RG-CPDW 165

# Boiler

## I.E.I.

## International Enamellers Institute

# The Request of I.E.I

**The I.E.I.**
**International Enamellers Institute,**
**who represents all the**
**European Enamel Associations**
**applies RG-CPDW for the creation**
**of a new sub group:**
**"GLASSY MATERIALS"**
**(Porcelain Enamel Linings)**

# The 5 reasons justifying this request

- Porcelain enamel linings are very important for hot water tanks
- Hot water tanks are already present in every house in all European countries
- To give a complete and correct information on a material with a prior knowledge of more than 40 years

# The reasons for our request

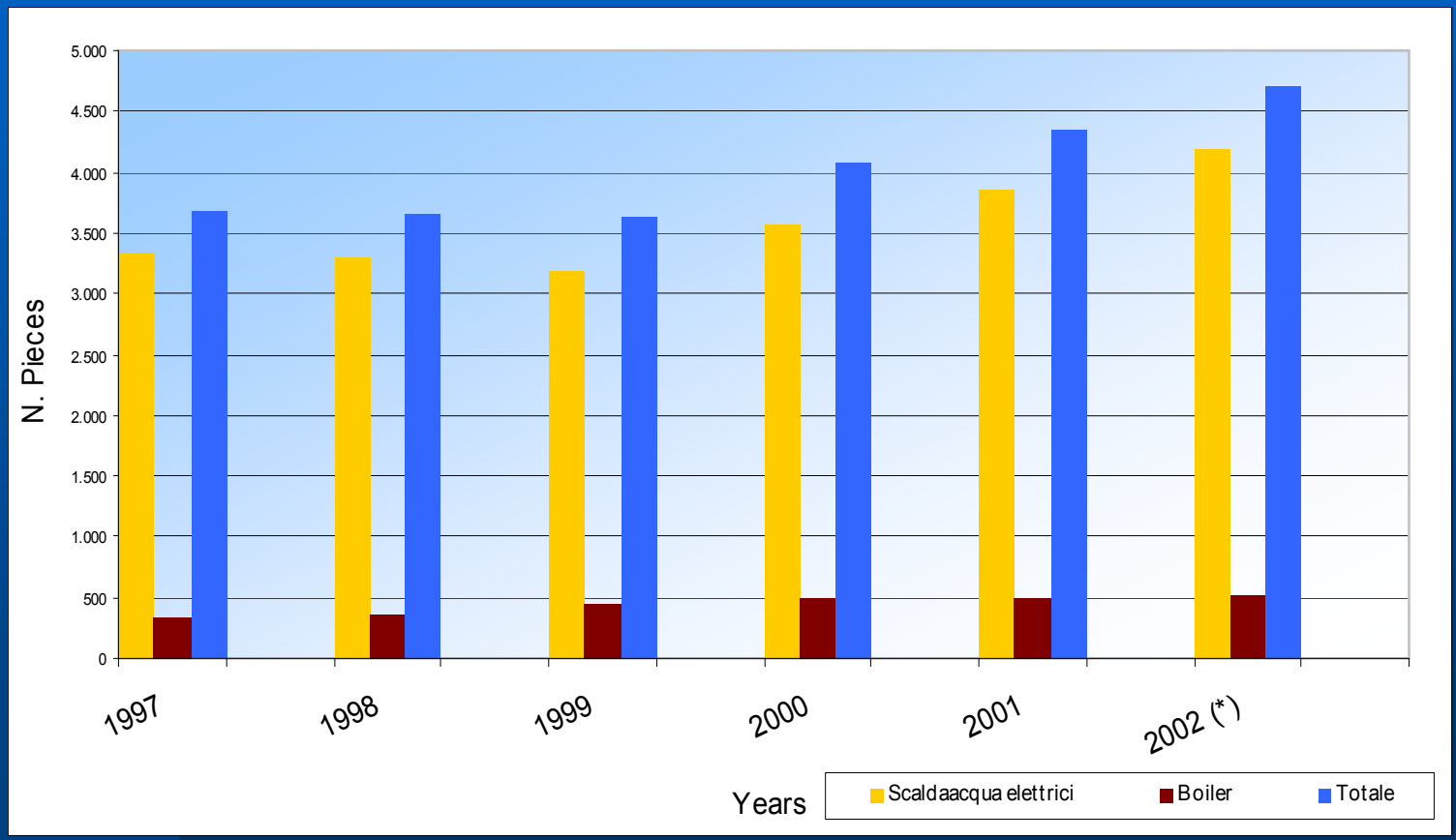
- To give porcelain enamel the same visibility reserved to metallic, plastic and cementious materials
- Because p. e. linings are not fully reported in the most important documents of RG-CPDW despite of all the technical inputs given sofar to RG-CPDW

