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*Excellence through innovation*

# IGD-TP 7th Exchange Forum

# Canister Design

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# Objectives for today

- **Give you something to consider**
- **What do you want your canister to do**
- **Understand how they are made**
- **Design to maximise efficiencies**

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# Your Speaker?

**Andrew McClusky – Owner & MD of BEP Surface Technologies Ltd**

- **BEP has been an electro plating company since 1970**
- **Specialise in plating Nickel, Copper & Chrome**
- **Approx 40 employees, based in Manchester UK**
- **World leaders in Cu electroplating of large components/cylinders**
- **<u>Research / Knowledge Transfer Activity:</u>**
  - **optimisation & control of Cu layer composition**
  - **surface finish /morphology**

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# Canister Design - Factors to consider?

- **Size and shape of your fuel bundles**
- **Shielding required**
- **Corrosion resistance required**
- **Mechanical strength of canister**
- **Materials to be used**
- **Retrievability**
- **Geological conditions**
- **Method of manufacture**

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# Pierce & Draw Copper Forging

Finishes with
7 tonne rough cast copper tube

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# Pierce & Draw Copper Forging

Machined in the bore to successfully insert the cast iron insert – 1 mm gap

Machined outside diameter, mainly cosmetic, however needs to fit in the emplacement machine

Both ends welded on

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# BEP's Electroforming method

- **Bath of copper sulphate with additive system and then either**
- **Make a seamless tube on a mandrel OR**
- **Plate on to the insert - no "gap"**
- **Rate approx. 1mm / day**
- **Remove shell of the mandrel or is finished plated canister**
- **The hemi end !**

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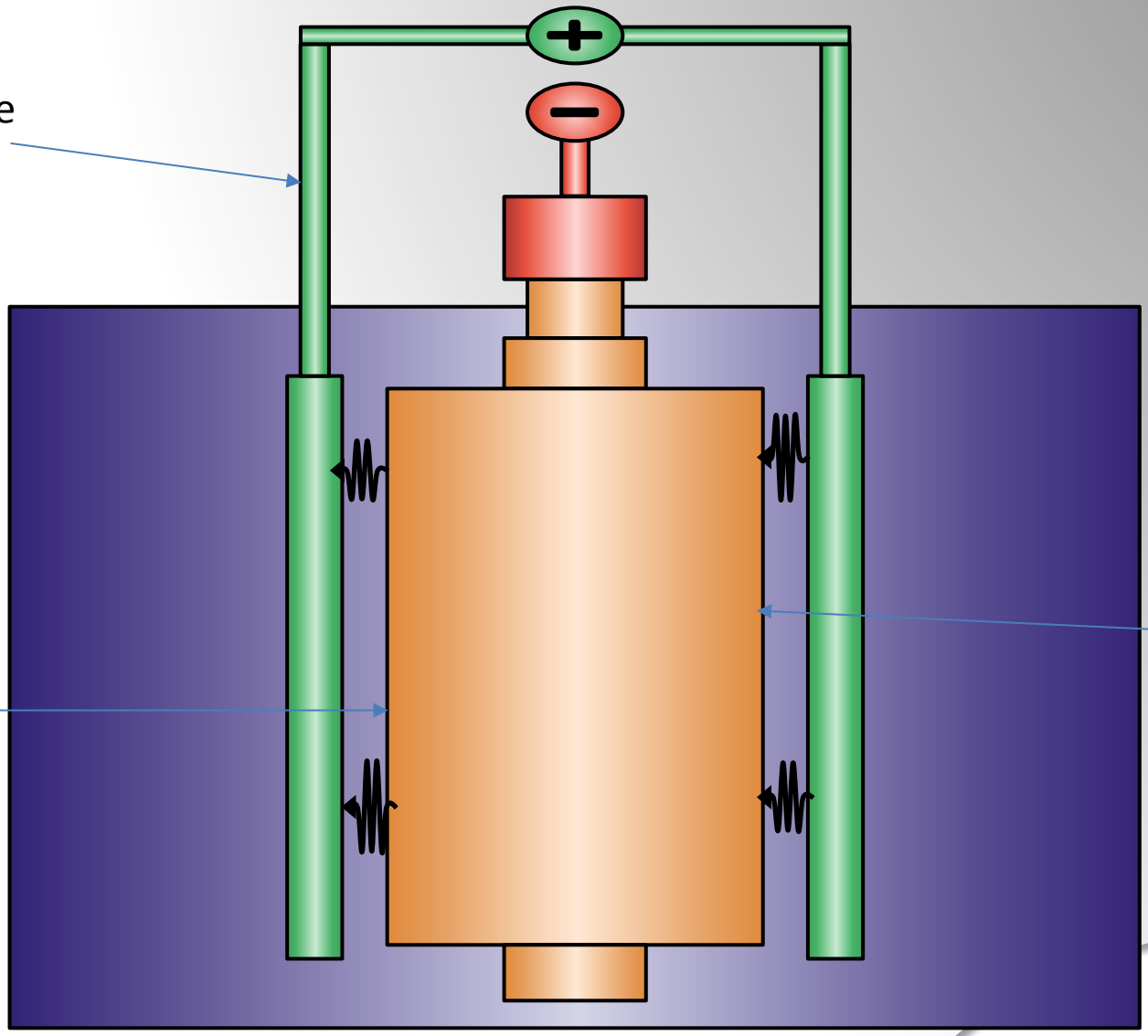
# How do we manufacture our rolls?

