FIRE SAFETY ASSESSESMENT TEST REPORT

EXTERNAL LAB NAME: TÜV SÜD Rail GmbH

UUT ITEM NUMBER: RCM SERIES

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INSPECTION REPORT

Fire Safety Assessment according to DIN EN 45545-2, DIN EN 45545-5 and NFPA 130

Converter
RCM Series

Report-No.: BU91228T, Version 8.0, Scope: 21 pages

Customer:

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Revision history

Version	Date	Author	Amended sections	Amendment and reason for amendment
1.0	2017-06-30	Michael Dallmer	All	Initial
2.0	2020-03-02	Christian Dettlaff	All	RCM60 series added; documents chapter 2 updated
3.0	2021-01-19	Christian Dettlaff	3.1, 5, 7	Comparison of NFPA130 and EN 45545
3.1	2021-01-21	Christian Dettlaff	2, 4.2.2	Document [D7] removed
4.0	2023-03-21	Christian Dettlaff	All	New report template Models 110RCM300-2424DMQF(K) and 24RCM300-2424DMQF(K) added New NFPA assessment
5.0	2025-01-10	Christian Dettlaff	All	Models 110RCM200-1515 DMQF(K) and 24RCM200-1515 DMQF(K) added Documents [D4], [D10], [D15] updated
5.1	2025-01-10	Christian Dettlaff	Table 4	Date of document CR-001453
6.0	2026-02-20	Christian Dettlaff	Table 4, 4.1, 4.2, 5.2.2, 6.3, 8	Models 72RCM500E and 110RCM500E added Documents [D1], [D2], [D3], [D4], [D8], [D9], [D15] updated Document [D21] added
7.0	2026-07-08	Christian Dettlaff	3, 5.2.2, 5.3.1, 5.3.2, 8	Updating the documents from Table 4
8.0	See release date	Kangyi Xu	3	Update D6

Version 8.0 replaces all previous versions.

Assessors involved in this report

Name	Activity
Kangyi Xu	Execution of inspection, Preparation of inspection report
Andrea Zecca	Review of inspection report

1. Client

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2. General

2.1. Contract

The fire safety assessment for the Bel Power Converter RCM Series in version 8.0 was commissioned by the company Bel Power to TÜV SÜD Rail GmbH on 2026-09-18. The assignment included the implementation of updated verification documents.

The assessment was carried out in the period from 2026-09-18 to the release of this inspection report by inspection of the documents provided by the client Bel Power or its subcontractors.

2.2. Regulations

This document deals with the assessment of the Bel Power Converter RCM Series in respect to compliance with the fire safety requirements according to the following acknowledged rules of technology:

Table 1: Regulations

No.	Regulations	Title
[R01]	DIN EN 45545-1: 2013-08*	Railway applications – Fire protection on rail vehicles – Part 1: General
[R02]	DIN EN 45545-2: 2020-10*	Railway applications – Fire protection on rail vehicles – Part 2: Requirements for fire behaviour of material and components
[R03]	DIN EN 45545-2: 2023-12	Railway applications – Fire protection on rail vehicles – Part 2: Requirements for fire behaviour of material and components
[R04]	DIN EN 45545-5: 2016-01*	Railway applications – Fire protection on rail vehicles – Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles
[R05]	NFPA 130:2020*	Standard for Fixed Guideway Transit and Passenger Rail Systems
[R06]	NFPA 130:2023	Standard for Fixed Guideway Transit and Passenger Rail Systems

* This standard is part of the accreditation D-IS-11190-01-00

2.3. Abbreviations

Table 2: Abbreviations

Abbreviation	Definition
HL	Hazard Level

Table 2: Abbreviations

Abbreviation	Definition
LOC&PAS	Locomotives and passenger rolling stock
max.	Maximum
min.	Minimum
N/A	Not Applicable
OC	Operation category
OI	Oxygen Index
PCB	Printed circuit board
TSI	Technical specification for interoperability

2.4. Management system at the time of inspection

The inspection was executed under application of the valid quality management system [M1] of the inspection body TÜV SÜD Rail GmbH accredited according to DIN EN ISO/IEC 17020:2012 [M2].