# Industry Status of Art

## 2002 Hot Water Tank Market

- China 12.000.000 ppa
- USA 9.000.000 ppa
- EU 8.500.000 ppa
- Italy 4.500.000 ppa

# Italian Hot Water Tanks Market 1997 - 2001

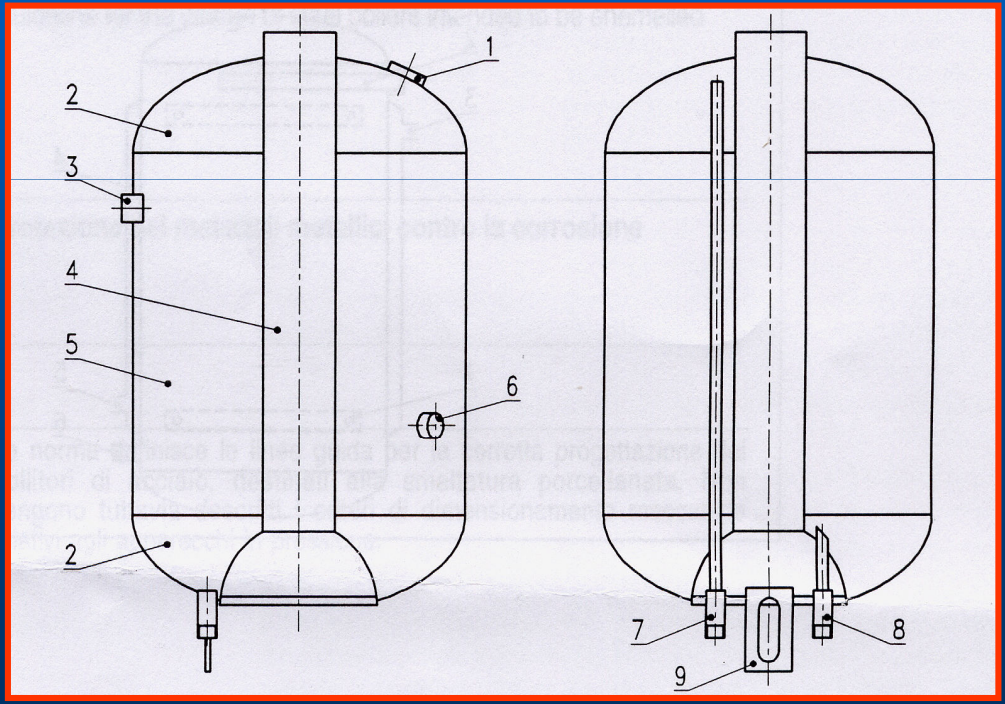


# The Product: Hot Water Tanks - Boilers

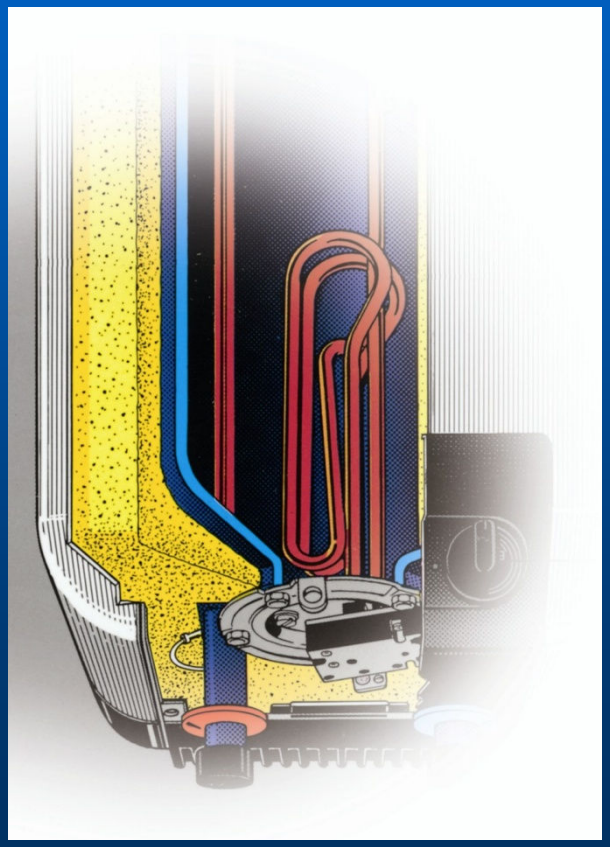
**Gas Hot Water Tank**

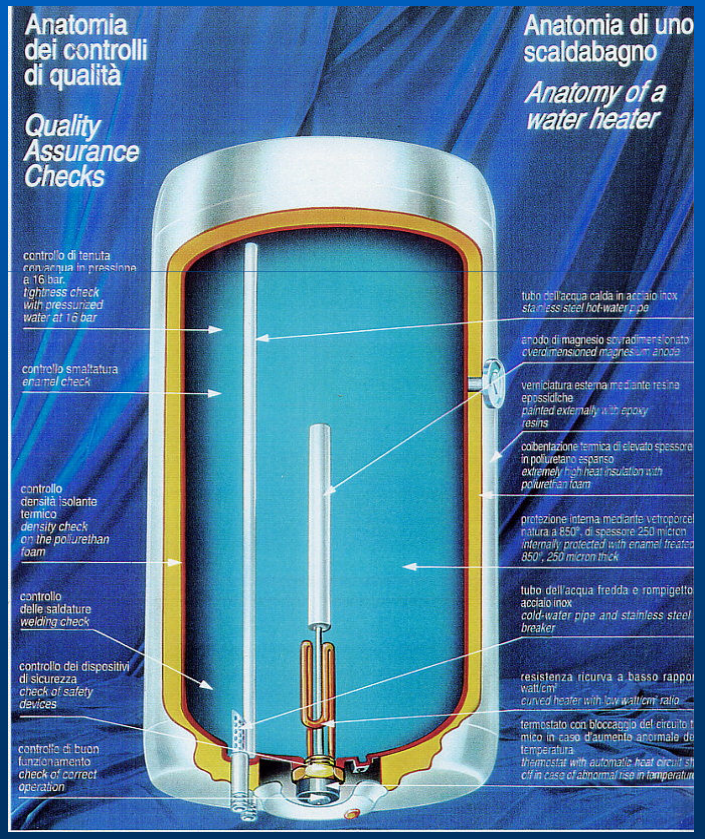
**Key:**

1. Anode sleeve coupling
2. Convex bottom
3. Suspending connection
4. Chimney pipe
5. Shell plate
6. Valve and thermostat sleeve
7. Outlet tube
8. Inlet tube
9. Enamelling hooke



# The Product: Hot Water Tanks - Boilers





# Technical Data Sheet

- Working T °C ..... 60 – 80
- Max T °C .....110
- Working Pressure ..... 0 – 8 bar
- Max W.Pressure ..... 6 – 8 bar
- Test Pressure ..... 10,4 bar
- S/V Ratio ..... ~ 1 $dm^{-1}$
- P.E. Max Weight Loss ..... 3,5 $g/m^2$

# Boilers -Some Existing Standards & Laws

- DIN 4753 – Part 3
- UNI 9905
- UNI 68.01.0682 (Draft)
- UNI – EN 764
- Italian Decree
- French Decree (29 May 1997)

# Hot Water Tank S/V Rate

| Capacity ($dm^3$) | Surface ($dm^2$) | S/V ($dm^{-1}$) |
|---|---|---|
| 10 | 33 | 3.30 |
| 15 | 34 | 2.60 |
| 30 | 54 | 1.80 |
| 50 | 70 | 1.40 |
| 80 | 100 | 1.25 |
| 100 | 117 | 1.17 |

