MTM Critical Metals Limited
Suite 2, 38 Colin Street
West Perth WA 6005

Phone +61 8 6391 0112
info@mtmmetals.com.au
ABN 27 645 885 463

ASX: MTM

ASX RELEASE

25 November 2024

Flash Joule Heating Technology Delivers Breakthrough in Rare Earth Element (REE) Processing

WATCH A VIDEO SUMMARY OF THIS ANNOUNCEMENT & ENGAGE WITH MTM *HERE*.

- **Breakthrough Impurity Removal: ~48% reduction in key impurities** (Fe, Al, Ca, P) from REE concentrate in a simple two-step FJH process, revolutionising traditional REE processing, with further optimisation ongoing.
- **Enhanced REE Concentration:** Delivered a **50% increase in total Rare Earth Element (REE) concentration** from a single operation, unlocking greater value from flotation concentrate.
- **Simplified REE Process:** Transformed a traditionally complex and costly "cracking and leaching" flowsheet into a streamlined two-step solution including rapid Flash Joule Heating and a water wash.
- **Sustainability Leap:** Significant potential reductions in water, acid, energy, and waste requirements compared to conventional sulphuric acid-based methods.
- **Challenges with Current Methods:** Incumbent REE extraction methods rely on energy-intensive acid baking and water-heavy processes, generating significant waste and environmental impact[1].
- **Path to Commercialisation:** Discussions underway with rare earth industry players to accelerate adoption of this game-changing technology.
- **Strategic Alignment:** FJH technology aligns with U.S. initiatives to re-shore critical mineral refining, reduce foreign reliance, and strengthen domestic REE supply chains, supported by recent Department of Defense investments in REE processing projects.
- **2,000-fold scale-up** from the original laboratory-scale process to the current version of the prototype has been successfully achieved, aligning closely with parameters required for commercial-scale applications.
- **Design Progress**: A major technical advancement has been achieved by transitioning from a batch to a **continuous operating design**. This shift not only enhances efficiency but also paves the way for faster scale-up to industrial levels, marking a pivotal step toward commercialisation.

MTM Critical Metals Limited (ASX: MTM) ("MTM" or "the Company") is pleased to announce that testing on REE flotation concentrate using Flash Joule Heating (FJH) technology has successfully removed nearly 50% of the main impurities (iron, aluminium, calcium, & phosphorus) in a single step, leading to a significant 50% increase in REE concentration in the final product. This represents a major breakthrough for rare earth processing, delivering significant efficiency gains with further optimisation work ongoing.

The FJH process offers a transformative alternative to traditional "cracking and leaching" methods, which typically involve sulfuric acid baking at high temperatures to convert rare earth minerals into partially soluble REE sulfates. This conventional approach is exceedingly resource-intensive, demanding substantial energy input for high-temperature operations and vast volumes of water to dissolve the sparingly soluble REE sulfates. The process also produces significant quantities of gypsum waste; a by-product that is difficult to manage, requiring extensive handling, storage, and disposal infrastructure. These inefficiencies not only drive-up operational costs but also create considerable environmental challenges.

[1] Gupta, C.K. & Krishnamurthy, N., 2005. *Extractive Metallurgy of Rare Earths*. CRC Press, Boca Raton, FL

In comparison, FJH technology aims to create purified REE chlorides in a single operation, offering substantial environmental and economic advantages:

- **Water Savings:** Unlike traditional sulfate-based methods that demand large water volumes for dissolution, FJH minimises water use through efficient dry chlorination reactions.
- **Energy Efficiency:** By heating the material directly, FJH drastically reduces energy consumption, eliminating the need for prolonged kiln operations.
- **Lower CAPEX:** Simplifying the flowsheet reduces unit operations, cutting complexity and costs in downstream processing.
- **Cleaner By-Products:** FJH generates fewer and less problematic waste streams, avoiding the gypsum-laden waste outputs typical of conventional methods.

In contrast, the low solubility of REE sulfates in traditional processes necessitates substantial water use and additional leaching agents like hydrochloric or nitric acid. This results in a complex, inefficient workflow requiring multiple purification and separation stages to isolate individual REEs, which FJH aims to simplify and optimise.

