Non Technical Summary

HyProMag wish to apply for a bespoke waste permit at Energy Way, Birmingham B25 8DW. They wish to import and treat waste metal components and WEEE in order to extract rare earth metals from the magnets contained in these elements.

The process (HPMS – Hydrogen Processing of Magnet Scrap) is new and innovative and is being done as a commercial enterprise.

The Treatment Process

In most cases HyProMag are aiming to divert existing material waste streams through the HPMS process. The process can liberate magnet material from components without the need to fully separate the magnet first. The rest of the component can return to the waste stream to continue it's previous recycling route. In a few cases these materials will need simple pre-processing to make them ready for the HPMS process – these pre-processing steps would involve some pre-damage to the components using either hydraulic or pneumatic systems.

Material is loaded into a hydrogen vessel. The quantity varies and the design for the Tyseley vessel is up to around 5 tonnes. The limit is the embedded magnets – that can be up to around 400kg. If the magnet material is 50% of the component material then we would be loading around 800kg and not 5 tonnes. We evacuate the atmosphere from the vessel and then back fill with nitrogen. We then evacuate the nitrogen (this gives us a very low oxygen content within the vessel) and back fill with hydrogen. It is possible in some downstream processing we may also use argon.
Heat is not required to start the process, but the hydrogen reaction is exothermic so heat is generated.
The hydrogen is under pressure inside the vessel. [redacted] The vessel is being built to be able to run at up to 4 bar.
The internal volume of the vessel is around 3000 litres. The design is still being developed, but externally it will be approximately 7 metres long, 3 metres wide and 4 metres high.

We put hydrogen gas into the vessel [redacted] pressure – the hydrogen reacts with the rare earth metals in the magnets, becoming a hydride. The hydriding causes a volume increase that causes the magnets to break apart into a powder. We liberate the powder from the rest of the waste stream and then refine the powder to go back into a magnet production route. The powder is fundamentally a product the same as virgin material from this point forwards.

A short video of the process can be seen here from a recent News piece.

https://www.youtube.com/watch?v=9P-dsNCffWw&t=2s

HyProMag Ltd Proposed Process at Tyseley Energy Park

Business Summary

HyProMag Ltd (in conjunction with the University of Birmingham) are planning to install a magnet production facility at the Tyseley Energy Park. Part of the process has been patented by the University of Birmingham and brings an indigenous source of critical rare earth material to the UK. The process involves capturing end of life magnets in various applications and components and then making new magnets from the resulting captured material. Currently these magnets are almost exclusively lost in processes not designed to capture them – they end up as slag in melting furnaces recycling steel or as waste to landfill. The patented process, exclusively licensed by HyProMag, uses hydrogen in an enclosed vessel which reacts with rare earth magnets and turns them into a powder. This powder can then be captured, refined and made into new magnets or supplied into other parts of the manufacturing supply chain. The magnets being reacted within the vessel can be pre separated but can also be embedded within end-of-life components. To capture magnets from waste streams HyProMag and the University of Birmingham are involved in studies and collaborations with organisations [redacted]. This would lead to a potential diversion of existing material waste streams through Tyseley Energy Park, where magnets can be liberated from components before the components themselves are returned back to their previous waste processing route.
Equipment at Tyseley Energy Park will potentially be coming online in late 2023 and would have a capacity of 100 tonnes. The actual quantity of rare earth magnet during 2024 is likely to be below 50% of that quantity. The magnets are often around 20% of the overall component weight so the total material throughput for the plant in 2024 is estimated as 250 t. The process utilises hydrogen and nitrogen, plus mechanical processes. The final magnet is sintered at around 1000 degrees. There are considerations to made around hydrogen usage and the nature of the material as a powder, however the equipment being purchased to process the material is designed with all of these considerations in mind.
The focus of HyProMag is to recycle end of life magnets. This could be to supply a magnet manufactured from the recycled material but it could also be to supply other processes that are able to recycle the liberated magnets using other parts of the manufacturing process, such as remelting or to separate the rare earths from the alloy. The process flow is detailed on the next page, with typical quantities of material given at every stage (note, this run is for hard disk drive material and the numbers would be different for other scrap sources).

REDACTED

Process Description

Pre-Processing

The components to go into the HPMS vessel might need some initial damage so that there is a route in to the magnet for hydrogen and a route out for the demagnetised powder. This pre-processing would be carried out using one of three pieces of equipment that have been bought as off the shelf solutions:

McIntyre 600HD Shears:

Moros H-H-11 Cracker:

SBC420 Foot Operated Sand Blast Cabinet with Built in Dust Extractor:

The waste codes that might be processed through these pieces of equipment would include:
16 01 17 ferrous metal (Housing of components?)
16 01 18 non-ferrous metal (Aluminium as housing of components?)
16 01 22 components not otherwise specified (Motors, pumps)
16 02 10* discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09 (HDDs, MRIs)
16 02 16 components removed from discarded equipment other than those mentioned in 16 02 15 (Speakers, MRIs)
20 01 36 discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35

HPMS

Hydrogen processing of magnetic scrap (HPMS) is a current process patented by University of Birmingham, with HyProMag the exclusive licensee. The HPMS vessel is a controlled environment pressure vessel which is used for recycling of NdFeB material – this material can be in pure NdFeB form (whole magnets) or can be embedded within a component (such as within a hard disk drive or rotor).