# Vitreous Enamel - Definition

## Vitreous Enamel

**is a glazed surface finish designed for application to metallic surfaces for protective, functional and or decorative purposes.**

**It is produced by the application of powdered inorganic glass, dry or suspended in water on to the metal surface and its subsequent fusion bonding (450 – 950°C).**

**The fused coating exhibits cubic thermal expansion of between 150 and 450 x $10^{-7}$ $°K^{-1}$ in the temperature range 20 – 100°C, the actual value varying specifically with the type of subtrate and field of application.**

# Vitreous Enamel identification

- EINECS N. 266 - 047 - 6
- CAS N. 65997 - 18 – 4

**Key:**
**EINECS = European Inventory Existing Commercial Substances**
**CAS = Chemical Abstract Substances**

# Vitreous Enamel Smelting

**Smelting Temperature**

**1.200 – 1.400 °C**

# V.E. Composition List

| Subst. | Min. | Max |
|---|---|---|
| $SiO_2$ | 25 | 80 |
| $B_2O_3$ | 0,1 | 20 |
| $Na_2O$ | 0 | 30 |
| $K_2O$ | 0 | 10 |
| $LiO_2$ | 0 | 10 |
| CaO | 0 | 10 |
| BaO | 0 | 15 |
| SrO | 0 | 5 |

| Subst. | Min. | Max |
|---|---|---|
| MgO | 0 | 5 |
| $CeO_2$ | 0 | 15 |
| ZnO | 0 | 10 |
| $Al_2O_3$ | 0 | 5 |
| CoO | 0 | 5 |
| NiO | 0 | 5 |
| CuO | 0 | 3 |
| $MnO_2$ | 0 | 5 |