MTM Chief Executive Officer, Michael Walshe, said: *"This transformative result validates the enormous potential of Flash Joule Heating in simplifying and improving rare earth processing. Achieving such high impurity removal and REE concentration in a single step is a game changer and we are only at the beginning of this testing regime. We are continuing discussions with leading industry players to advance this technology towards commercial-scale deployment. Furthermore, there is a substantial near-term opportunity to reestablish onshore REE refining capacity in the U.S., particularly in light of policy shifts and incentives introduced by the newly announced Trump administration".*

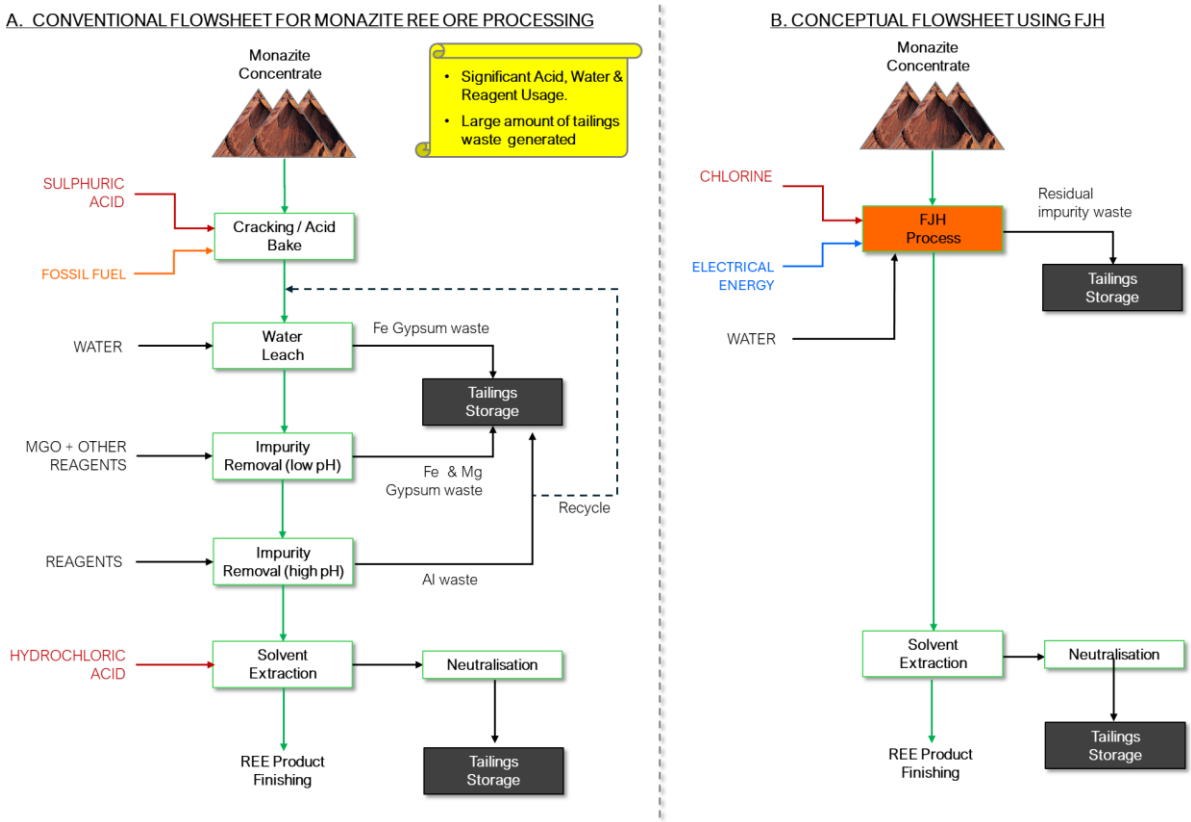

Figure 1: Simplified flowsheet comparison of convention vs FJH process for treating monazite REE concentrate[2]

[2] Gupta, C.K. & Krishnamurthy, N., 2005. *Extractive Metallurgy of Rare Earths*. CRC Press, Boca Raton, FL

STRATEGIC IMPLICATIONS

This FJH breakthrough has significant implications for the rare earth industry, addressing critical challenges in sustainable production, onshoring refining and increased supply chain security. Producing REE chlorides directly from flotation concentrate simplifies the refining process, making REEs more accessible for key sectors such as renewable energy, advanced manufacturing, and defence.