Table 3: Management System

Ref.	Designation	Title
[M1]	QMS	Quality management system of TÜV SÜD Rail GmbH
[M2]	D-IS-11190-01-00	Accreditation by the DAkkS according to DIN EN ISO/IEC 17020:2012 as a Type A inspection body. The accreditation is only valid for the scope of accreditation listed in the document annex D-IS-11190-01-00.

3. Documents

Table 4: Documents

ID	Title	Author	Doc./File ID	Date	Rev.
[D1]	RCM150/300 Series 150/300 W DC-DC Converters	Bel Power	BCD.00791	2025-09-11	AW
[D2]	RCM500/1000 Series 500/1000 W DC-DC Converters	Bel Power	BCD.00803	2025-07-18	AN
[D3]	RCM60 Series 60 W DC-DC Converters	Bel Power	BCD.00989	2025-12-08	E
[D4]	List of burnable materials RCM family	Bel Power	PRJ-000151	2026-06-06	5
[D5]	List of burnable materials RCM60	Bel Power	PRJ-000153	2023-03-16	2
[D6]	Test Report STEEL ALUZINK, ENCLOSURE SURFACE; DURPOL EPOXIDE BLACK, POWDER PAINT	Bel Power	CR-002062 2-0	2026-08-14	01
		CZ Testing	0088-26-F	2026-08-11	–
[D7]	Test Report PCB material ZGX.FXX01.2 and ZGX.FXX01.3 PCB material S1000-2M (SHENGYI) FR4 + H-9100 (RONGDA) SOLDER MASK + AVR80 BA CONFORMAL COATING, AB CHIMIE	Bel Power	CR-001476	2026-06-10	2-0
		CZ testing	0035-26-F	2026-06-03	–
		CZ testing	0033-26-F	2026-05-28	–
	Test Report PCB material S1000H (SHENGYI) FR4 + H-9100 (RONGDA) SOLDER MASK + AVR80 BA CONFORMAL COATING (AB CHIMIE)	Bel Power	CR-000038	2025-03-24	2-0
		CZ testing	0194-24-F	2025-03-03	–
	Test Report PCB material ZGX.FXX01.2 and ZGX.FXX01.3 PCB material PCL370HR (ISOLA) FR4 + ELPEMER-2467 (PETERS) SOLDER MASK + AVR80 BA CONFORMAL COATING, AB CHIMIE	Bel Power	CR-001453	2026-06-10	2-0
		CZ testing	0026-26-F	2026-06-03	–
		CZ testing	0028-26-F	2026-05-28	–
	Test Report PCB material ZGX.FXX01.2 and ZGX.FXX01.3 PCB material S1000-2M (SHENGYI) FR4 + PSR-2000 (TAIYO) SOLDER MASK + AVR80 BA CONFORMAL COATING, AB CHIMIE	Bel Power	CR-001451	2026-06-10	2-0
		CZ testing	0034-26-F	2026-06-03	–
		CZ testing	0032-26-F	2026-05-28	–
	Fire & Smoke Test Report PCB material ZGX.FXX01.2 and ZGX.FXX01.3 PCB material S1000H (SHENGYI) FR4 + PSR-2000 (TAIYO) SOLDER MASK + AVR80 BA CONFORMAL COATING, AB CHIMIE	Bel Power	CR-001475	2026-06-10	2-0
		CZ testing	0025-26-F	2026-06-03	–
		CZ testing	0024-26-F	2026-05-28	–

Table 4: Documents

ID	Title	Author	Doc./File ID	Date	Rev.
[D8]	UL Certificate Gap Pad VO ULTRA SOFT (Last Revised: 2025-11-14)	UL	E59150	2025-11-14	–
[D9]	Classification report WELLAMID 6600-PA66-HWV0CP	Bel Power	CR-007687	2026-06-10	1-0
		Currenta	C22-0388D_rev.1	2022-07-13	1
[D10]	RCM200/300 Dual Output Series Data Sheet 200 W/300 W DC-DC Converter	Bel Power	BCD.20202	2025-12-08	D
[D11]	Test Report ENCLOSURE SURFACEvXEE.20087.0 AlMg3	Bel Power	CR-003313	2022-10-03	1-0
		RST	P60-22-0424	2022-09-29	–
[D12]	Test Report ENCLOSURE SURFACEvXEE.20086.0 Steel Aluzinc	Bel Power	CR-003314	2022-10-03	1-0
		RST	P60-22-0423	2022-09-29	–
[D13]	UL Certificate FR1(E1) (GG1)(a), DL1722(E1)(a) (Last Revised: 2025-09-17)	UL	E539253	2026-01-01	–
[D14]	UL Certificate BN-FS250 (Last Revised: 2025-09-17)	UL	E256822	2026-01-01	–
[D15]	UL Certificate BERGQUIST GAP PAD TGP 1300(o), Gap Pad 1500S30(o) (Last Revised: 2025-09-17)	UL	E59150	2026-01-01	–
[D16]	RCM500E Series 500 W DC-DC Converter	Bel Power	BCD.20300	2026-03-27	C