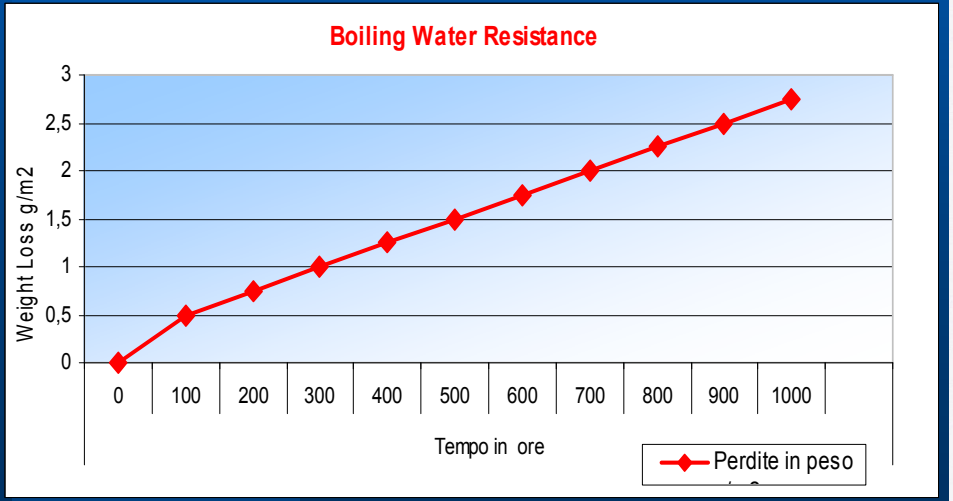
| Subst. | Min. | Max |
|---|---|---|
| $Fe_2O_3$ | 0 | 5 |
| $MoO_3$ | 0 | 5 |
| $P_2O_5$ | 0 | 5 |
| $SnO_2$ | 0 | 5 |
| $TiO_2$ | 0 | 10 |
| $ZrO_2$ | 0 | 30 |
| F | 0 | 10 |

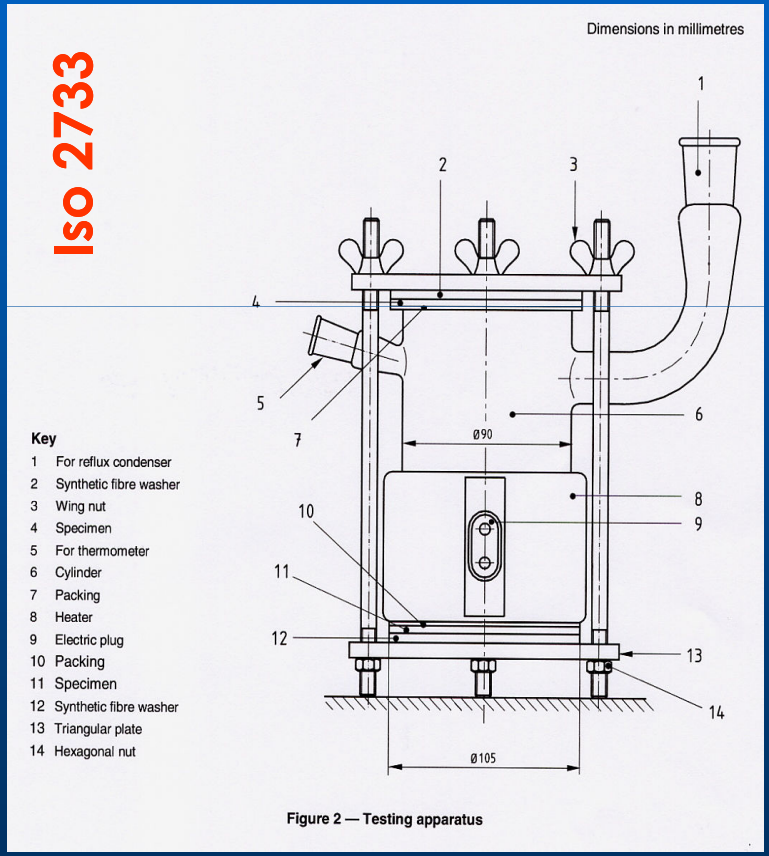
The concentration ranges are giving the possible element oxides, which could be present in the different v. e. recipes for boilers. The lower limit "0" means that some elements could not be present in the enamel formulation, it is not a guarantee for their absence