This progress update comes as the incoming Trump U.S. administration prioritises re-shoring critical mineral refining and advanced manufacturing[3]. With a strong push to strengthen domestic supply chains, reduce reliance on foreign processing, and support innovative technologies, MTM's FJH technology offers a timely and impactful solution. It enables a streamlined, sustainable pathway for rare earth processing, aligning with U.S. efforts to enhance economic security, advance technological leadership, and create high-value manufacturing jobs. Discussions are underway to explore how MTM's advancements will integrate into this strategic vision.

Recent initiatives highlight this commitment, including a US$35 million **Department of Defense (DoD)** award to **MP Materials** for rare earth oxide processing at the U.S.'s only operating rare earth mine, and a US$4 million DoD award to **Rare Earth Salts** in Nebraska for expanding terbium oxide production from recycled materials[4]. These actions underscore the government's drive to reduce foreign dependency and strengthen national security through a robust domestic rare earth element (REE) supply chain. MTM's FJH technology, with its ability to simplify and improve REE processing by producing purified REE chlorides directly from monazite flotation concentrate, is well-positioned to contribute to these critical national objectives.

Innovative Alternative Processing Route for REEs

MTM is advancing an innovative alternative processing route for REEs that has the potential to streamline production, reduce costs, and minimise environmental impact. Conventional REE production involves multiple stages — sulfuric acid cracking, leaching, and complex solvent extraction — which require significant acid, large volumes of water, and generate substantial by-products, including iron phosphor-gypsum and magnesium-rich gypsum. MTM's proposed method leverages FJH chlorination and carbochlorination to directly convert flotation concentrate into REE chlorides (Fig. 2), potentially **eliminating the need for sulfuric acid cracking.**

This alternative FJH approach offers multiple potential advantages (see *Fig. 1*), such as:

1. **Reduced Acid Consumption**: By focusing on FJH chlorination / carbochlorination, the process could minimise or even eliminate the need for sulfuric acid, reducing overall acid handling & associated costs.
2. **Lower Water Requirements**: FJH technology could potentially lower water consumption compared to conventional leaching processes, as it may involve dry chlorination reactions, thus reducing the need for extensive water-based dissolution stages.
3. **Targeted REE Recovery**: Chlorination and carbochlorination are highly selective and could enable more direct separation of REE chlorides, which may simplify downstream processing compared to complex solvent extraction systems.
4. **Improved By-Product Management**: Instead of generating large volumes of gypsum by-products, this route may produce fewer or different by-products, possibly easing waste management challenges.

[3] https://www.reuters.com/markets/us/trump-20-wont-reverse-bidens-critical-minerals-push-andy-home-2024-11-21/
[4] www.defense.gov/News/Releases/Release/Article/2941793/ & www.defense.gov/News/Releases/Release/Article/3898948/department-of-defense-awards-422-million-to-increase-production-of-terbium-and/

By focusing on producing REE chlorides directly from flotation concentrate, MTM aims to establish a more sustainable, cost-effective pathway for REE production, positioning itself at the forefront of technological innovation in the critical minerals sector.

SULFATE CHEMISTRY

Monazite (REE-Phosphate) + Impurities	+	Sulphuric Acid	=	REE-Sulfates	+	Waste Byproducts Impurities

CHLORIDE CHEMISTRY

Monazite (REE-Phosphate) + Impurities	+	Chlorine	=	REE-Chlorides	+	Waste Byproducts Impurities

Figure 2: **Simplified chemistry comparison of convention vs FJH process for treating monazite REE concentrate**

