The Safe House

Non-Destructive Testing

of .99 > purity metals via multiple complementary testing procedures

About The Safe House

Responsible for:

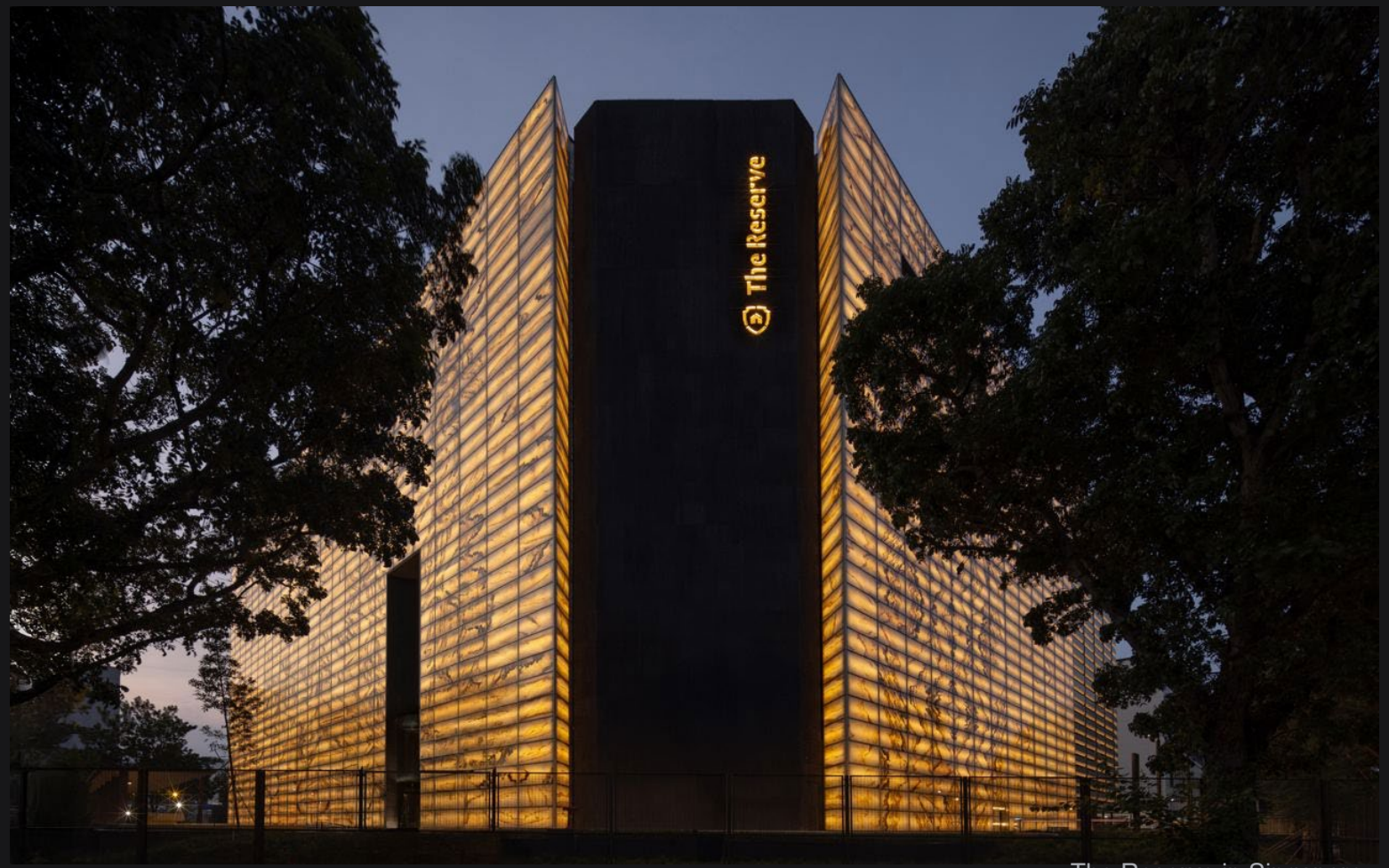
- Vault Operations
- Bullion Testing

In The Reserve Facility

We Operate:

- 15 UL Class 2 Gold Vaults
- 10,000 ton Silver Vault

Currently storing 1.2 Billion USD worth of metals, representing 4% of vaulting capacity but growing around 25% p.a.