# Enamelling Process Flowchart

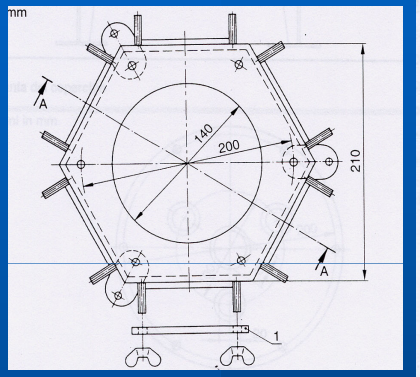
# Water – Vitreous enamel Compatibility

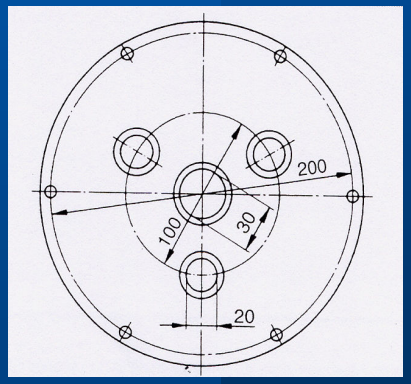
## Weight loss gr/m²

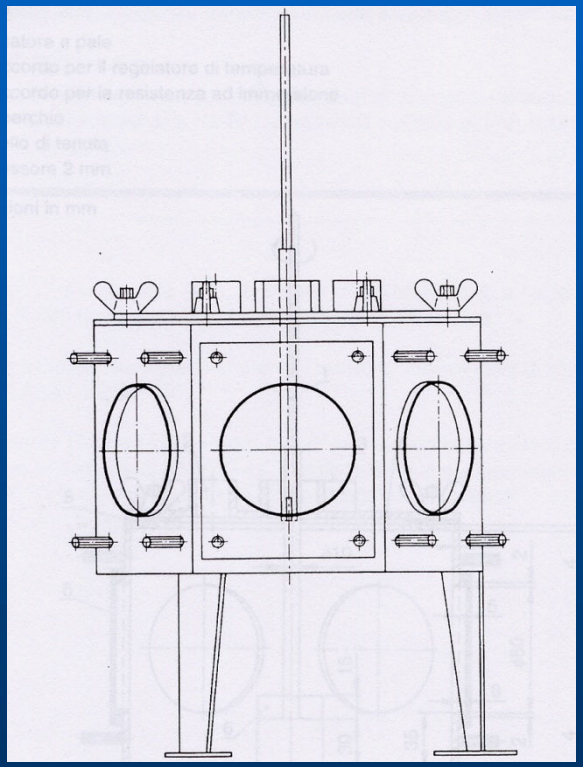


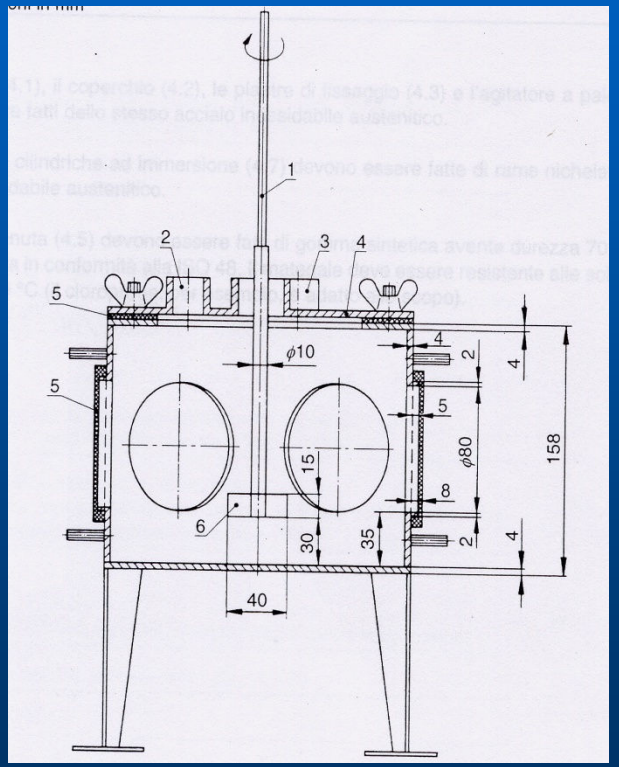



# Apparatus according to ISO 4535





# Boiler: Minimum Requirements

## Re: DIN 4753/3:

- Enamel coating thickness: 0,15 – 0,50 mm
- Impact Resistance – ISO 4532 – No visible damage greater than 1,5 mm (diameter)
- Thermal Shock Resistance - No damage – Test according par. 5.4.1 DIN 4753/3
- Resistance to warm water - ISO 2744 – Max. W.L. 3,5 g/m$^2$
- Acid Resistance - ISO 2722 – Min. Class A

# Enamels for boilers – Ref. UNI Standards

- They do not contain Pb and Cd (UNI 9905)
- Resistance to hot water & vapours (UNI 6722)
- Acid Resistance (UNI 5717)
- Thermal shock resistance (UNI 9905)
- Adherence (UNI 8883)
- Hardness (EN 101)
- Abrasion Resistance (UNI 7233)
- Impact Resistance (UNI 9613)
- Continuity of the surface (UNI-ISO 8289)