4. Equipment under inspection

4.1. Description of equipment

The Converters of RCM Series was developed for application in rolling stock [D1], [D2], [D3], [D10], [D16].

The Converters are power supplies for railway and transportation systems. There are 4 input voltage ranges covering all common railway batteries. The output delivers 60, 150, 200, 300, 500 or 1000 W at 12, 15 or 24 V. The converters are designed for chassis mounting and exhibit a closed housing.



Fig. 1 Converters RCM Series – source: Bel Power

Connection cables of the vehicle wiring or brackets for mounting are not part of this assessment.

In accordance with the assignment, this fire safety assessment deals with the following models:

Table 5: Converters of RCM Series – models, [D1], [D2], [D3], [D10], [D16]

No	Product Series	Lead Model	Description
1	RCM60	XRCM60-24DQF(K)	Covering models 12RCM60-12, -15 and -24 as well as XRCM60-12, -15 and -24 with all or less options DQFK
2	RCM150	110RCM150-24DMQF(K)	Covering models 24RCM150-12, -15 and -24 as well as 110RCM150-12, -15 and -24 with all or less options DMQFK
3	RCM200	110RCM200-1515DMQF(K)	Covering models 24RCM200-1515 as well as 110RCM200-1515 with all or less options DMQFK
4	RCM300	110RCM300-24DMQF(K)	Covering models 24RCM300-12 and -24 as well as 110RCM300-12 and -24 with all or less options DMQFK
		110RCM300-2424DMQF(K)	Covering models 24RCM300-2424 as well as 110RCM300-2424 with all or less options DMQFK
5	RCM500	110RCM500-24DMQF(K)	Covering models 72RCM500-24 as well as 110RCM500-24 with all or less options DMQFK
6	RCM500E	110RCM500E-24DMQF(K)	Covering models 72RCM500E-24 as well as 110RCM500E-24 with all or less options DMQFK
7	RCM1000	110RCM1000-24DMQF(K)	Covering models 72RCM1000-24 as well as 110RCM1000-24 with all or less options DMQFK

4.2. Electrical Data

Table 6: Converters of RCM Series - Electrical data, [D1], [D2], [D3], [D10], [D16]

	60 W DC-DC Converters	150/300 W DC-DC Converters	200/300 W Dual Output DC-DC Converter	500/1000 W DC-DC Converters
Nominal input voltage (depending on model)	max. 110 VDC			
Nominal output voltage (depending on model)	12 / 15 / 24 VDC	12 / 15 / 24 VDC (RCM150) 12 / 24 VDC (RCM300)	+24 / -24 VDC	24 VDC
Output power (depending on model)	60 W	150 W / 300 W	200 W / 300 W	500 W / 1000 W
External fuses (depending on model)	8 / 15 A	5 / 8 / 15 / 30 A	8 / 10 / 25 / 30 A	15 A (RCM500) 16 / 20 A (RCM500E) 25 A (RCM1000)

4.3. Installation Conditions

The Converters of RCM Series are intended for installation in technical compartments. They are not regularly accessible for passengers or staff during operation.

5. Conformity assessment acc. to DIN EN 45545

5.1. Classification according to DIN EN 45545-1

The Converters of RCM Series are to be used in vehicles of all design categories and for operation in all environments corresponding to operation categories 1 to 4.

The safety objectives according to DIN EN 45545-1, Section 4.2 “Fire resulting from accidental ignition or arson”, Section 4.3 “Fires caused by technical defects” as well as Section 4.4 “Fire resulting from larger ignition models than those described in 4.2 and 4.3” have been incorporated in the assessment in a risk-oriented approach.