The Reserve in Singapore

Our Testing Requirements

>99.5% Gold and Silver is stored on a guaranteed (not said to contain) basis.

Our bullion guarantee requires testing methodologies that are:

- Reliable
- Practical
- Non-destructive

We take the risk on behalf of the client, certainties are required.

About DUX Testing

Our first testing and tracking methodology “DUX” began in 2012.

DUX is an acronym for:

- Density
- Ultrasound
- X-Ray Spectrography

Over the years we added:

- Electrical Conductivity Measurement (ECM)
- Magnetic Susceptibility Measurement (MSM)

The Testing Principle

We test at least 3 separate physical characteristics, or 2 plus X-ray

Metal	Density (g/cm^3)	Speed of Sound (m/s)	Electrical Conductivity (mS/m)	Magnetic Susceptibility (χM)
Gold	19.30	3,240	44.7	-2.8
Tungsten	19.25	5,220	18.52	6.8
Silver	10.49	3,650	61.35	-2.6
Lead	11.34	2,160	5	-1.8
Copper	8.94	4,760	59.1	-1

Celerity Testing via Ultrasound

Advantages

- Penetrates deep into samples
- Detects internal voids and anomalous inserts

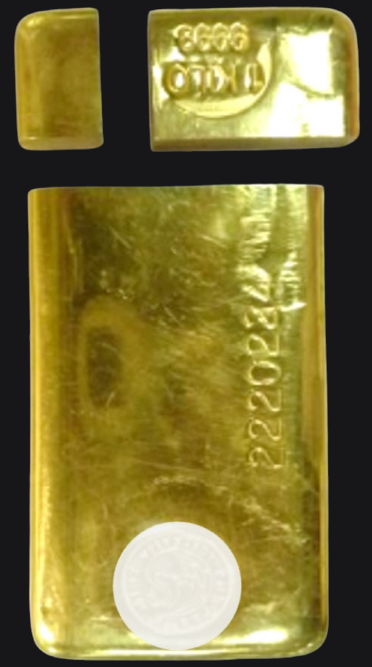
Disadvantages

- May require advanced expertise (e.g. different frequencies depending on bar types)
- Requires continuous physical contact with sample (alleviated by submerging the sample in water)
- Cannot be used if the sample is internally porous

Metal Properties	Density (g/cm^3)	Speed of Sound (m/s)
Gold	19.30	3,240
Tungsten	19.25	5,220
Silver	10.49	3,650
Lead	11.34	2,160
Copper	8.94	4,760

A Sample Whose Porosity Prevented Celerity Testing

Porosity caused ultrasound waves to bounce back prematurely creating abnormal measurements results, failing the test.



The porous sample was .9999 gold and all required mass was present. Only the volume was slightly larger.

Electric Conductivity Measurement (ECM)

Advantages

- Works through plastic packaging
- Both silver and gold are highly conductive, making it very difficult to create “fakes” than pass this test
- Requires minimal training to use

Disadvantages

- Limited depth penetration (better than X-ray fluorescence) makes it best suited for 1 kg bars and smaller
- Not as reliable when used on lower purity (< 99.5%) samples
- Ambient temperature and humidity has slight impact on results

Metal Properties	Density (g/cm^3)	Theoretical Conductivity (mS/m)
Gold	19.30	44.7
Tungsten	19.25	18.52
Silver	10.49	61.35
Lead	11.34	5
Copper	8.94	59.1

Magnetic Susceptibility Measurement (MSM)