# Migration Process with respect to chemical water composition (Doc. Meyer 24.10.2000)

| Type of material | Cementious | Organic | Metallic | Glassy |
|---|---|---|---|---|
| Chemical reaction with water | Yes | No | Yes | No |
| Type of process leading to deterioration of water quality | Reaction<br>Dissolution<br>Migration (only for organic additives) | Migration | Dissolution of corrosion products | Dissolution |
| Influence of chemical water characteristics within range of drinking water | Determining for inorganic part. No for organic additives | No | Determining | Low |
| Restrictions for use necessary with respect to chemical water composition | Yes | No | Yes | No |
| Effective water treatment possible to reduce quality deterioration | Yes | No | Limited | No |

# Ref. Meyer Document 24.10.2000

| | | |
|---|---|---|
| T.O.C. | n.a. | Vitreous enamel is free from organic products deposit, because fused at 830 – 860 °C |
| COLOUR | n.a. | Vitreous enamel is an insoluble product in cold water and does not release components with colour sensitivity |
| FLAVOUR | n.a. | See T.O.C. |
| TURBIDITY | n.a. | See T.O.C. |
| MICROB. GROWTH | n.a. | 1. No biofilm<br>2. Very smooth and hard surface<br>3. Bacteriological Research<br>4. Hot water tank at working temperature over 60°C |

# CEN/TC 164 – WG 3 - The WG 3 Matrix

## Test methods needed for glassy materials

| Organoleptic Tests | | Migration Tests | | | | Other Tests | | |
|---|---|---|---|---|---|---|---|---|
| O/F | C/T | T.O.C. | PL | DWD | GCMS | Cldem | EMG | Cyto Tox. |
| N | N | N | N | Y(+) | N | N | N | N |

