The proof is there!!
The proof is there!!

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!
The proof is there!!
The proof is there!!

>>> Bedding-, Insulation- and Jacket-Compounds <<<

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

"Fire protection from the inside"!

Bedding-, Insulation- and Jacket-Compounds
Highly flame-retarded non-halogen bedding compounds show remarkable effects on:

**BURNING PERFORMANCE** acc. to specifications. such as:

IEEE 1202, CSA FT4 and UL 1685

and are a **short route** to achieve:

**LOW SMOKE (LS)** recognition

The proof is there!!

"Fire protection from the inside"!
“Fire protection from the inside”!

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Our presentation was all about:

Hi-FR, non-halogen bedding compounds

**Thermoplastic** * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds....:

“Fire protection from the inside”!

The advantages of

**highly flame-retarded non-halogen bedding compounds**
Highly flame-retarded non-halogen bedding compounds....:

“Fire protection from the inside”!

* Applications and functions

* Bedding compounds make a cable round
  (More esthetic + easier pulling during installation)

* Fill gaps between insulation and jacket
  (also helps to reduce chimney effects during burning)

* It can embed (enclose) metal braids, tapes and
  other ‘armour’ (Thus reduces potential damage by
  the armour to jackets + keeping braids, tapes and
  armours in position)

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds.....: “Fire protection from the inside”!

* Applications and functions

- Improved protection against mechanical damage of the insulation.

- Reduced humidity penetration into the insulation *(Due to implementation of a radial barrier)*

- The contribution to ‘materials cost’ reduction *(Due to minimizing wall thicknesses of (more) expensive sheathing/jacketing compounds)*

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds....:

“Fire protection from the inside”!

For many XLPE-insulated cable constructions, the bedding compound shall **not adhere** to the insulation.

**Reason:**

- To improve ‘easy peeling’,

  *(and thus reduce installation time)*
Highly flame-retarded non-halogen bedding compounds.....: “Fire protection from the inside”!

Main topics ....

* Some selection criteria ➔ Processing

- Important, as 2 extrusion processes can be applied:
  * The 2-Step process (= off-line), and
  * The One step “Tandem” process (= in-line)
Highly flame-retarded non-halogen bedding compounds:

“Fire protection from the inside”!

2-Step process (off-line)

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds.....:
“Fire protection from the inside”!

2-Step process (off-line)

Step 1: Bedding compound is extruded over the insulated wire(s) or core.

Bedding compound
Insulated wires or core
Cable drum containing insulated wire
Highly flame-retarded non-halogen bedding compounds....:
“Fire protection from the inside”!

2-Step process (off-line)

Step 1: Bedding compound is extruded over the insulated wire(s) and DIRECTLY coiled on a cable drum.

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic *  Moisture-crosslinkable *  CV-curable *  E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds....:
“Fire protection from the inside”!

2-Step process (off-line)

After the bedding compound has been applied, the full drum is moved to another (or the same) extrusion line for the 2nd step:

Extrusion of the jacket over the bedding compound.

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds:...
“Fire protection from the inside”!

2-Step process (off-line)

After the bedding compound has been applied, the full drum is moved to another (or the same) extrusion line for the 2nd step:

Extrusion of the jacket over the bedding compound.

Cable drum containing insulated wire, embedded in the bedding compound

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds:...
“Fire protection from the inside”!

2-Step process (off-line)

Step 2: Jacket compound is extruded over the bedding compound

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds.....:
“Fire protection from the inside”!

2-Step process (off-line)

Step 2: Jacket compound is extruded over the bedding compound (and can be coiled again)

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds:....:
"Fire protection from the inside"!

**Processing of bedding compounds**

- **Tandem process (= in-line)**
  - In this process the bedding compound AND the sheathing compound are extruded on 2 extruders, which stand ‘in-line’.

**Diagram**
- Insulated wire(s) or core
  - Bedding compound
  - Sheathing compound
  - Finished cable

**Text**
- Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable

- Ron Goethals, Philadelphia; June 18, 2014
Highly flame-retarded non-halogen bedding compounds....:
“Fire protection from the inside”!

Processing of bedding compounds

Tandem process (= in-line)

In this process the bedding compound AND the sheathing compound are extruded on 2 extuders, which stand ‘in-line’.
Highly flame-retarded non-halogen bedding compounds:...

“Fire protection from the inside”!