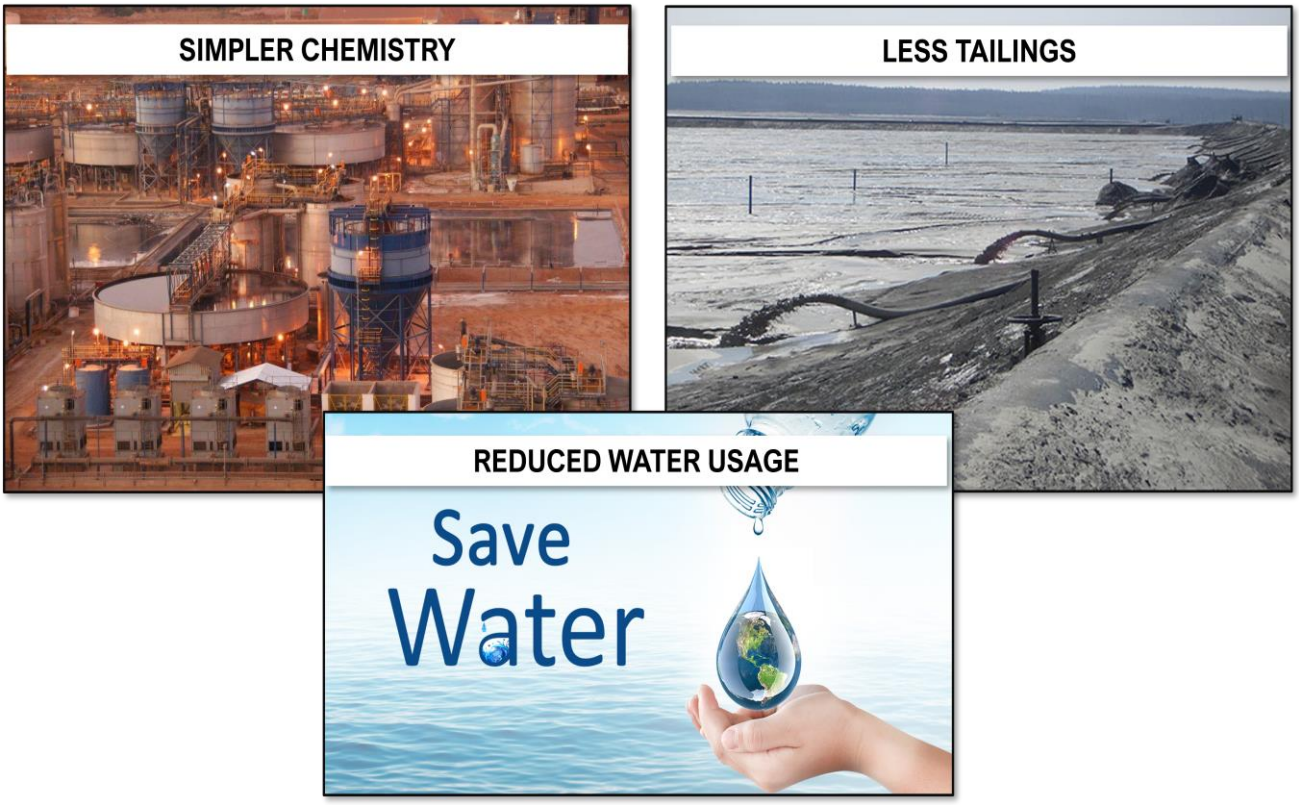

Figure 3: **Benefits of alternative FJH process for treating monazite concentrate**

Summary of Method & Results

The testing utilised Flash Joule Heating technology in a dual-step chlorination and carbochlorination process to treat rare earth flotation concentrate accompanied by a water wash, where the primary REE mineral is monazite. The feedstock consisted of a dried flotation concentrate with ~31% (by mass) Total Rare Earth Oxide (TREO) content. This material had undergone a typical monazite concentration process, including crushing, grinding, flotation, thickening, and drying, to prepare it for further processing.

- The process delivered a significant improvement in REE concentration, including a 50% increase in total REE concentration[5].
- This innovative approach achieved significant impurity removal, reducing Fe_2O_3, Al_2O_3, P_2O_5, CaO, and other impurities by 48% while retaining rare earth elements (REEs) in the solid product as chlorides.
- These tests were preliminary / 'proof-of-concept' only, with further optimisation ongoing.