Section 4.2 refers to typical ignition models involving newspaper, matches, cigarettes and gas lighters. Those will be taken into consideration for any areas that are freely accessible to passengers and staff (ignition models 1 and 2 in accordance with Annex A, DIN EN 45545-1). According to the intended installation conditions in 4.3 of this report, the access for passengers is regularly not intended. Hence this ignition model has not been considered in the following assessment.

Section 4.3 refers to ignition models comparable to electrical arcing or overheating and the spread of fire by any potentially flammable gases and liquids present (ignition models 3 and 4 in accordance with Annex A, DIN EN 45545-1).

Section 4.4 refers to larger ignition models (model 5 in accordance with Annex A, DIN EN 45545-1) than those defined in sections 4.2 and 4.3 of DIN EN 45545-1. The assessment of this ignition model was made with focus on the material selection and the intended installation conditions.

According to section 8, the proof of conformity must be provided for the defined fire protection requirements. Proof of conformity for the fire behaviour of materials and/or components can be provided in the form of test reports or certificates.

- Test reports must be issued by testing laboratories that are accredited for the respective tests according to EN ISO/IEC 17025.
- Certificates must be issued by certification bodies, which are accredited for the respective testing or classification standards according to EN ISO/IEC 17065.

Annex ZA of DIN EN 45545-2 presents the correlation between DIN EN 45545-2 and Interoperability Directive (EU) 2016/797 as well as the TSI LOC&PAS (Regulation (EU) No. 1302/2014). For a vehicle approval according to the TSI LOC&PAS, test reports or certificates, with a maximum validity of 5 years from the date of issue, must be submitted.

For test reports or certificates with an issue date older than 5 years, the verification can alternatively be issued by a corresponding manufacturer's declaration according to section 4.2.10.2.1 of TSI LOC&PAS, paragraph 3 in connection with the application guideline for the TSI LOC&PAS (GUI/LOC&PAS TSI/2021) in addition to the present test report or certificate.

5.2. Assessment according to DIN EN 45545-2

5.2.1. Requirements

Based on the classification according to DIN EN 45545-1, the materials / components shall meet the requirements of Hazard Level 3 (HL3). The components are to be regarded as electrotechnical equipment covered by the DIN EN 45545-2 standard. Generally, the requirement sets are listed in section 4.4 “Listed products”. The applicable requirements are the following:

Table 7: Requirement sets DIN EN 45545-2

No.	Name	Details	Requirement
EL9	Printed circuit boards	Printed circuit boards with all applied coatings but without any attached technical equipment	R26 EN 60695-11-10 Classification = V0 or R25 EN 60695-2-11 Glow Wire 850 °C or R24 ISO 4589-2 OI ≥ 32%
EL10	Low-power electrical and electronic components	All electrotechnical low power equipment, including protection against contact and similar	R26 EN 60695-11-10 Classification = V0
EL1A	Cables for interior	Cables not compliant with one of the standards referenced in 4.2 c)	R15 EN 60332-1-2 burned part ≤ 540 mm and unburned part > 50 mm EN 50305 burned part ≤ 1.5 m EN 61034-2 Transmission ≥ 70% EN 50305 ITC ≤ 6

In addition to the requirements of listed products, the grouping rules according to section 4.3 for components with low combustible mass and/ or surfaces are applicable.

No requirements apply to products with a combustible mass of < 10 g not in touching contact with another unclassified product (DIN EN 45545-2 section 4.3.1).

Table 8: Grouping rule 1

No.	Section	Requirement	Remark
1-1	4.3.2. Grouping rule 1 Products without requirements	≤ 100 g for interior grouped products	No requirements
1-2		≤ 400 g for exterior grouped products	No requirements

Table 9: Grouping rule 2

No.	Section	Requirement	Remark
2-1	4.3.3. Grouping rule 2 Products tested according to R24	≤ 500 g for interior grouped products tested according to R24	Proof R24 Oxygen index
2-2		≤ 2000 g for exterior grouped products tested according to R24	Proof R24 Oxygen index

The following general rules shall be considered:

Table 10: General requirements DIN EN 45545-2

Section	Requirement
4.2. a) General	Products which comply with the highest level of reaction to fire performance and therefore need no further testing are - products classified as A1 according to EN 13501-1 - all products described in commission decision 96/603/EC (as amended) - Laminated glass in which the inner organic layers are not exposed and the mass fraction in percentage of the organic material is less than or equal to 6%.
4.2. i) Coatings	All coating systems shall be tested in end use condition. This means inclusion of levelling fillers at a thickness estimated at mean end use application, primers and finish coatings with specified coating thickness and number of layers;
4.2. k) Coatings	For organic coatings applied to products conforming to 4.2 a), ISO 5658-2 or EN ISO 9239-1 flame spread tests shall be carried out, but other test requirements such as heat release, smoke emission and toxic gas emission tests are not required if the nominal coating thickness, including any surfacing filler for exterior products is < 0,3 mm, or for interior products the nominal thickness of organic coating is < 0,15 mm;
4.2. l) Size of test specimen	If the end use condition does not allow sizes of test specimen for ISO 5658-2 (if this is part of the requirement set): R6 interior use R9 exterior use
4.2. m)	If listed products are used in an application below the mass and area thresholds given in 4.3, they may be treated as non-listed products.
4.5 Non-listed products	Any product not listed in EN 45545-2 Table 2 shall be considered as a non-listed product or shall be assessed using the grouping rules stipulated in EN 45545-2 section 4.3. The requirements of non-listed products are the following: > 0.2 m² R1 (interior), R7 (exterior) ≤ 0.2 m² R22 (interior), R23 (exterior)
4.7 Products to be approved on functional necessity	If it can be shown that any of the requirements specified above are not technically achievable with functionally suitable products, then existing commercially available products can be used until and unless a suitable product is developed. There shall be no requirement to consider products made available after the date after the date of the contract.
5.3.7 Fire integrity test	There shall not be more than one hole after the test T03.01. or T03.02. This hole shall have no dimension in the plane of the test piece greater than 3 mm. Alternatively, the material fulfils the requirements of Conventional Classified Products acc. to EN 45545-3. Those products are considered to meet the integrity requirements.

5.2.2. Material verification

The combustible materials are listed in the material lists [D4] and [D5]. The housing is made from powder coated aluminium. The exposed surface of the paint is less than 0.2 m² according to the dimensions of the housing [D1], [D2], [D3], [D10], [D16].

According to the available documentation the combustible material required to be verified by test are PCBs and small electrotechnical products and coating. The relevant requirements according to DIN EN 45545-2 as well as the test results are listed in Table 11. All other combustible materials have a combustible mass of less than 10 g with no touching contact with any other unclassified material and are therefore not required for verification by test.

Table 11: Listing of material testing

Material	Requirement	Result	Certificate	HL
EL9 – PCB Mainboard RCM family	*R24, R25, R26*	 fulfilled	 [D7]	 HL3
EL10 - Low-power electrical/electronic components Gap Pad VO ULTRA SOFT GAP PAD; BN-FS250GF GAP PAD; TGP 1300(o)/1500S30(o) Insulator VALOX FR1	*R26*	 fulfilled fulfilled fulfilled fulfilled	 [D8] [D14] [D15] [D13]	 HL3 HL3 HL3 HL3
4.2. k) Coatings DURPOL EPOXIDE BLACK, POWDER PAINT AlMg3, Akzo Nobel, Interpon 700 RAL 9005 DURPOL epoxide 6L series RAL 9005	*T02 ISO 5658-2*	 fulfilled fulfilled fulfilled	 [D6] [D11] [D12]	 HL3 HL3 HL3
4.5 non-listed products Wago connectors - WELLAMID	*R22/R23*	 fulfilled	 [D9]	 HL3

Material treated according to the grouping rules > 10 g but ≤ 100 g:

- None

The combustible materials used for the Converters of RCM Series fulfil the requirements according to DIN EN 45545-2 for HL3.

5.3. Requirements for DIN EN 45545-5

DIN EN 45545-5 focuses on safety requirements for electrical equipment in railway vehicles with the goal of reducing to a minimum the risk of a fire and of a technical error and/or failure of equipment which may occur as a result. The requirements are listed in the following tables and compliance with the design is assessed.