Halogen-free, highly flame-retarded bedding compounds can help to significantly reduce hazards, like:

- Reduce toxicity
- Reduce corrosive gases
- Reduce smoke

And reduce:

Flame-spread

>>> Bedding-, Insulation- and Jacket-Compounds <<<

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds...:
"Fire protection from the inside!"

Results which were shown at the IWCS 2014:

Test 1

-- Bedding-, Insulation- and Jacket-Compounds --

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds....:
“Fire protection from the inside”!

These 2 (European) cables were tested acc. to EN 60332-3 Part 23 (Class B). Cables were mounted in a ‘touching configuration’ (1 layer).

- LSZH jacket: LOI = 45
- Non-flame retarded bedding
- XLPE-insulation
- OD = 8.3 mm
- Jacket WT = 1.8 mm

- LSZH jacket: LOI = 45
- Highly flame retarded LSZH bedding
- XLPE-insulation
- OD = 8.3 mm
- Jacket WT = 1.2 mm

Test 1

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds.....:
“Fire protection from the inside”!

These 2 (European) cables were tested acc. to EN 60332-3 Part 23 (Class B).
Cables were mounted in a ‘touching configuration’ (1 layer)

Test set-up: The cables are secured to a ladder, close together or spaced apart depending on the type of fire. The cables can be secured in several layers.
Test apparatus acc. to IEC / EN 60332-3-10.

Flame temperature:
Determined by the stipulated quantity of propane gas and air.

Test duration: IEC Part 21/EN Part 21: Category A F/R for special applications only
IEC Part 22/EN Part 22: Category A (7 l flammable material/m): 40 min
IEC Part 23/EN Part 23: Category B (3.5 l flammable material/m): 40 min
IEC Part 24/EN Part 24: Category C (1.5 l flammable material/m): 20 min
IEC Part 25/EN Part 25: Category D (0.5 l flammable material/m): 20 min

Compliance criterion: The visible area of fire damage to the cables must not exceed 2.5 m in height from the bottom edge of the burner.
Highly flame-retarded non-halogen bedding compounds....:
“Fire protection from the inside”!

Results

= 2.5 m (8.2 ft)
THR : 18 MJ

(THR= Total Heat Release)
Highly flame-retarded non-halogen bedding compounds.....:
“Fire protection from the inside”!

Results:

- Improved fire retardancy
- Considerable reduction of Total Heat Release (THR= Total Heat Release)

 THR : 18 MJ

(THR= Total Heat Release)

LSZH jacket: LOI = 45
Non-flame retarded bedding
XLPE-insulation
OD = 8.3 mm
Jacket WT = 1.8 mm

Hi-FR Bedding: LOI = 80
Highly flame retarded LSZH bedding
XLPE-insulation

LSZH jacket

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds:

“Fire protection from the inside”!

**Results**

- Improved fire-retardancy
- Considerable reduction of Total Heat Release

<table>
<thead>
<tr>
<th></th>
<th>LOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSZH jacket</td>
<td>45</td>
</tr>
<tr>
<td>Non-flame retarded bedding</td>
<td></td>
</tr>
<tr>
<td>LSZH jacket</td>
<td>45</td>
</tr>
<tr>
<td>Hi-FR Bedding</td>
<td>80</td>
</tr>
</tbody>
</table>

**Results**:

- THR = 18 MJ
  - OD = 8.3 mm
  - Jacket WT = 1.8 mm

- THR = 5.5 MJ
  - OD = 8.3 mm
  - Jacket WT = 1.2 mm

Bedding-, Insulation- and Jacket-Compounds

- Thermoplastic
- Moisture-crosslinkable
- CV-curable
- E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds.....

“Fire protection from the inside”!

Test 2

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds....:
“Fire protection from the inside”!

Test 2

Cable construction:

- **Non-FR XLPE Insulation**  \(3 \times 1,5 \text{ mm}^2 (= 16 \text{ AWG})\)
- **LSZH Bedding**  \(\text{compare : 3 different compounds}\)
- **LSZH Jacket**  \(\text{compare : 2 different compounds}\)

19 of these cables were vertically mounted, acc to EN 50399.

*Distance between cables : 1 cm  \((= 0,4”)\)*

20 minutes : burner of 21 kW
Highly flame-retarded non-halogen bedding compounds....:  
“Fire protection from the inside”!