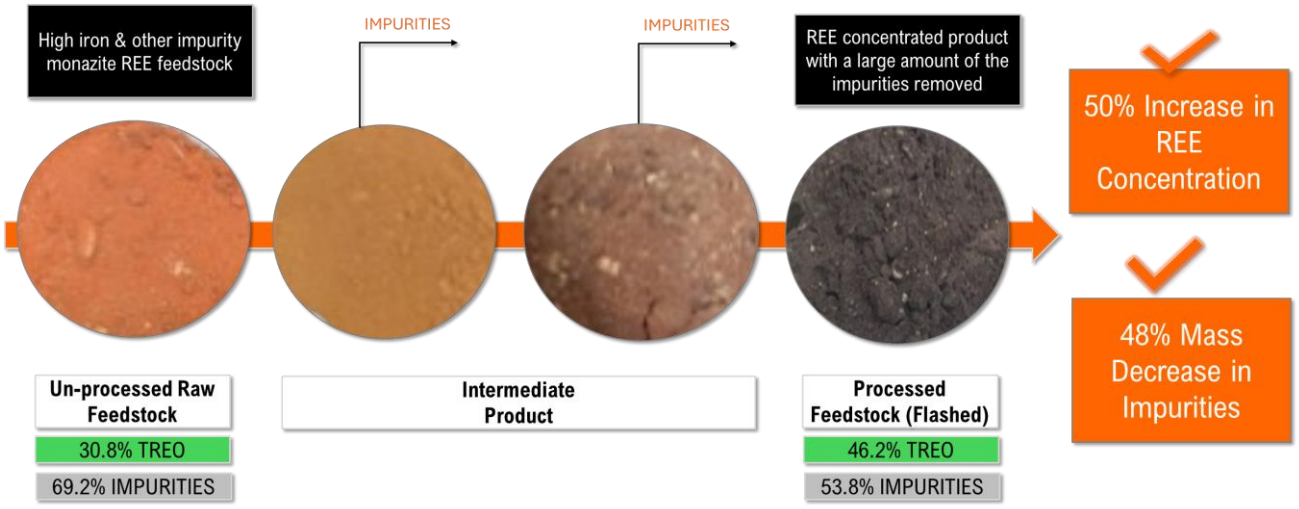

Figure 4: Photos of the raw feedstock, intermediate and final flashed products for initial FJH testwork

Table 1: Overall summary of initial FJH test results

		FEED mass %	PRODUCT mass %	Concentration Change
Rare Earth Elements	**TREO**	30.84%	46.2%	**50%**
IMPURITIES	**Fe_2O_3**	20.77%	13.9%	**-33%**
	Al_2O_3	2.75%	1.8%	**-35%**
	P_2O_5	18.63%	12.9%	**-31%**
	CaO	9.53%	4.2%	**-56%**
	Other	17.48%	21.0%	
		100%	**100%**	

[5] Assays determined using Energy-Dispersive Spectroscopy (EDS). EDS is considered a qualitative (or semi-quantitative) technique, with an accuracy typically within ±5-10%. It provides a broad overview of the elements present in a sample without the rigorous calibration required for fully quantitative results. Additionally, EDS does not fully account for potential elemental interferences, such as overlapping peaks between different metals, which can affect accuracy.

FJH Scale-Up Acceleration Strategy

The current design phase represents a major engineering milestone, achieving a transformative breakthrough by **transitioning from batch to continuous operations**. This advancement significantly enhances scalability, efficiency, and reliability. In collaboration with our engineering partner, KnightHawk, MTM has already successfully achieved an impressive 2,000-fold scale-up from the original laboratory process to the current prototype, closely aligning with parameters required for commercial-scale applications. By optimising metal recovery efficiency and sustainability, the continuous operation design accelerates the pathway to industrial-scale deployment, marking a pivotal step toward full commercialisation.

