



# Wallace Trading Ltd

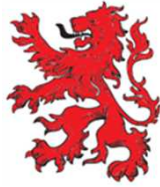
## Best Practices in Gold and Silver Refining

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# **Wallace Trading Ltd**

**Wide ranging experience in Gold, Silver and PGMs Refining**

**Specialists in Developing and Improving:**

- **Pyrometallurgical & Hydrometallurgical Refining Processes**
- **Preparation & Sampling - High & Low Grade Refining Materials**

**Refining Operations Management:**

- **Inventory Management & Material Control Systems,**
- **Environmental Controls and Security.**
- **External Refining Contracts**

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## **Best Practices in Gold and Silver Refining**

- **Very High Intrinsic Value Materials**
  - **Gold ~ \$40,000,000 per tonne**
  - **Copper ~ \$6,000 per tonne**
- **Strong Acids and High Temperature Melting**
- **Highly Competitive**
  - **Metal Recoveries – 99.9%**
  - **Low Cash Charges**
  - **Financing – Metal Pipelines & Prepayments**



# **Best Practices in Gold and Silver Refining**

- **Best Practices in Inventory Management are Vital**
  
- **The Core Issue in Every Refinery**
  - **Inventory Control & Management**
  - **Trace and Find Every Gram**
  
- **IT - Integration of Paper Recording Systems & Physical Reconciliation**



# **Best Practices in Gold and Silver Refining**

- **Real Estate:**

- **Location, Location, Location**



# **Best Practices in Gold and Silver Refining**

- **Gold and Silver Refining:**
  
- **Inventory, Inventory, Inventory**



# **Best Practices in Gold and Silver Refining**

## **Presentation Objective**

- **Define Best Practices in Inventory Management**
- **Highlight Key Issues**
  - **Receiving,**
  - **Evaluation,**
  - **Refining,**
  - **By-Product Recycling**
  - **Liquid and Gaseous Emissions**
  - **Security**
- **Mass Balance Benchmarking**



# **Best Practices in Gold and Silver Refining**

## **Inventory Management: Receiving**

### **Integrated IT system**

- **Job identification for traceability.**
- **Integration with accounting system.**
- **Records job weights, assay, content and discrepancies.**

**Objective: Creation and monitoring of real-time inventory centre contents.**





# Best Practices in Gold and Silver Refining

## Inventory Management: Inventory Centre Mass Balancing

- **Inventory control is as important as achieving a consistent pure product.**
- **Understanding inventory gains or losses is essential to the viability of the business.**
- **Based on processes, define individual Inventory centres to enable accurate mass balancing.**

$$\text{Inputs} = \text{Outputs} + \text{Work in Progress}$$



# Best Practices in Gold and Silver Refining

## Inventory Management: Melting and Sampling

- **Homogenise materials to enable representative sampling**
- **Match furnace type to material**
- **Induction – high and medium frequency**
  - **Dore, jewellery scrap**
- **Gas –**
  - **Slags and residues**
- **Sampling - vacuum pin tubes are more consistently accurate than button or drill sampling - speed of freezing prevents layering.**





# Best Practices in Gold and Silver Refining

## Inventory Management

## Internal Residues and External Materials

**Heterogeneous inputs most challenging**

**Just blending not the answer:**

- **Small dense valuable particles**
- **Large low-density particles**
- **Fine particles to dust**



**Sampling must still be representative**



# Best Practices in Gold and Silver Refining

## Inventory Management:

## Residues treatment and Sampling

- Reproducible results do not necessarily indicate the correct answer
- It could demonstrate consistent **bias**
- Results must be validated

**The mass balance is key**

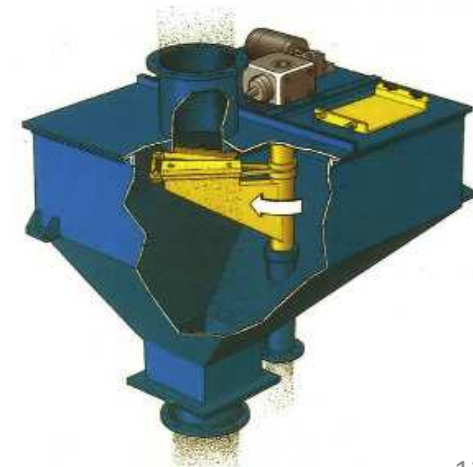




# Best Practices in Gold and Silver Refining

## Inventory Management: Residues treatment and Sampling

- **Mechanical sampling is strongly recommended**
- **From the bulk to the analytical laboratory**
- **Consistent feed rate is required**
- **Results must be validated**