5.3.1. Assessment for DIN EN 45545-5, chapter 4

Table 12 - General requirements: Requirements of DIN EN 45545-5, chapter 4

Section	Requirement	Evaluation
4 General requirements	Resistance of the electrical equipment to the expected electrical/thermal/mechanical stress (see DIN EN 50125-1)	Designed according to the expected load [D1], [D2], [D3], [D10], [D16]
	Wiring and reliability of connections in accordance with DIN EN 50343	Designed according to the expected load [D1], [D2], [D3], [D10], [D16]
	Requirements for fire behaviour according to DIN EN 45545-2	See chapter 5.2

5.3.2. Assessment for DIN EN 45545 part 5, chapter 5

Table 13 - Design requirements: Requirements of DIN EN 45545-5, chapter 5

Section	Requirement	Evaluation
5.1 Overload protection	Selection and design of overload protection between current collector and consumer	N/A
	Selection of other overload protection devices (fuses, circuit breakers)	Fulfilled - External fuse specified in manual [D1], [D2], [D3], [D10], [D16] and chapter 4.2
	Unprotected circuits	Not present
5.2 Wiring	Cable cross section, environmental requirements	N/A
5.4 Housing	Screen to prevent touching Fire protection enclosure Danger of explosion	Fulfilled – Earthed metal housing, IP30 (IP20 for RCM500/1000 Series) [D1], [D2], [D3], [D10], [D16]
5.5 Cable channels	Temperature rise, water drain	N/A
5.6 Batteries and battery power circuits	Ventilation, short circuit protection	N/A
5.7 Switchgear equipment	Spark arresting, overload current	N/A
5.8 Electrical emergency equipment	Cable installation in the vehicle	N/A
5.9 Protective connections	Protection against electrical hazards	Fulfilled – Earthed metal housing
5.10 Resistors and heating elements	Surface temperatures	N/A
5.11 Installation locations in the current collector area	Spark arresting	N/A

Table 13 - Design requirements: Requirements of DIN EN 45545-5, chapter 5

Section	Requirement	Evaluation
5.12 Forced ventilated equipment	Switching off the forced ventilation	N/A
5.13 Container with liquid insulating material	Combustible fluids	N/A

6. Conformity assessment acc. to NFPA 130

6.1. Scope and goals of NFPA130

The standard covers "[...]fire protection requirements for fixed guideway transit and passenger rail systems, including, but not limited to, stations, trainways, emergency ventilation systems, vehicles, emergency procedures, communications, and control systems" (see NFPA 130, section 1.1.1).

According to the section 4.2.1 of the NFPA 130 "*The goals of this standard shall be to provide an environment for occupants of fixed guideway and passenger rail system elements that is safe from fire and similar emergencies to a practical extent based on the following measures:*

(1) Protection of occupants not intimate with the initial fire development

(2) *Maximizing the survivability of occupants intimate with initial fire development*"

6.2. Assessment according to NFPA 130

6.2.1. Requirements

The requirements of the NFPA 130 section 8 are taken as a basis for the assessment. Only the requirements applicable to the Converter RCM Series mounted in a railway vehicle are evaluated. The cables and any additional bracket are not part of this assessment.

The key requirement characteristics from section 8 of NFPA 130 are as follows:

Table 14: Requirement characteristics of NFPA 130 section 8

Section	Content	Requirement characteristics / Keywords
8.	**Vehicle**	
8.1	Applicability	New and retrofitted vehicles
8.1.1	New Vehicles	New Vehicles: "All new passenger carrying vehicles shall be, at a minimum, designed and constructed to conform to the requirements set forth in this section."
8.1.2	Retrofitting	Retrofit: "Where existing passenger-carrying vehicles are to be retrofitted, the appropriate sections of this standard shall apply only to the extent of such retrofit."
8.2	Compliance Options	Alternative: Fulfilment of prescriptive requirements in section 8.3 - 8.10 for passenger vehicles *or* application of engineering analysis (8.11)
8.4	Flammability and Smoke Emission	sub-divided in 8.4.1 (fire test procedures and performance criteria for materials) and 8.4.2 (fire hazard analysis for material not fulfilling the req. of section 8.4.1)
8.4.1	Requirements and test methods	The test procedures and minimum performance for materials and assemblies shall be as detailed in Table 8.4.1 Material requirements, component assembly, test methods; reference to numerous ASTM codes
8.4.2	Material handling, that do not comply with 8.4.1	In case of deviation refers to a risk-based approach

Table 14: Requirement characteristics of NFPA 130 section 8

Section	Content	Requirement characteristics / Keywords
8.6	Electrical Fire Safety	physical, mechanical, and electrical performance of cables: ICEA S-95-658/NEMA WC-70 or ICEA S-73-532/NEMA WC-57, as applicable wire size: 2.1 mm^2 or 0.33 mm^2 respectively Air clearance, creepage from Annex F
8.11	Engineering Analysis Option	Option for analysis (refer to 8.2) if prescriptive requirements are not applicable; general (qualitative) requirements; need for independent review or approval