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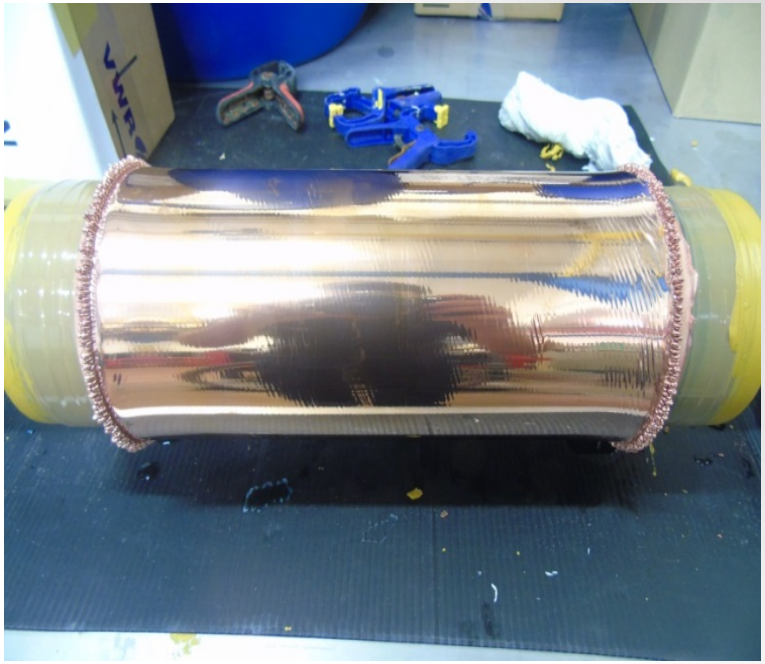
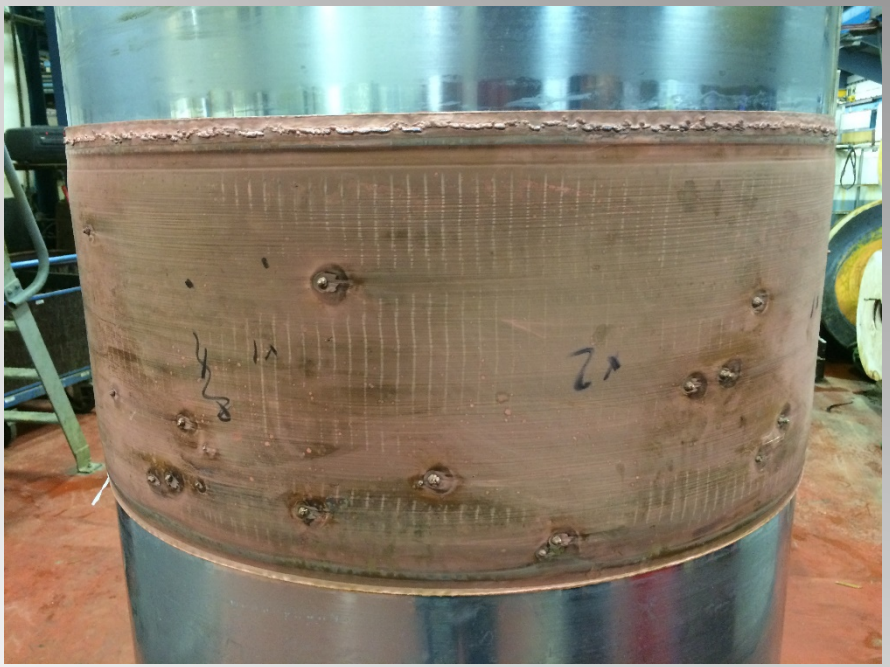
# Copper shell on a mandrel