A typical procedure for HPMS is:

1. Load material into the reactor and seal the vessel.
2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]
6. [redacted]
7. [redacted]
8. [redacted]

The vessel volume is 3000 L, with a floorplan of approx. 2m x 5.5m x 3.3m* (LxWxH) and a [redacted]
All gases which are exhausted are done so through a custom designed exhaust stack.

Sieving

Given that the majority of NdFeB magnets in service have received some form of protective coating, these coating materials are carried with the NdFeB powder. Coatings are varied, however the most common coatings are nickel, nickel-copper-nickel, zinc, or epoxy. Removal of these coatings is a key step in the short loop recycling process.

Due [redacted]
which is [redacted]

Jet Milling

Jet milling is a process which utilises a large volumetric flow of gas and cyclone technology to significantly reduce the particle size of a powder. The powder travels at significant velocity within the cyclone, causing large numbers of high energy collisions, in turn, yielding the reduction in particle size.

Jet milling is performed using nitrogen gas, again within a secondary nitrogen isolator. While [redacted]

** Height will vary somewhat as vessel will tilt during normal operation.*

taken [redacted] beds. [redacted]

Aligning & Pressing

The Tyseley facility has both a transverse and axial aligning press, both supplied by the same manufacturer. The fundamental operation of these systems is equivalent, with the main difference being the direction of applied magnetic field with respect to the pressing direction.

The [redacted]

Compacts are double sealed in vacuum packages before removing from the press system.

Sintering

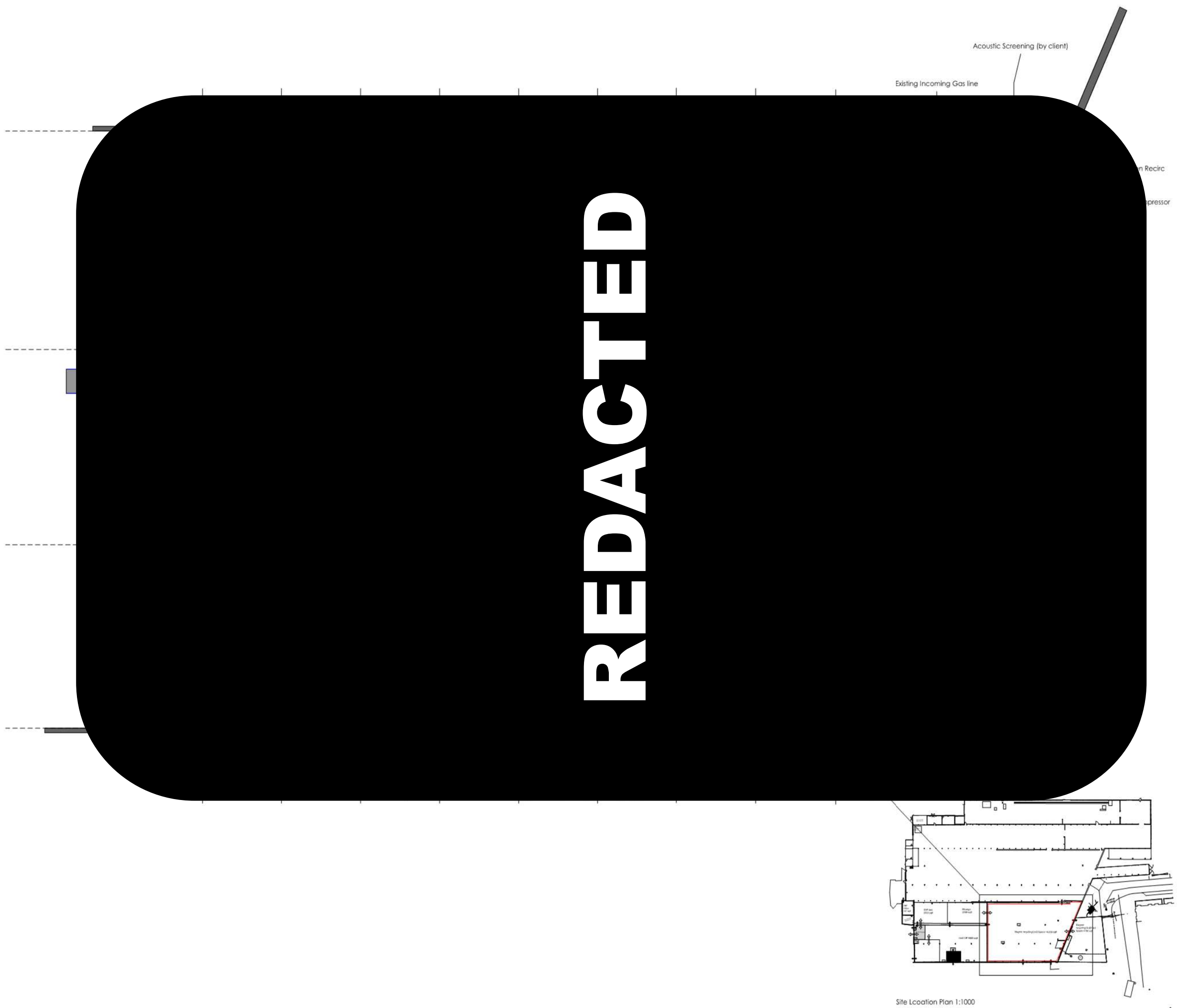
[redacted]

