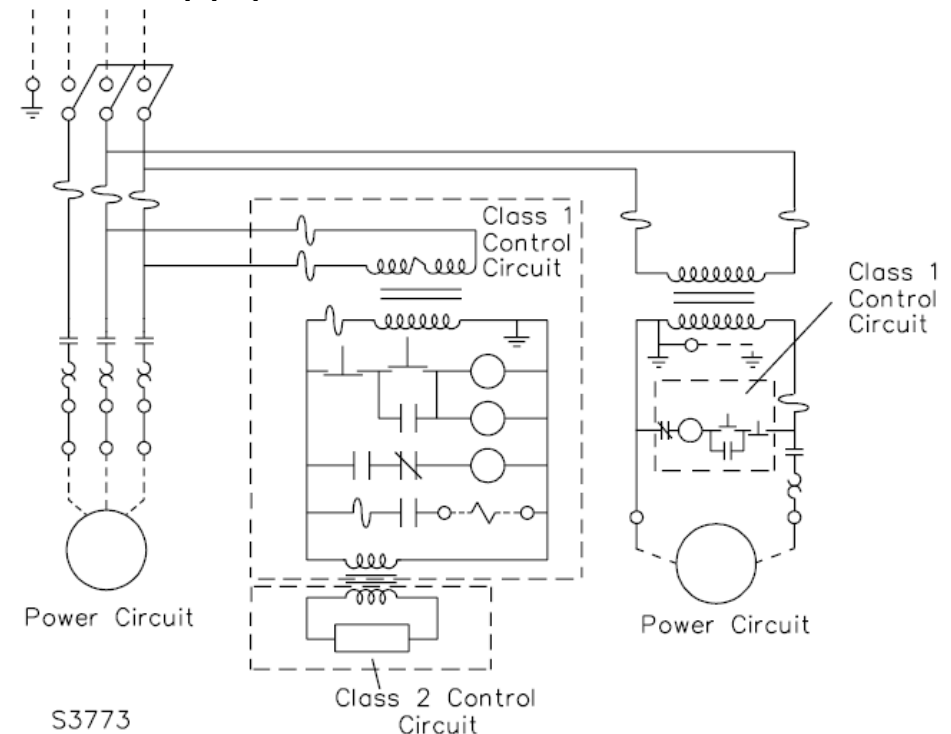
Class 1 Control Circuits

Definition acc. to UL508A §2.6

- Control Circuits connected to
 - Load side of the Branch Circuit Protective Device (BCPD)
 - Secondary side of an power transformer
 - Secondary side of an control transformer or control power supply
- Max. Voltage
 - Acc. to UL 508A: $U_N = 600V$
 - Acc. to NFPA 79: $U_N = 120V$
- Max. Current: in most cases limited to 15A

Possible „devices“ for the power supply

- Direct connected to the supply
- Power Transformers / Control Transformers
- Power Supply units for DC



Definition of Control Circuits

Class 2 Control Circuits

Have to be used, if control devices require a Class 2 control circuitry (e.g. **Sensors**) with terms like: „for use in class 2 circuits only“

Definition acc. to UL508A §2.8

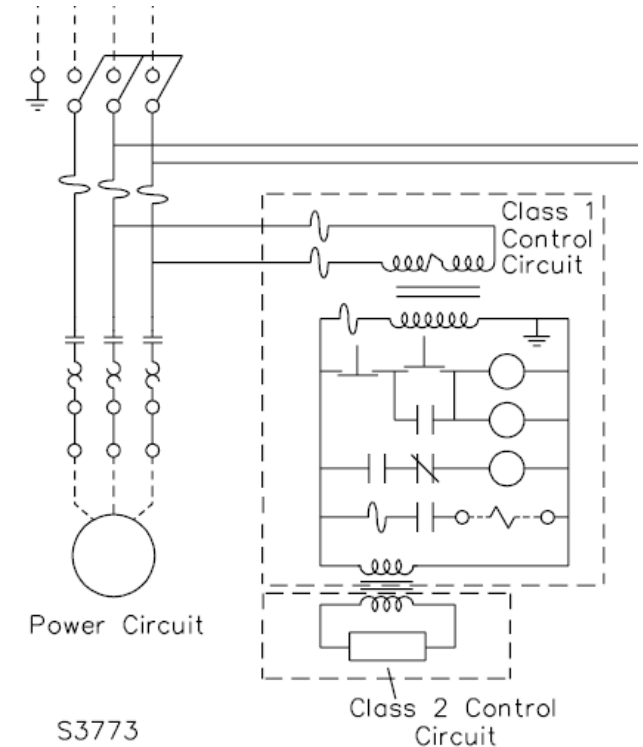
- Control circuits with limited power, supplied by an specific source with max. 30V rms and limited power (e.g. Class 2 transformer).