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# Finished shells

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# Full size seamless shells

BEP's standard production shells for packaging industry

900mm dia X 2000mm face x 16mm thick

Note, perfect bore
Minimal machining required of outside diameter

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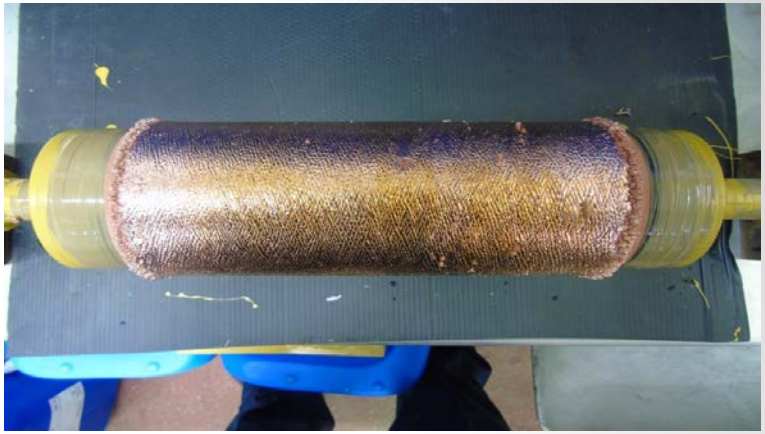
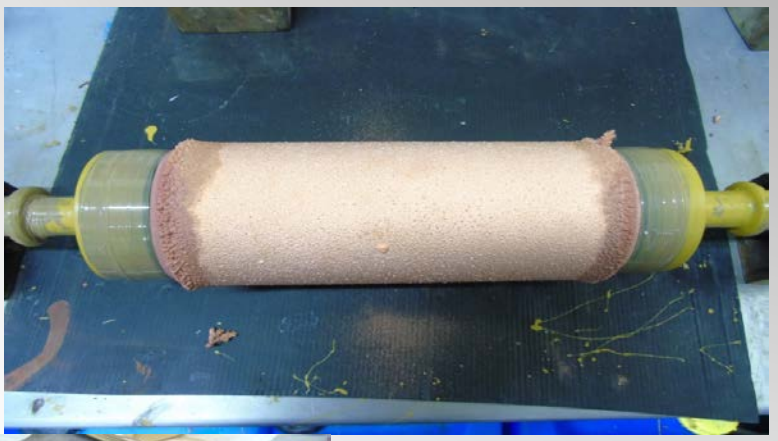
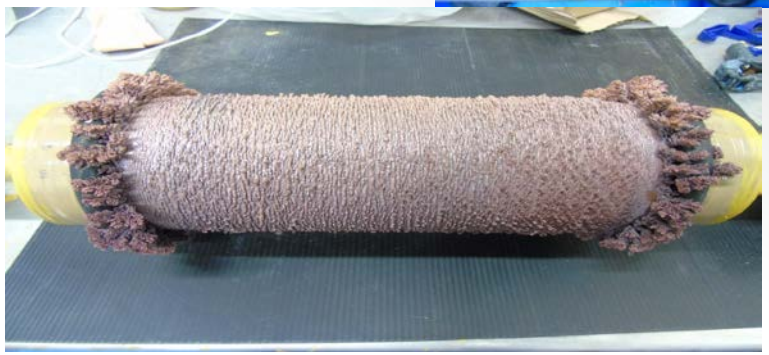
# Trials for NWMO







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# NWMO initial study results

*Table 1. Results obtained from testing of copper samples produced by electroforming using the five additives under study.*

| ADDITIVE ID | Compositional analysis - AMG | | | | | Mechanical analysis – WMT&R | | |
|---|---|---|---|---|---|---|---|---|
| | O (ppm) | H (ppm) | C (ppm) | S (ppm) | P (ppm) | Grain size (mm) | m-hard (HV) | Elong. (%) |
| NWMO_01 | 13 | 1 | 75 | 2 | < 2 | < 25 | 103 | 33.4 |
| NWMO_02 | < 2 | < 0.5 | < 10 | < 2 | < 2 | < 25 | 104 | 33.5 |
| NWMO_03 | 95 | 14 | 112 | 36 | < 10 | < 150 | 105 | 26.1 |
| NWMO_04 | <1 | < 0.5 | < 10 | 12 | < 5 | < 260 | 93.9 | 41.6 |
| NWMO_05 | 91 | 15 | 142 | 22 | < 5 | < 10 ? (3) | 218 | 10.2 |

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# Chemistry Specification

## KBS -3

| | |
|---|---|
| Oxygen | tens of ppm |
| Sulphur | <12ppm |
| Hydrogen | <0.6ppm |
| Phosphorous | 30 – 100 ppm |

Source SKB TR-10-14, Dec 10
page 32

Do we need phosphorous?

## Electro forming spec

| | |
|---|---|
| Oxygen | <1 - < 95 |
| Sulphur | <2 - 40 |
| Hydrogen | <0.5 - 15 |
| Carbon | <10 - 142 |
| Phosphorous | <2 - < 10 |

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# Mechanical Specification

## KBS -3

| | |
|---|---|
| Gain size | <360 µm |
| Hardness | |
| Elongation% | >40 |
| Creep ductility % | >15 |

## Electro forming

| | |
|---|---|
| Grain size | 10 - 20µm |
| Hardness | 100 – 200 HV |
| Elongation % | 26 - 41 |
| Creep ductility % | ? |

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## Forge Pierce & Draw

Hot working
Off site
Large waste to be recycled
Wasted energy
“The Gap”
Very thick, can it be reduced?