# Best Practices in Gold and Silver Refining

## Inventory Management: Residues treatment and Sampling



### Blending

- **Mixed density materials are difficult**
- **Blender needs careful design or may compound the problem**
- **Spear sampling can give consistent bias where the material has segregated**

**Integrated mechanical sampling processes can produce representative samples from a wide range of inputs**



# Best Practices in Gold and Silver Refining

## Mass Balance Benchmarking

- **A mass balance...the only way!**
- **Best practice is regular monitoring of procedures and results.**
- **Periodic mass balances across inventory centres is recommended**

**Find every gram**





# Best Practices in Gold and Silver Refining

## Inventory Management: Refining Processes

### Dissolution

### Aqua Regia and Wet Chlorination

- Batch processes
- Minimal inventory control issues
- Solution sampling



Courtesy Italmimpianti





# Best Practices in Gold and Silver Refining

## Inventory Management : Refining Processes

### Miller Chlorination

- **Batch-continuous processes**
- **Complex inventory management issues**
- **Challenging sampling**
  - **Hygroscopic fume residues**
  - **End point determination**
  - **Silver chloride slag**
  - **Particulate losses to atmosphere**





# Best Practices in Gold and Silver Refining

## Bullion Product Manufacturing

### Gold giveaway

- **Automation minimises gold weight giveaway**
  - **Gold Value \$0.40 per 0.01 g**
  - **Kilo bars – 1000.02 g**
  - **Requires effective statistical process monitoring.**
- **Blending minimises gold assay giveaway**
  - **Gold Value \$0.40 per 0.001 %**
  - **Requires efficient laboratory support.**





# Best Practices in Gold and Silver Refining

## Inventory Management: By-products and residues



- **Air:**
  - **Treatment route depends on fume composition**
- **Liquid:**
  - **Minimise at source**
  - **Dilution complicates inventory management**
- **Solid:**
  - **Highest values,**
  - **Heterogeneous**
  - **Homogenisation first stage**





# Best Practices in Gold and Silver Refining

## Inventory Management: By-products and Residues

- **Liquid:**
  - **Slurries difficult to evaluate**
  - **Hydrolysis or cementation treatment**
  - **Both present difficulties for inventory management**

**Impurities must exit refinery**



## **Best Practices in Gold and Silver Refining**

### **Inventory Management:** **External Refining**

**To achieve consistency:**

- **Negotiate and agree detailed preparation, sampling and assay protocols with external refiner**
- **Back up with detailed statistical data to assess for any bias.**
- **Effective independent or self-representation required to ensure protocols are followed**



# Best Practices in Gold and Silver Refining

## Inventory Management: Security

## Personnel Security



- **Refinery - 100% metal-free personnel on entry and exit - wand search, metal detecting arch, X ray.**
- **All personnel - contractors, visitors & VIP's**



# Best Practices in Gold and Silver Refining

## Inventory Management: Security



## Building Security

- **Interactive CCTV monitoring with close- scrutiny zoom and check.**
- **Well-defined, secure storage areas between processes.**



# **Best Practices in Gold and Silver Refining**

## **Inventory Management:** **Improvements via Process Technology**

### **Objectives:**

- **Process flexibility – treat a wider range of inputs**
- **Reduced number of process steps – beneficial impact on in-house logistics and evaluation**
- **Reduce by-product production – higher overall yield with less value in fume, effluent and solid residues**





# Best Practices in Gold and Silver Refining

## Inventory Management: Improvements via Process Technology

### Methods:

- Wider use of:
  - Solvent Extraction
  - Ion Exchange Resins
  - Vacuum Melting Technology
  - Ionic Liquids