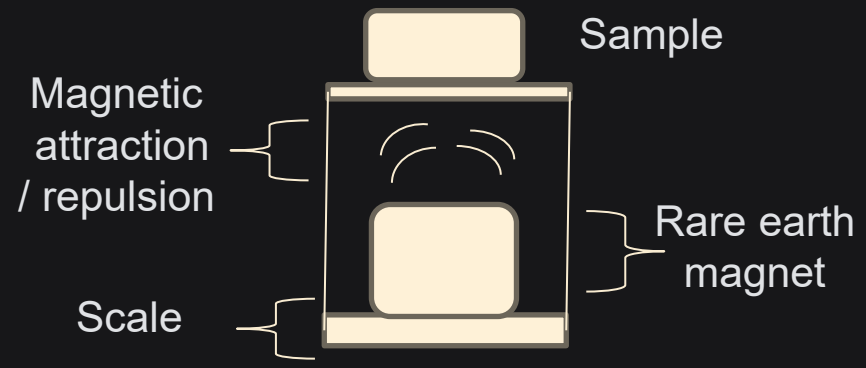
Advantages

- Fast and no surface contact required
- Effective, both silver and gold resolutely repulse magnets
- Simple and inexpensive to build and use

Disadvantages

- Strong magnet, best kept away from electronics/credit cards
- Ambient temperature and humidity has impact on results
- Results need to be interpreted and should be combined with other tests

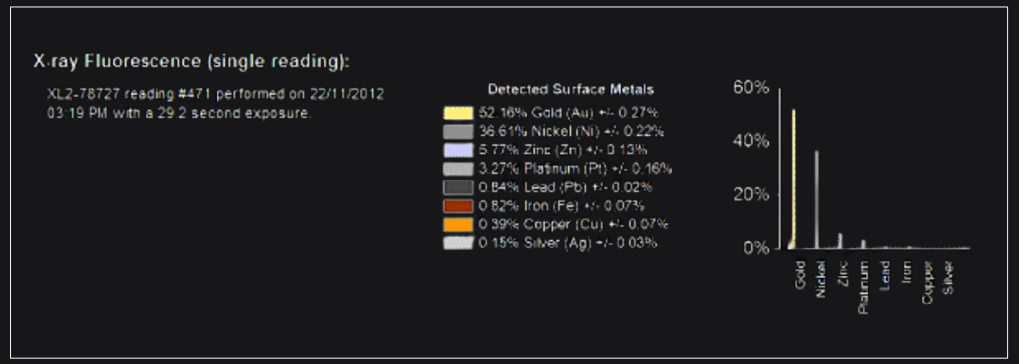
Metal Properties	Density (g/cm^3)	Magnetic Susceptibility (χM)
Gold	19.30	-2.8
Tungsten	19.25	6.8
Silver	10.49	-2.6
Lead	11.34	-1.8
Copper	8.94	-1



X-ray Fluorescence (XRF)

Advantages

- No surface contact required
- Accurate surface composition
- Quantitative data can be easily integrated with automated testing



Disadvantages

- Cannot detect beyond sample surface (~15 micron depth)
- Surface results not necessarily indicative of content
- Expensive, licensable equipment

An example where surface and sample content differ

The XRF tests indicated spots with of 98.7% purity, not 99.9%

Subsequent fire assay confirmed 99.9%

Discrepancy was due to tiny amounts of iron on the sample surface

Indicative Testing Matrix by Sample Type

> .995 Sample	Density	Celerity	ECM	MSM	XRF
Packaged	Approx.		Primary	Secondary	
Small (<10 t oz)	Primary		Primary	Secondary	Secondary
Medium (Up to 1 kg)	Primary	Primary	Secondary		Secondary
Large (Up to 1000 oz)	Primary	Primary			Secondary