Quick - a day

## Electroformed Copper

Cold working
On site
Kg’s not tonnes
Copper plating is 100% efficient
No gap or a gap
Any thickness 2mm – 50 mm

1mm per day

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# Advantages of Electroforming

- Choose your copper thickness
- Eliminate the gap
- If hemi end, only one seal
- Locate in the repository, under your control
- Minimal machining required
- Minimal waste
- Lights out operation
- Consistent small grain size aids ndt

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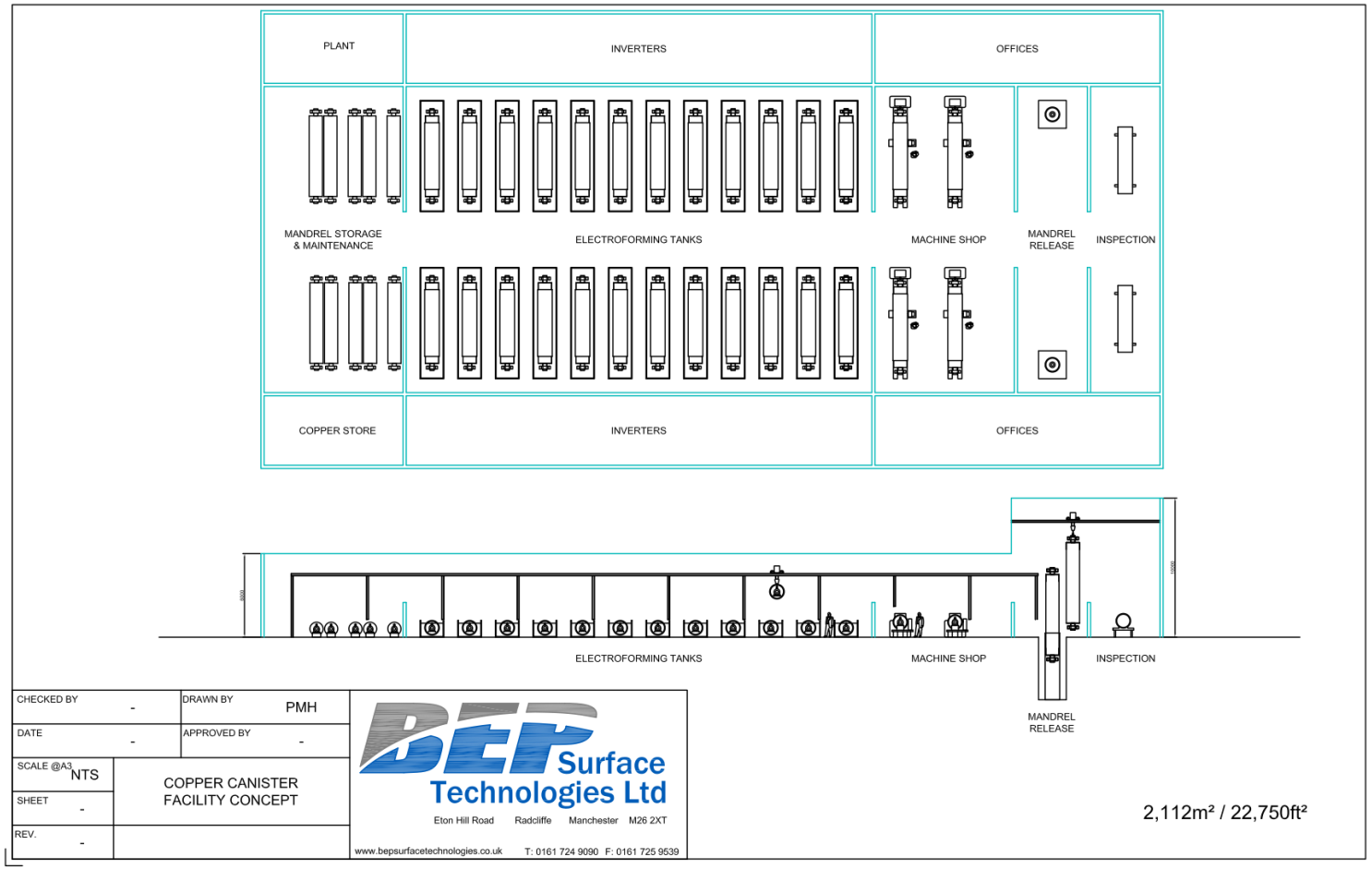
# Mock up electroplating plant

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# Thank you

# Any Questions?

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