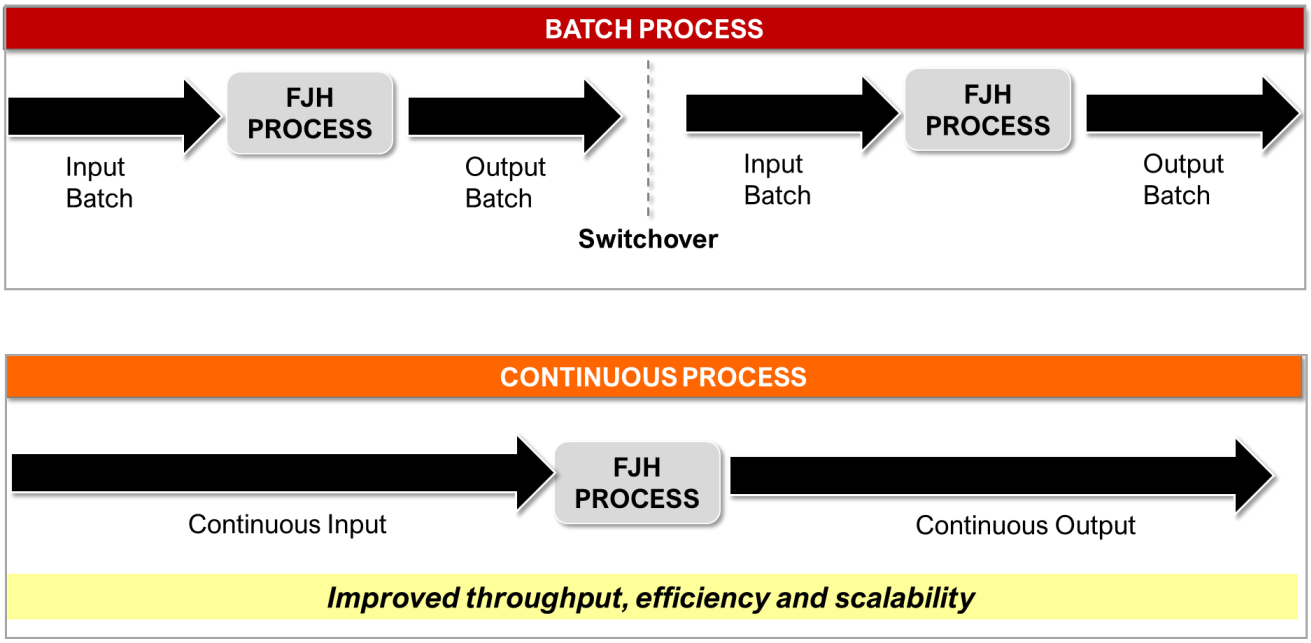

Figure 5: Conceptual Schematic comparing Batch versus Continuous Processing

A Strategic Move Towards a U.S.-Based Rare Earth Supply Chain

Separating REEs poses a significant technical challenge due to the chemical similarities shared across the group of 17 REE elements, which ranging from neodymium and praseodymium to dysprosium and terbium. They are typically found bonded together in mineral deposits, and their atomic properties make it difficult to isolate them individually. Traditional separation methods, such as solvent extraction, are reagent-intensive, environmentally taxing, and require hundreds of processing stages to achieve a high purity separated REE product, which can be costly and complex. This intricate process has, for decades, led countries like the U.S. to rely on overseas supply chains where processing was both cheaper and more efficient.

However, as geopolitical tensions rise, and the strategic importance of rare earth elements becomes clear—especially in sectors like defence, electronics, and renewable energy. The U.S. is increasingly committed to onshoring rare earth processing and supply. With a growing awareness of the risks of foreign dependence, the U.S. government has introduced policies and funding to incentivise domestic extraction, processing, and recycling of rare earths. This initiative marks a strategic shift aimed at enhancing self-sufficiency in critical materials essential for the future of technology and national security and MTM's FJH technology can effectively contribute to the supply solutions.

Significant U.S. Government Support for Critical Metal Supply Chain Initiatives

MTM is actively pursuing additional grant funding from both the U.S. Department of Defence and Department of Energy to drive innovation in critical metals recovery and supply within the U.S. MTM's work aligns with the U.S.'s national priorities to secure sustainable supplies of heavy rare earths and related materials.

Next Steps:

1. Further optimisation of the FJH prototype reactor to scale up processing capabilities.
2. Advanced testing on additional feedstock types to broaden the application of this technology.
3. Strategic partnerships with major REE producers to accelerate commercialisation.

This announcement represents an interim progress update, highlighting significant advancements in the application of FJH technology to rare earth flotation concentrate processing. While the results to date are highly promising, demonstrating substantial impurity reduction and a notable increase in rare earth concentration, further refinement and optimisation work is ongoing. The primary focus of this continued development is to prepare a purified REE chloride product directly from the monazite flotation concentrate feedstock. This will involve fine-tuning the chlorination and carbochlorination processes to maximise the recovery of valuable rare earth elements while ensuring the highest possible purity of the final product. Achieving this goal would not only simplify downstream processing but also align with industry priorities for more sustainable, cost-effective, and efficient rare earth production methods. Future updates will detail additional breakthroughs as MTM progresses toward the commercialisation of this transformative technology.

WATCH A VIDEO SUMMARY OF THIS ANNOUNCEMENT & ENGAGE WITH MTM *HERE*

This announcement has been authorised for release by the Board of Directors.