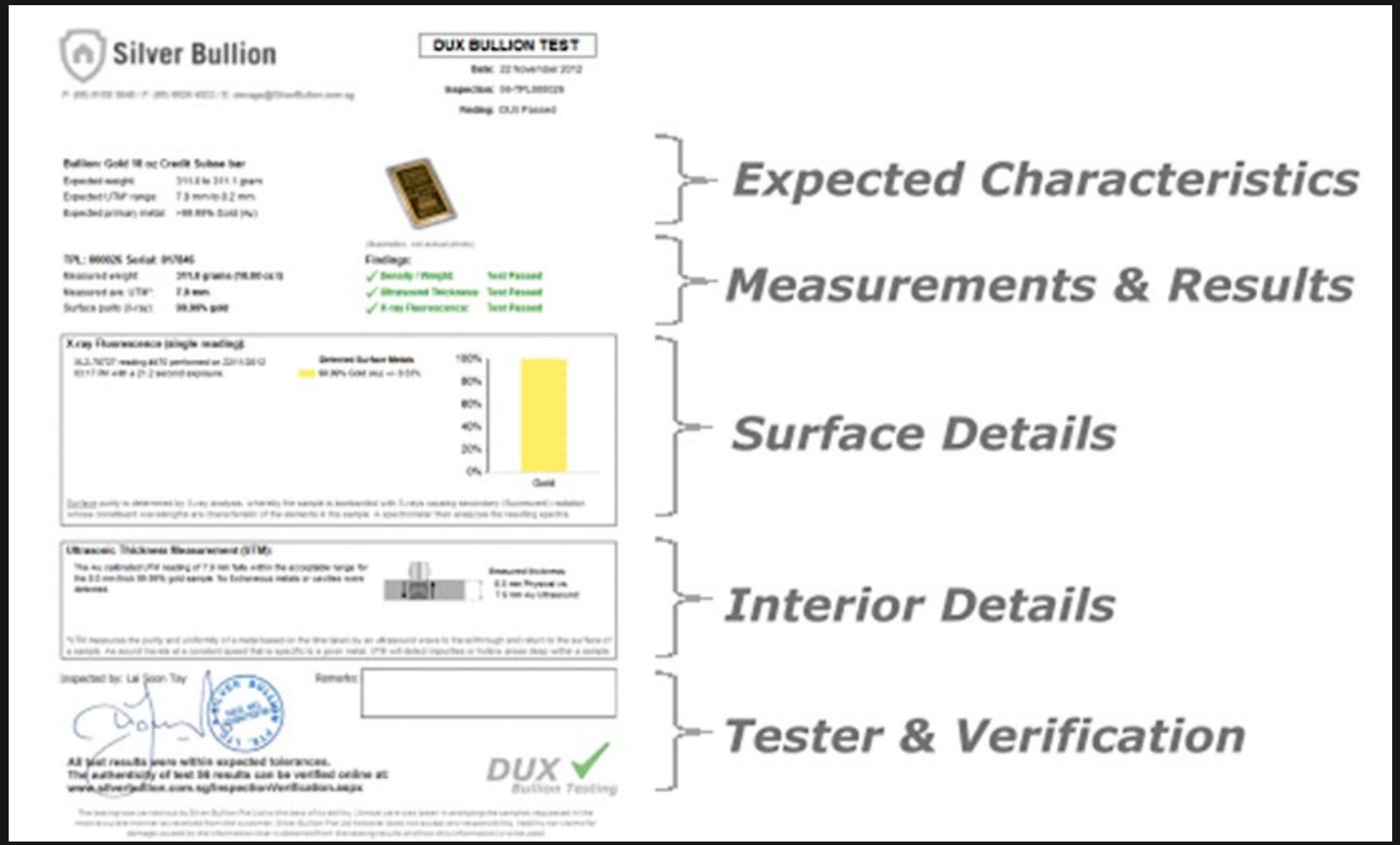
- When results have small abnormalities we conduct additional test
- If abnormalities cannot be explained we request fire assay as next step

DUX Test Result are tracked with the parcel (sample)

DUX has been in operation for more than 12 years and we have tested millions of troy ounces.

Test results can be retrieved online by parcel ID or test ID. Alternatively results can be visualized as a PDF.

Integrated into our proprietary GramChain system, adds real-time, tamper evident public tracking.



Questions?

The Safe House