Possible power supply devices

- Need to be approved acc. to UL 1310; UL 1585; UL 60950-1

Additional note

- Wires should be laid and routed separately
- Field wiring terminals for Class 2 circuits should be separated as well



Note: Components and wiring located entirely within an „Class 2 circuit“ are not required to be investigated (by e.g. AHJ, UL-Inspector) !

➔ Unlisted devices and wiring could be used !

Definition of Control Circuits

Low-voltage limited energy circuit

Control circuit with low-voltage limited energy

- Circuit with max. 42.4 V peak voltage or DC voltage
- Max. power 100 VA or 5A with a voltage of 20V or lower
- Circuit must be protected against overcurrent
- Tap-off of load voltage by means of a voltage divider is not permissible
- Direct connection to the power circuit is not permissible!

Possible devices:

- Transformers acc. to UL506 or UL1561
- Power supply units (isolated secondary) acc. To UL508; 508C; UL1012 or UL1950
- Lithium battery acc. to UL1642
- Sealed battery acc. to UL1989
- Current transformer acc. to UL506 or current transformer with max. sec. current of 5A

Note: Components and wiring located entirely within an „limited energy circuit“ are not required to be investigated (by e.g. AHJ, UL-Inspector) !

→ Unlisted devices or wiring could be used !

Protection of Control Transformer / Power Supply Unit

Protection on primary side only, if

- The load on the secondary side is not higher than the rated current of the primary side protective device (Ratio of primary to secondary side has to be observed)

Primary plus Each Secondary branch has to be protected separately, if

- Above condition is not given
- The total sum of all consumers is higher than the nominal rated current of
- the transformer / power supply unit
- The secondary wiring „leaves“ the „Industrial Control Panel“
- The transformer / power supply unit has several secondary windings / tap offs

Attention: Standard power supply units can only be used for up to 50% of their nominal rated secondary current (UL508A - §42.2.3) !

Exception: Power supply units approved acc. to UL508, can be used for up to 100% of their nominal rated secondary current !

Protection devices in *dc control circuits above 32V* shall be *approved for the rating equal or greater*

40.1.5 Where a branch circuit fuse, inverse-time circuit breaker, miscellaneous or miniature type fuse, or supplemental protector is applied in a dc circuit with a voltage above 32 V, it must be evaluated in accordance with the appropriate product standard to have a dc voltage rating equal to or greater than the circuit voltage.

Excerpt from *Certificate of compliance of Siemens supplementary protectors 5SY...*

Supplementary protectors.

Cat. No.	Type	UG	FW	Max Volts	Max Amperes	TC	OL	SC
5SY4, 5SY6, 5SY7, 5SY8	OC	A	0	480	63	2	0	5kA U2, 7.5kA U2, 14kA U2
5SY4, 5SY6	OC	A	0	60 Vdc	1A - 63	2	0	3.5kA U2

Primary side tapped off **the line side** of the BCP

- Inverse Time Circuit Breaker (UL489), e.g. 3RV, 3VL, 5SJ...HG
- Fuses (UL 248-4 ... UL 248-12)

Primary side tapped off **the load side** of the BCP, additionally to above

- Miniature Circuit Breaker acc. to UL1077 (= supplementary protector); e.g. 5SJ
- Supplemental Fuse acc. to UL248-14

Secondary side for each ungrounded „conductor“ - Control circuit **does not extend** beyond the Industrial Control Panel

- Miniature Circuit Breaker acc. to UL1077 (= supplementary protector); e.g. 5SJ
- Supplemental Fuse acc. to UL248-14

Secondary side for each ungrounded „conductor“ - Control circuit **extends** beyond the Industrial Control Panel (**→ recommendation**)

- Inverse Time Circuit Breaker (UL489), e.g. 3RV, 3VL, 5SJ...HG
- Fuses (UL 248-4 ... UL 248-12)

Miniature Circuit Breaker instead of Circuit Breakers

UL differentiates between

- Circuit Breaker acc. to **UL489**



and Supplementary Protectors acc. to **UL1077**



Example:

Supplementary Protector: Miniature Circuit Breaker acc. to **UL1077**; Supplementary Protectors are UL Recognized (r/c) – not useable as BCPD.