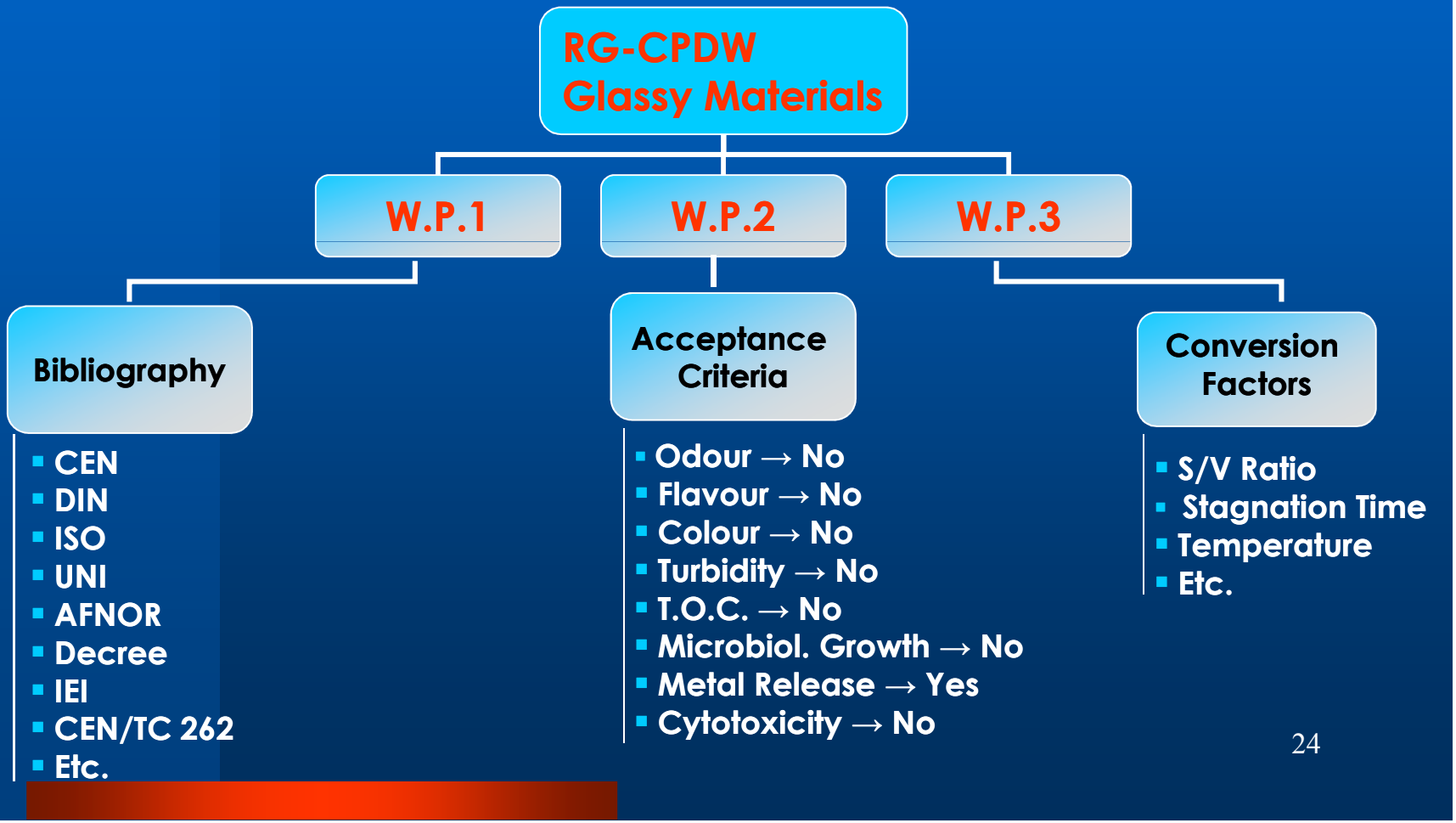
**Key:**

O/F = Odour & Flavour
C/T = Colour & Turbidity
T.O.C. = Total Organic Carbon
PL = Positive List
DWD = Drinking Water Directive
GCMS = GC-MS Testing

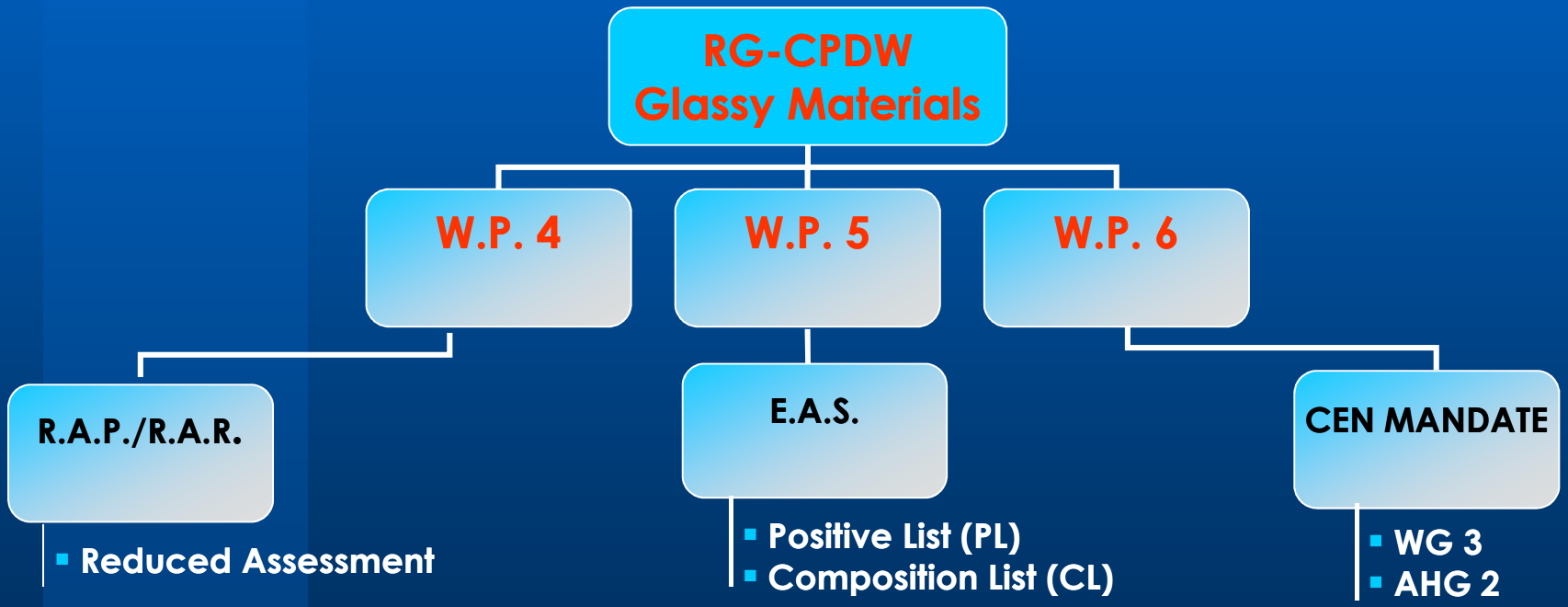
Cldem = Chlorine Demand
EMG = Enhancement Microbial Growth
Cyto Tox. = Cytotoxicity Testing