<table>
<thead>
<tr>
<th>Insulation</th>
<th>Bedding compound</th>
<th>LOI</th>
<th>Jacket</th>
<th>LOI</th>
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<tbody>
<tr>
<td>3 x 1,5 mm² XLPE (non FR)</td>
<td>FM 1249</td>
<td>Non FR</td>
<td>S 1003 F</td>
<td>40</td>
</tr>
</tbody>
</table>

21 kW Burner; 20 minutes

Damaged cable > 10 feet

Bedding-, Insulation- and Jacket-Compounds: Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds.....:
“Fire protection from the inside”!

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<td>3 x 1,5 mm² XLPE (non FR)</td>
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<td>45</td>
<td>„</td>
<td>40</td>
</tr>
</tbody>
</table>

21 kW Burner, 20 minutes

Damaged cable

> 10 feet
= 7 feet

Bedding-*, Insulation-* and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds.....:
"Fire protection from the inside!"

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<tr>
<td>XLPE (non FR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>FM 1248</td>
<td>45</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>FM 1239</td>
<td>55</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

21 kW Burner, 20 minutes

Damaged cable
- > 10 feet
- = 7 feet
- = 5 feet

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds.....:
“Fire protection from the inside”!

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<td>40</td>
</tr>
<tr>
<td>3</td>
<td>FM 1239</td>
<td>55</td>
<td>„</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>FM 1248</td>
<td>45</td>
<td>S 1027 F</td>
<td>45</td>
</tr>
</tbody>
</table>

Damaged cable:
- > 10 feet
- = 7 feet
- = 5 feet
- = 6.5 feet

21 kW Burner, 20 minutes

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds.....:
“Fire protection from the inside”!

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<th></th>
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<th>Bedding compound</th>
<th>LOI</th>
<th>Jacket</th>
<th>LOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3 x 1,5 mm²</td>
<td>XLPE (non FR)</td>
<td>45</td>
<td>FM 1249</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>”</td>
<td>”</td>
<td>55</td>
<td>”</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>”</td>
<td>FM 1239</td>
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So.... using a highly flame-retarded bedding compound may have more impact on fire-tests than looking for a more flame-retarded jacket!

21 kW Burner, 20 minutes

<table>
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<tr>
<th>Damage</th>
<th>feet</th>
<th></th>
<th>feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damaged cable</td>
<td>&gt; 10</td>
<td>= 5 feet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 6.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

21 kW Burner, 20 minutes

So.... using a highly flame-retarded bedding compound may have more impact on fire-tests than looking for a more flame-retarded jacket!

<table>
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<tr>
<td></td>
<td>Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable</td>
</tr>
</tbody>
</table>
The proof is there!!

What we tried to accomplish in 2014 was:

- Attract USA cable manufacturers to use our bedding compounds
- Convince them to start a trial project
- Help them with selecting the right product for their construction
- Show them how simple these compounds can be processed
- Hope for positive results in 2015
The proof is there!!

After 1 year, we CAN confirm that our expectations ... did turn into reality!!

Our highly flame-retarded bedding compounds DO SHOW REMARKABLE RESULTS in cable constructions, according to US specifications.
The proof is there!!

**Project 1: Multicore cable**
UL 1685 – smoke test; UL 1277 Vertical Tray Cable; CSA FT-4 Vertical Tray Cable

3 core cable, 14 AWG (2.0 mm2), Insulation: Halogenated XLPE VW-1 (LOI = 27) or Non VW-1 (LOI = 24)
Jacket: E-beam crosslinkable oil resistant non-halogen flame-retarded LSZH (LOI = 40)

Variables in the construction: ➔ 1) Filler material and 2) Fire-resistant aramid tape

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

**Project 1 : Multicore cable**
UL 1685 – smoke test; UL 1277 Vertical Tray Cable ; CSA FT-4 Vertical Tray Cable

Insulation : XLPE VW-1 ; Jacket : LSZH, LOI 40

Variables in the construction : ➔ 1) Filler material and 2) Fire-resistant aramid tape

---

**Large scale Flame Test : FT 4**

<table>
<thead>
<tr>
<th>BTU’s</th>
<th>70,000 (21 kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>20 minutes</td>
</tr>
</tbody>
</table>

For your info: 1 BTU (British Thermal Unit) is the amount of heat, which is needed to raise 1 lbs of water by 1 degree Fahrenheit.

* Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
**The proof is there!!**

**Project 1 : Multicore cable**
UL 1685 – smoke test; UL 1277 Vertical Tray Cable ; CSA FT-4 Vertical Tray Cable

Insulation : XLPE VW-1 ; Jacket : LSZH, LOI 40

Variables in the construction : ➔ 1) Filler material and 2) Fire-resistant aramid tape

Large scale Flame Test : FT 4
BTU’s : 70,000 (21 kW)
Time : 20 minutes

Following properties were tested:

- Damaged cable length
- Peak smoke
- Total smoke

>>> Bedding-, Insulation- and Jacket-Compounds <<<

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

Char length (= damage) in cm

Non VW-1 insulation

1: PP yarn filler
2: Aramid based tape

Char length (= damage) in cm

1: Bedding compound FM 0474/5
2: No tape

Non VW-1 insulation

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
**The proof is there!!**

- **Char length (= damage) in cm**
  - UL 1685: max 244 cm
  - FT 4: max 155 cm

- **Non VW-1 insulation**
  - 1: PP yarn filler
  - 2: Aramid based tape

---

**Thermoplastic** * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable

Ron Goethals, Philadelphia; June 18, 2014

The proof is there!!

<table>
<thead>
<tr>
<th>Char length (damage) in cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>150</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>50</td>
</tr>
</tbody>
</table>

UL 1685: max 244 cm

FT 4: max 155 cm
The proof is there!!

**Char length (= damage) in cm**

- UL 1685: max 244 cm
- ET 4: max 155 cm

**Non VW-1 insulation**

1: PP yarn filler
2: Aramid based tape

Char length (damag) in cm

<table>
<thead>
<tr>
<th>PP yarn + aramide tape</th>
<th>213 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT 4: max 155 cm</td>
<td></td>
</tr>
<tr>
<td>1: PP yarn filler</td>
<td></td>
</tr>
<tr>
<td>2: Aramide based tape</td>
<td></td>
</tr>
</tbody>
</table>

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

Char length (= damage) in cm

UL 1685 : max 244 cm

ET 4 : max 155 cm

(213 cm)

PP yarn + aramide tape

(125 cm)

FM 0474/5

No tape

1: PP yarn filler

2: Aramide based tape

1: Bedding compound FM 0474/5

2: No tape

Non VW-1 insulation

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

Peak smoke in m²/s

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable

Bedding-, Insulation- and Jacket-Compounds
The proof is there!!

Peak smoke in $m^2/s$

UL 1685: max 0.25
FT 4: max 0.40

Non VW-1 insulation

1: PP yarn filler
2: Aramid based tape

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

Peak smoke in m²/s

UL 1685: max 0.25
FT 4: max 0.40

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable

Ron Goethals, Philadelphia; June 18, 2014
The proof is there!!

Peak smoke in $m^2/s$

PP yarn + aramide tape (0.75 m$^2$/s)

FT 4: max 0.40

UL 1685: max 0.25

(0.05 m$^2$/s)

FM 0474/5 No tape

1: PP yarn filler
2: Aramide based tape

1: Bedding compound
2: No tape

Non VW-1 insulation

>>> Bedding-, Insulation- and Jacket-Compounds <<<

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

Total smoke in \(m^2\)

VW-1 insulation

1: PP yarn filler

2: Aramid based tape

Thermoplastic \* Moisture-crosslinkable \* CV-curable \* E-beam Irradiation Crosslinkable
The proof is there!!

Total smoke in m²

FT 4 : max 150 m²
UL 1685 : max 95 m²

VW-1 insulation

1: PP yarn filler
2: Aramid basedtape

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

**Total smoke in m²**

- **VW-1 insulation**

**Graph:**
- PP yarn + aramide tape
- FT 4: max 150 m²
- UL 1685: max 95 m²

**Legend:**
1: PP yarn filler
2: Aramide based tape

**Fire Tests:**
- UL 1685: max 95 m²
- FT 4: max 150 m²

**Notations:**
- Thermoplastic
- Moisture-crosslinkable
- CV-curable
- E-beam Irradiation Crosslinkable
The proof is there!!

Total smoke in $m^2$

- PP yarn + aramide tape
  - FM 0474/5
  - NO tape
  - FT 4: max 150 $m^2$
  - UL 1685: max 95 $m^2$
  - (20 $m^2$)

- VW-1 insulation
  - 1: PP yarn filler
  - 2: Aramid based tape

- 1: Bedding compound FM 0474/5
  - 2: No tape

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!
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Project 2:
Evaluation and preparation for CPR (*European regulations*)

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

Project 2:
Evaluation and preparation for CPR

Cone calorimeter tests
according to ISO 5660 (Heat flux = 50 kW/m²)

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Burn test acc. EN 13501: Euroclasses