Only to protect e.g. control circuits.

E.g. 5SY made by Siemens; CCN = QVNU2

Circuit Breaker (C.B.): also named as Inverse Time C.B., are “Listed” acc. to **UL489**. Use in e.g. Branch- or Feeder Circuit as Overcurrent Protection Device

E.g.: 3VL; 3RV17; 3RV18; 5SJ4 made by Siemens; CCN = DIVQ

→ Please be sure to use „suppl. Protectors“ at the correct position.

→ Same applies also to supplemental (miniature) fuses acc. to UL248-14 (r/c)

Protection of Control Circuits

Dimensioning

The following applies in general:

The protective device for the control wires have to be in acc. with the cross section of the control wires !

1st Exception:

Control circuit connected to the load side of the Branch Circuit Protection and **entirely inside** the Industrial Control Panel

→ Wire cross section acc. to UL508A, Tab.41.1

2nd Exception:

Control circuit connected to the load side of the Branch Circuit Protection and **not entirely inside** the Industrial Control Panel

→ Wire cross section acc. to UL508A, Tab.41.2

UL508 A
tables 41.1 & 41.2

Wire cross-section

Table 41.1

Motor branch circuit protection of common control circuit without remote control devices

Table 41.1 effective April 25, 2003

Control circuit wire size		Maximum protective device rating, amperes
AWG	(mm ²)	
22	(0.32)	12
20	(0.52)	20
18	(0.82)	25
16	(1.3)	40
14	(2.1)	100
12	(3.3)	120

Table 41.2

Motor branch circuit protection of common control circuit with remote control devices

Table 41.2 effective April 25, 2003

Control circuit wire size		Maximum protective device rating, amperes
AWG	(mm ²)	
22	(0.32)	3
20	(0.52)	5
18	(0.82)	7
16	(1.3)	10
14	(2.1)	45
12	(3.3)	60

Conductor Cross-Sections

Acc. to UL508A

Dimensioning of the cross section for internal wires acc. to the:

- Nominal rated current of the overcurrent protective device
- Nominal rated current of the secondary side of the transformer / power supply unit

Table 28.1
Ampacities of insulated conductors
Table 28.1 effective April 25, 2003

Wire size		60°C (140°F)		75°C (167°F)	
AWG	(mm ²)	Copper	Aluminum	Copper	Aluminum
14	(2.1)	15	–	15	–
12	(3.3)	20	15	20	15
10	(5.3)	30	25	30	25
8	(8.4)	40	30	50	40
6	(13.3)	55	40	65	50
4	(21.2)	70	55	85	65
3	(26.7)	85	65	100	75
2	(33.6)	95	75	115	90
1	(42.4)	110	85	130	100
1/0	(53.5)	–	–	150	120

Selection of the cross section for internal wires acc. to:

- UL 508A, Tab. 38.1 – if rated less than 10A
- UL 508A, Tab. 28.1 – if rated for more than 10A

Table 38.1
Ampacities of control circuit conductors
Revised Table 38.1 effective March 1, 2007

Ampacity, amperes	Conductor size	
	AWG	(mm ²)
10	16	(1.3)
7	18	(0.82)
5	20 ^b	(0.52)
3	22 ^b	(0.32)
2	24 ^b	(0.20)
1	26 ^b	(0.13)
0.8	28 ^{a, b}	(0.08)
0.5	30 ^{a, b}	(0.05)

^a Where these conductors are contained in a jacketed multi-conductor cable assembly.

^b These sizes of conductors are only for connection of control circuits for electronic programmable input/output and static control (having no moving parts).

For Use By Siemens

Possible devices:

- Signalling lamps acc. to UL508 (lamp sockets acc. to UL496)
- Electrical operated valve acc. to UL429
- Solenoid shall be evaluated for the intended use
- Time-indicating or time-recording device (e.g. hourmeter) acc. to UL863
- Audible signaling appliance (e.g. bell, buzzer) acc. to UL464
- A coil or input to another control circuit switching device or to a load controller need to comply with other component requirements of UL508A

Determination of the power:

- Ratings on the device (A; VA; W)
- The power of devices without indicated ratings has to be determined acc. to UL508A, Table 46.1

Questions?



Note / Disclaimer

The circuit examples and interpretations of the standard are non-binding and do not claim completeness concerning configuration, equipping and contingencies. They do not represent customized solutions but merely provide support for typical tasks.

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