Summary

The works performed at Tyseley Energy Park are a continuation of scaling a technology from a pilot scale into production. The facility will utilise bespoke equipment, with a target capacity [redacted]nnes per annu[redacted]le run[redacted] mo[redacted]

[redacted]

Figure 1. Engineering drawing of HPMS vessel.



Shop R Proposed Strategic Layout Plan 1:100 @A1

This drawing to be read in conjunction with all specifications and all other consultants design information. Any contradictions between this drawing and any other design information to be advised to the contract administrator and author immediately.

The contractor to site measure, check and verify all information issued, and confirm the correctness of the contents prior to the commencement on site.

The contractor to comply with all current statutory legislation, Building Regulations, British Standards, and good building practice. Do not scale from this drawing.

Revision				
Rev	description	date	dr by	ap by

client: HyproMag / University of Birmingham

project: CESA/Shop R

title: Proposed Strategic Layout

date: 08/07/2023	scale:	status: Information	suitability: S0
drawn: SJ / chkd: SJ			
gna project ref: 22017	dwg ref: 22017- GNA- XX- XX- DR- A- 0001		rev :

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Waste Codes

The waste codes to be accepted at the site are

16 01 end-of-life vehicles
16 01 17 ferrous metal (Housing of components?)
16 01 18 non-ferrous metal (Aluminium as housing of components?)
16 01 22 components not otherwise specified (Motors, pumps)
These are materials we will be processing, being supplied to us from other processing companies. Under 20 tonnes.

16 02 wastes from electrical and electronic equipment
16 02 10* discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09 (HDDs, MRIs)
16 02 16 components removed from discarded equipment other than those mentioned in 16 02 15 (Speakers, MRIs)
These are materials we will be processing, being supplied to us from other processing companies. Under 20 tonnes.

19 10 wastes from shredding of metal-containing wastes
19 10 01 iron and steel waste
19 10 02 non-ferrous waste
19 10 06 other fractions other than those mentioned in 19 10 05
These are materials we will be processing, being supplied to us from other processing companies. Under 20 tonnes.

19 12 wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified
19 12 02 ferrous metal
19 12 03 non-ferrous metal
19 12 12 other wastes (including mixtures of materials) from mechanical treatment of wastes other than those mentioned in 19 12 11
This is likely to be a catch all for things that don't fit in the above categories. Under 10 tonnes.

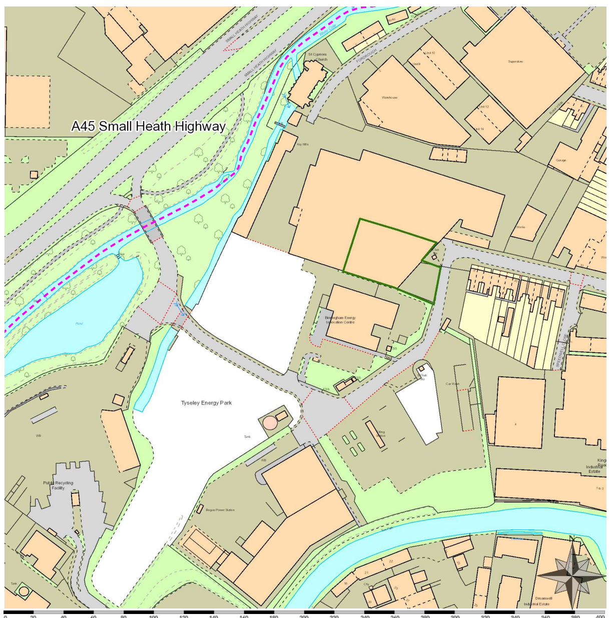
20 01 separately collected fractions (except 15 01)
20 01 36 discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35
20 01 40 metals
This is likely to be a catch all for things that don't fit in the 16.02 section

The Site

All waste acceptance, storage and processing will be inside a warehouse with a sealed drainage system. Firebays will be installed inside the warehouse. The site will accept no more than 20,000t of waste material per year.

17/04/2023

ENERGY WAY, BIRMINGHAM, B25 8DW



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