<table>
<thead>
<tr>
<th>classification</th>
<th>A&lt;sub&gt;ca&lt;/sub&gt;</th>
<th>B1&lt;sub&gt;ca&lt;/sub&gt;</th>
<th>B2&lt;sub&gt;ca&lt;/sub&gt;</th>
<th>C&lt;sub&gt;ca&lt;/sub&gt;</th>
<th>D&lt;sub&gt;ca&lt;/sub&gt;</th>
<th>E</th>
<th>F</th>
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</thead>
<tbody>
<tr>
<td>EN ISO 1716</td>
<td>H / mm</td>
<td>≤ 425</td>
<td>≤ 425</td>
<td>≤ 425</td>
<td>≤ 425</td>
<td>≤ 425</td>
<td>≤ 425</td>
</tr>
<tr>
<td>EN 60332</td>
<td>FS / m</td>
<td>≤ 1.75</td>
<td>≤ 1.5</td>
<td>≤ 2.0</td>
<td>≤ 425</td>
<td>≤ 425</td>
<td>≤ 425</td>
</tr>
<tr>
<td>EN 50399</td>
<td>THR&lt;sub&gt;1200s&lt;/sub&gt; / MJ</td>
<td>≤ 10</td>
<td>≤ 15</td>
<td>≤ 30</td>
<td>≤ 70</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HRR / kW</td>
<td>≤ 20</td>
<td>≤ 30</td>
<td>≤ 60</td>
<td>≤ 400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FGRA / Ws-1</td>
<td>≤ 120</td>
<td>≤ 150</td>
<td>≤ 300</td>
<td>≤ 1300</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional classification:
- EN 61034 smoke production: s<sub>1a</sub>, s<sub>1b</sub>, s<sub>2</sub>, s<sub>3</sub>  s<sub>1a</sub>, s<sub>1b</sub>, s<sub>2</sub>, s<sub>3</sub>  s<sub>1a</sub>, s<sub>1b</sub>, s<sub>2</sub>, s<sub>3</sub>  s<sub>1a</sub>, s<sub>1b</sub>, s<sub>2</sub>, s<sub>3</sub>  no  no
- EN 50267 acidity: a<sub>1</sub>, a<sub>2</sub>, a<sub>3</sub>  a<sub>1</sub>, a<sub>2</sub>, a<sub>3</sub>  a<sub>1</sub>, a<sub>2</sub>, a<sub>3</sub>  a<sub>1</sub>, a<sub>2</sub>, a<sub>3</sub>  no  no
- EN 50399 flaming droplets: d<sub>0</sub>, d<sub>1</sub>, d<sub>2</sub>  d<sub>0</sub>, d<sub>1</sub>, d<sub>2</sub>  d<sub>0</sub>, d<sub>1</sub>, d<sub>2</sub>  d<sub>0</sub>, d<sub>1</sub>, d<sub>2</sub>  no  no

CPD: abbreviations:
- FS Flame Spread
- THR Total Heat Release
- FIGRA Fire Index Growth Rate
- HRR Heat Release Rate
- TSP Total Smoke Production
- SPR Smoke Production Rate
- CEMAC CE Marking of Cables
- FIPEC Fire Performance of Electrical Cables

‘The’ class which is a challenge already for the cable industry

The 4 Classes in which the cable industry is going to ‘move’

The proof is there!!

Project 2 : CPR (European regulations)

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

Total Heat Release (MJ)

Cone calorimeter results acc. to ISO 5660 (Heatflux = 50 kW/m²)

- CPR Class D: max 70 MJ
- CPR Class C: max 30 MJ
- CPR Class B2: max 15 MJ
- CPR Class B2: max 10 MJ

Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
**The proof is there!!**

Total Heat Release (MJ)

Cone calorimeter results acc. to ISO 5660 (Heatflux = 50 kW/m²)

- **Standard LSZH sheathing compound**: 20 – 25 MJ
- **Highly flame-retarded LSZH sheathing compound**: (70 – 75) MJ

- CPR Class D: max 70 MJ
- CPR Class C: max 30 MJ
- CPR Class B2: max 15 MJ
- CPR Class B2: max 10 MJ

Bedding-, Insulation- and Jacket-Compounds

- Thermoplastic
- Moisture-crosslinkable
- CV-curable
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The proof is there!!