For further information, please contact:

Michael Walshe
Managing Director & CEO
MTM Critical Metals Ltd
+61 (0)8 6391 0112
info@mtmcriticalmetals.com.au

Media Contact
David Tasker
Chapter One Advisors
+61 (0)433 112 936
dtasker@chapteroneadvisors.com.au

PREVIOUS DISCLOSURE

The information in this announcement is based on the following MTM Critical Metals Limited Australian Stock Exchange (ASX) announcements, which are all available from the MTM Critical Metals Limited website www.mtmcriticalmetals.com.au and the ASX website www.asx.com.au.

The Company confirms that it is not aware of any new information or data that materially affects the information included in the original ASX announcements and that all material assumptions and technical parameters underpinning the relevant ASX announcements continue to apply and have not materially changed. The Company confirms that the form and context in which the Competent Person's findings are represented have not been materially modified from the original ASX announcements.

ABOUT MTM CRITICAL METALS LIMITED

MTM Critical Metals Limited is an ASX-listed company headquartered in Perth, Western Australia, with a dual focus on metal recovery technology development & mineral exploration. MTM's 100%-owned USA subsidiary **Flash Metals USA Inc** is based in Texas, USA. MTM possess exclusive licensing rights to the innovative *Flash Joule Heating technology*, a cutting-edge metal recovery and mineral processing method developed by esteemed researchers at Rice University, USA. Additionally, MTM holds exploration assets prospective for niobium (Nb), rare earth elements (REE), and gold, strategically located in Western Australia and Québec.

- Flash Joule Heating (FJH) is an advanced electrothermal process that enhances metal recovery and mineral processing compared to traditional methods. By rapidly heating materials in a controlled atmosphere, FJH efficiently extracts metals like lithium from spodumene, gallium from scrap, and gold from e-waste, among others. This technology has the potential to revolutionise metal recovery by reducing energy consumption, reagent use, and waste, offering a more economical and environmentally friendly alternative.

- MTM's West Arunta Nb-REE exploration assets are situated in one of Australia's premier exploration hotspots, where over $60 million has been invested by ASX-listed companies such as WA1 Resources, Encounter Resources, Rio Tinto (in JV with Tali Resources), and IGO Limited. MTM also holds tenements in other key mineral regions across Western Australia, including the Mukinbudin Nb-REE Project, East Laverton Gold & Base Metals Project, and Mt Monger Gold Project. In Québec, the Pomme Project is a highly promising carbonatite intrusion rich in REE and niobium, located near the world-class Montviel deposit.

To learn more, visit:

Website: *https://www.mtmcriticalmetals.com.au/*

MTM's Investor Hub: *https://investorhub.mtmcriticalmetals.com.au/*

CAUTIONARY STATEMENT REGARDING VALUES & FORWARD-LOOKING INFORMATION

The figures, valuations, forecasts, estimates, opinions and projections contained herein involve elements of subjective judgment and analysis and assumption. MTM Critical Metals does not accept any liability in relation to any such matters, or to inform the Recipient of any matter arising or coming to the company's notice after the date of this document which may affect any matter referred to herein. Any opinions expressed in this material are subject to change without notice, including as a result of using different assumptions and criteria. This document may contain forward-looking statements. Forward-looking statements are often, but not always, identified by the use of words such as "seek", "anticipate", "believe", "plan", "expect", and "intend" and statements than an event or result "may", "will", "should", "could", or "might" occur or be achieved and other similar expressions. Forward-looking information is subject to business, legal and economic risks and uncertainties and other factors that could cause actual results to differ materially from those contained in forward-looking statements. Such factors include, among other things, risks relating to property interests, the global economic climate, commodity prices, sovereign and legal risks, and environmental risks. Forward-looking statements are based upon estimates and opinions at the date the statements are made. MTM Critical Metals undertakes no obligation to update these forward-looking statements for events or circumstances that occur subsequent to such dates or to update or keep current any of the information contained herein. The Recipient should not place undue reliance upon forward-looking statements. Any estimates or projections as to events that may occur in the future (including projections of revenue, expense, net income and performance) are based upon the best judgment of MTM Critical Metals from information available as of the date of this document. There is no guarantee that any of these estimates or projections will be achieved. Actual results will vary from the projections and such variations may be material. Nothing contained herein is, or shall be relied upon as, a promise or representation as to the past or future. MTM Critical Metals, its affiliates, directors, employees and/or agents expressly disclaim any and all liability relating or resulting from the use of all or any part of this document or any of the information contained herein.