In accordance with NFPA 130 section 8.4.1.10 materials used to fabricate miscellaneous, discontinuous small parts where the surface area of any individual small part is less than 100 cm^2 in end use configuration and that will not contribute materially to fire growth in end use configuration can be evaluated by an appropriate fire hazard analysis (8.4.1.10.1) or can be tested in accordance with ASTM E1354 (8.4.1.10.2).

In accordance with NFPA 130 section 8.4.2, materials that do not comply with the requirements of NFPA 130 Table 8.4.1 may be used in limited areas of the vehicle if it is demonstrated by an appropriate fire hazard analysis that the fire hazard of that material is equal to or less than compliant materials.

6.3. Material verification for NFPA 130

The Converters of RCM Series consists of different small components built together. Each component is listed on material list [D4] and [D5]. The combustible materials on the printed circuit board and in the device are miscellaneous, discontinuous small parts with a surface area less than 100 cm^2. According to the intended installation conditions in 4.3 of this report, the Converter RCM Series are intended for internal use. They can be placed in a limited area in technical compartments. The access for passengers is regularly not intended.

The total considered combustible mass of the Converters of RCM Series is listed in the following table.

Table 15: Converter RCM Series – Combustible mass [D4], [D5]

Product Series	Model	Combustible mass
XRCM60	XRCM60-24DQF(K)	100.8 g
RCM150	110RCM150-24DMQF(K)	111.6 g
RCM200	24RCM200-1515DMQF(K)	209.2 g
	110RCM200-1515DMQF(K)	202.9 g
RCM300	110RCM300-24DMQF(K)	318.5 g
	110RCM300-2424DMQF(K)	211.9 g
	24RCM300-2424DMQF(K)	209.9 g
RCM500	110RCM500-24DMQF(K)	206.2 g
RCM500E	72RCM500E-24DMQF(K)	163.7 g
	110RCM500E-24DMQF(K)	163.7 g
RCM1000	110RCM1000-24DMQF(K)	234.9 g

Based on available documentation, no combustible material has been verified by testing in accordance with NFPA 130 Table 8.4.1. The verification is carried out with the use of the following fire risk analysis.

6.4. Fire risk analysis

6.4.1. Methodology of the fire hazard analysis

For the fire risk analysis, the standards DIN EN 60812 and DIN EN 50126 are taken as guidelines.

Three parameters are taken in consideration:

- **Severity**, this parameter classifies how big the impact of a failure will be
- **Occurrence**, this parameter classifies how often a failure can happen
- **Detection**, this parameter classifies how easy or difficult is to detect a failure

These parameters are calculated using the following tables.

Table 16: Severity (S)

Value	Frequency	Meaning	Personal Safety
a	Insignificant	A fire of the component results in a negligible severity: No fire or limited, enclosed fire inside a rack, cabinet or container box	No or little risk to persons
3	Marginal	A fire of the component results in a medium severity: Enlarged fire consequence – spread to surrounding location (e.g. to passenger compartment, to underfloor area)	Hazard to persons (Slightly injured and / or significant environmental damage)
5	Critical	A fire of the component results in a high severity: Fully developed fire possible	Acute danger to persons (individual accident victim and / or severely injured and / or significant threat to Environment)

Table 17: Occurrence (O)

Value	Frequency	Meaning
1	Improbable	Hazard can be expected to occur exceptionally seldom during system life cycle.
3	Rare	Hazard can be expected to occur sometime during system life cycle.
5	Probable	Hazard can be expected to occur several times during system life cycle.

Table 18: Detection (D)

Value	Likelihood of detection	Meaning
1	Frequent	Fire/ failure detection or reported fire followed by persistent and self-sustaining shut off
2	Occasional	Fire/ failure detection or reported fire not followed by persistent and self-sustaining shut off
3	Rare	Open visible fire
5	Improbable	The component is not directly visible; the fire detection is practically impossible (hidden fire)

After the single valuation of each parameter, a calculation is done to consider if the risk is acceptable through the RPN. The RPN is calculated with the following formula:

RPN = (Severity) x (Occurrence) x (Detection)

The evaluation of the RPN and thus the fire risk is based on the risk categories according to DIN EN 50126, as described in the following Table 19.