Total Heat Release (MJ)  
Cone calorimeter results acc. to ISO 5660 (Heat flux = 50 kW/m²)

<table>
<thead>
<tr>
<th>Total Heat Release (in MJ)</th>
<th>Standard LSZH sheathing compound</th>
<th>Highly flame-retarded LSZH sheathing compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>(70 – 75)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(60 – 65)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CPR Class D : max 70 MJ  
CPR Class C : max 30 MJ  
CPR Class B2 : max 15 MJ  
CPR Class B2 : max 10 MJ

Thermoplastic *  
Moisture-crosslinkable *  
CV-curable *  
E-beam Irradiation Crosslinkable
The proof is there!!

**Total Heat Release (MJ)**

*Cone calorimeter results acc. to ISO 5660 (Heaflux = 50 kW/m²)*

- **CPR Class D**: max 70 MJ
- **CPR Class C**: max 30 MJ
- **CPR Class B2**: max 15 MJ
- **CPR Class B2**: max 10 MJ

**Standard LSZH sheathing compound**

- (70 – 75) MJ

**Highly flame-retarded LSZH sheathing compound**

- (60 – 65) MJ

**Highly flame-retarded LSZH bedding compound**

- (45 – 50) MJ

**** Bedding-, Insulation- and Jacket-Compounds ****

**Thermoplastic** * **Moisture-crosslinkable** * **CV-curable** * **E-beam Irradiation Crosslinkable**
The proof is there!!

Total Heat Release (MJ) Cone calorimeter results acc. to ISO 5660 (Heatflux = 50 kW/m2)

Standard LSZH sheathing compound

Highly flame-retarded LSZH sheathing compound

Highly flame-retarded LSZH bedding compound

Remarkable bedding compound FM 0474/5

CPR Class D : max 70 MJ
CPR Class C : max 30 MJ
CPR Class B2 : max 15 MJ
CPR Class B2 : max 10 MJ

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable

Ron Goethals, Philadelphia; June 18, 2014
The proof is there!!

Total Smoke Production (m2)

Cone calorimeter results acc. to ISO 5660 (Heat flux = 50 kW/m2)

>>> Bedding-, Insulation- and Jacket-Compounds <<<

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

Total Smoke Production (m2)

Cone calorimeter results acc. to ISO 5660 (Heatflux = 50 kW/m2)

- Bedding-, Insulation- and Jacket-Compounds
- Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
**The proof is there!!**

**Total Smoke Production (m²)**

Cone calorimeter results acc. to ISO 5660 (Heaflux = 50 kW/m²)

- **Standard LSZH sheathing compound**: (700 – 1000)
- **Highly flame-retarded LSZH sheathing compound**: (350 - 500)

---

**Thermoplastic** * **Moisture-crosslinkable** * **CV-curable** * **E-beam Irradiation Crosslinkable**
The proof is there!!

Cone calorimeter results acc. to ISO 5660 (Heatflux = 50 kW/m²)

Total Smoke Production (m²)

- Standard LSZH sheathing compound: (700 – 1000)
- Highly flame-retarded LSZH sheathing compound: (350 - 500)
- Highly flame-retarded LSZH bedding compound: (250 - 400)

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
The proof is there!!

Cone calorimeter results acc. to ISO 5660 (Heat flux = 50 kW/m²)

- **Standard LSZH sheathing compound**: (700 – 1000) m²
- **Highly flame-retarded LSZH sheathing compound**: (350 – 500) m²
- **Highly flame-retarded LSZH bedding compound**: (250 – 400) m²

Remarkable bedding compound
FM 0474/5
The proof is there!!

**Total Smoke Production (m²)**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Total Smoke Production (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard LSZH sheathing compound</td>
<td>(700 – 1000)</td>
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<tr>
<td>Highly flame-retarded LSZH sheathing compound</td>
<td>(350 - 500)</td>
</tr>
<tr>
<td>Highly flame-retarded LSZH bedding compound</td>
<td>(250 - 400)</td>
</tr>
<tr>
<td>Remarkable bedding compound</td>
<td>(60-70)</td>
</tr>
</tbody>
</table>

Cone calorimeter results acc. to ISO 5660 (Heat flux = 50 kW/m²)

- Thermoplastic
- Moisture-crosslinkable
- CV-curable
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Ron Goethals, Philadelphia; June 18, 2014
The proof is there!!

- Bedding-, Insulation- and Jacket-Compounds

Thermoplastic * Moisture-crosslinkable * CV-curable * E-beam Irradiation Crosslinkable
Highly flame-retarded non-halogen bedding compounds show remarkable effects on: **BURNING PERFORMANCE** acc. to specifications. such as: IEEE 1202, CSA FT4 and UL 1685 and are a **short route** to achieve: **LOW SMOKE (LS)** recognition.
"Fire protection from the inside!"