Y(+) = CEN Method needed – Standard or w. i. exists
N = CEN Method not needed

# Work Breakdown Structure 1



# Work Breakdown Structure 2



# Gandt Diagram

| N. | Action | Who | When | What |
|---|---|---|---|---|
| 1. | Bibliography | IEI/ISS | June '03 | |
| 2. | Acceptance criteria | ISS/I.E.I | * | Matrix |
| 2.1. | Odour | ISS/I.E.I | * | Matrix |
| 2.2. | Flavour | ISS/I.E.I | * | Matrix |
| 2.3. | Colour | ISS/I.E.I | * | Matrix |
| 2.4. | Turbidity | ISS/I.E.I | * | Matrix |
| 2.5. | T.O.C. | ISS/I.E.I | * | Matrix |
| 2.6. | Microbiological Growth | ISS/I.E.I | * | Matrix - RGCPDW 123 |
| 2.7. | Cytotoxicity | ISS/I.E.I | * | Matrix |

Key: ISS = Istituto Superiore di Sanità / IEI = International Enamellers Institute / RG-CPDW = Regulators Group Construction Products in Contact with Drinking Water

* Depending on contract formalisation timing



continue

# Gandt Diagram

| N. | Action | Who | When | What |
|---|---|---|---|---|
| 2.8. | Metal Release | | | |
| 2.8.1. | Composition List | IEI | Available | |
| 2.8.2. | DWD Limits | EU | Available | Dir. 98/83 CE |
| 2.8.3. | S/V Definition | ISS/IEI/RG | June '03 | Discussion with Mr. Fielding |
| 2.8.4. | Test Procedure Definition | CEN/IEI/RG | June '03 | PrEN 12873-1 |
| 2.8.5. | Apparatus Definition | ISS/IEI/CEN | June '03 | ISO 2733 & 4535 - Other Apparata |
| 2.8.6. | Metal Release Test | ISS | Dec. '03 | at Room Temp. |
| 2.8.7. | Metal Release Test | ISS | Dec. '03 | at 60 & 85 °C |
| 2.8.8. | Metal Release Test | ISS | Dec. '03 | With chlorinated water |
| 2.8.9. | Metal Release Test | ISS | Dec. '03 | With $H_2O_2$ added water |



continue

# Gandt Diagram

| Action | Who | When | What |
|---|---|---|---|
| 3. Conversion factors | | | |
| 3.1. S/V | ISS/IEI/RG * | June '03 | Extend range from 1 – 40<br>Prior knowledge<br>Discussion with Mr. Fielding |
| 3.2. Stagnation time | RG-CPDW | Ad hoc planning | Max. 12 h |
| 3.3. Temperature | RG-CPDW | Ad hoc planning | $T_1$ – Room T. cold water<br>$T_2$ 60°C – Warm water<br>$T_3$ 85°C – Hot water |

ISS = Istituto Superiore di Sanità (Italian Regulator)
IEI = International Enamellers Institute



continue

# Gandt Diagram

| | Action | Who | When | What |
|---|---|---|---|---|
| 4. | R.A.P./R.A.R | | | |
| 4.1. | Reduced Assess. | RG-CPDW | Ad hoc planning | ▪ When metal release test shows that P.E. limit is below DWD limits only composition List (CL) required<br>▪ Positive List (PL) to be encluded in E.A.S. |



continue

# Gandt Diagram

| Action | Who | When | What |
|---|---|---|---|
| 5. E.A.S. | | | |
| 5.1. Composition List | IEI | March '03 | To be discussed by RG-CPDW |
| 5.2. Metal Release List Report | ISS | June '04 | To be discussed by RG-CPDW |
| 5.3. Positive List | RG-CPDW | Nov. '04 | ▪ To be approved by RG-CPDW<br>▪ Recent Italian Decree |



continue

# Gandt Diagram

| | Action | Who | When | What |
|---|---|---|---|---|
| 6. | CEN Mandate | | | |
| 6.1. | CEN | RG-CPDW | | |
| 6.2. | WG 3 Tests Working Programm | CEN/TC 164 | | |

# CEN Directive 98/83

## Chemical Parameters - Part B

| Parameters | Param.Values | Unity of meas. | Notes |
|---|---|---|---|
| Sb | 5.0 | µg/l | |
| B | 1.0 | mg/l | |
| Cd | 5.0 | µg/l | |
| Cr | 50 | µg/l | |
| Cu | 2.0 | mg/l | 3 |
| $F^-$ | 1.50 | mg/l | |
| Pb | 10 | µg/l | 3 & 4 |
| Ni | 20 | µg/l | 3 |

# CEN Directive 98/83

## Chemical Parameters - Part C

| Parameters | Param.Values | Unity of meas. | Notes |
|---|---|---|---|
| Al | 200 | µg/l | |
| Fe | 200 | µg/l | |
| Mn | 50 | µg/l | |
| Na | 200 | mg/l | |