Table 19: Fire risk assessment based on the RPN

RPN	Risk category	Measures to be applied
1 ≤ RPN ≤ 15	Negligible	Risk can be accepted without measures
15 < RPN ≤ 30	Tolerable	Risk can be accepted with appropriate monitoring
30 < RPN ≤ 50	Undesirable	Risk may only be accepted if risk reduction is not practically feasible
50 < RPN ≤ 125	Intolerable	Risk must be excluded

6.4.2. Execution of fire hazard analysis

The calculation of RPN and the result are shown in the following Table 20.

Table 20: Calculation of RPN

Parameter	Value	Justification
Severity (S)	1 - Insignificant	Due to the small combustible mass, a fire of the converters results in a negligible severity. A spread of the fire to other components cannot be completely excluded. The mounting position is in technical compartments of the vehicle. Persons are not in danger. The evaluation results in a value of S = 1.
Occurrence (O)	1 - Improbable	A fire due to technical failure of the converters is very unlikely. The evaluation results in a value of O = 1
Detection (D)	5 - Improbable	The converters are mounted inside the railway vehicle in technical compartments. They are not visible for passengers or staff during operation. They are not directly visible. The fire detection is practically impossible (hidden fire). The evaluation results in a value of D = 5
RPN Result (S x O x D):		**5**

Based on the RPN of 5 the Fire Risk according to the Table 19 is negligible. No additional measures need to be taken. The installation of the Converters of RCM Series in technical compartments does not involve any additional risks.

7. Plausibility check of the ignition sources

7.1. Fire development starting from the component

The maximum failure power is limited by external fuse. The theoretical ignition potential in the event of a failure, irrespective of the technical cause, is below the relevant ignition model 4 (max. 1 kW over 30 seconds) in accordance with Annex A, DIN EN 45545-1. Due to the small amount of combustible mass, the predominantly qualified materials and the low electrical power, which is limited in time by the existing fuse, ignition and fire development in the event of an electrical failure are sufficiently prevented from "fire caused by technical defects", in accordance with DIN EN 45545-1, Chapter 4.3. In addition, the metal housing protects against further fire spread in the unlikely event of ignition.

7.2. Fire involvement of the component by external ignition source

An external fire event, starting from a vandalism or technique fire, can affect the materials with thermal radiation (ignition models 2 and 3 according to Annex A, DIN EN 45545-1) and additionally with direct flame or arc action (see ignition models 1 and 4 according to Annex A, DIN EN 45545-1) and involve them in the fire. The materials have been qualified in terms of ignition prevention at low ignition power, which does not completely prevent fire involvement in major fire events. The component housing is made of non-combustible material, and the combustible mass of the component is very low, which greatly limits the promotion of fire spread.

8. Summary

The assessments result is that the Converters of RCM Series meets the requirements of the listed acknowledged codes of practice:

- DIN EN 45545-2:2020 hazard levels HL1 to HL3
- DIN EN 45545-2:2023 hazard levels HL1 to HL3
- DIN EN 45545-5:2016
- NFPA 130:2020
- NFPA 130:2023

Groupings to be considered for installation in the vehicles, if the distance of the grouped components from a non-qualified component is less than ≤ 20 mm horizontally and ≤ 200 mm vertically (see section 5.2.2):

- None.

The verification for the Converter acc. to NFPA 130 using the appropriate fire hazard analysis was done as described in section 8.4.2 of NFPA 130 and therefore meeting safety objectives in section 4.2 and 4.3 of NFPA 130. The verification was done regarding the principle of equivalency acc. to section 1.4 of NFPA 130.

For regular intended operation the required level of safety for passengers and staff is ensured.

The assessment is based on documents provided by the customer (see list of documents Table 4). At the time of the inspection and based on the relevant test reports listed in Table 11, the validity of the fire protection technical verification within the framework of EC conformity test procedures is confirmed until 2027-07-12 [D9].

This inspection is also valid for any other Converters of the evaluated types as long as Bel Power confirms with manufacturer declaration that the material used did not change and the mass and surface of the material treated according to grouping rules (see section 5.2.2) is not higher than for the inspected items.

This inspection report was written under the specified accreditation without influence of third party.