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MAGS Low Level Waste Storage at Atomic Energy of Canada Limited's Chalk River Laboratories

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ABSTRACT

The recent introduction of Modular Above Ground Storage (MAGS) constitutes a substantial improvement in the way solid Low-Level Radioactive Waste (LLRW) is handled and stored at AECL's Chalk River Laboratories (CRL). The LLRW generally contains items such as lightly contaminated clothing, paper towels, glassware, used equipment and building materials produced at CRL, or received from Canadian hospitals, universities and other waste generators. These materials, previously stored in unlined sand trenches, are now being stored in a dry, monitored and more easily retrievable state in steel containers in MAGS storage buildings.

The MAGS project involved design and construction of three elements: a Waste Handling Building, the first of a series of pre-engineered steel storage buildings, and a new Waste Management Area to house the storage buildings and containers of bulk waste.

This project was well received by the local municipalities during the public consultation conducted as a part of the licensing process. The MAGS system entered service in 2002 and has operated satisfactorily since then. A second storage building was completed in 2003.

1. INTRODUCTION

Waste Management Area C (WMA C), an unlined sand trench facility used for storing Low-Level Radioactive Waste (LLRW) has been in operation since 1963 at Chalk River Laboratories (CRL). In the 1990s, it was recognized that this facility was approaching its capacity, and the Modular Above-Ground Storage (MAGS) facility was built to provide improved new storage capacity for LLRW.

The MAGS system for processing and storing LLRW came into operation in November 2002. The MAGS system signifies a substantial change in the way low-level wastes are handled and stored at CRL. The LLRW waste generally contains items such as lightly contaminated clothing, paper towels, glassware, used equipment and building materials produced at CRL or received from Canadian hospitals, universities and other waste generators. These materials, previously stored in unlined sand trenches, are now stored, in a dry, monitored and easily retrievable state in steel containers in MAGS storage buildings. This project was well received by the local municipalities during public consultation sessions conducted as a part of the licensing process.

The principal environmental benefits derived by the MAGS project are reduction in overall volume of LLRW wastes being stored at CRL (due to compaction of loose wastes), and a significant reduction in the quantity of waste (up to 95%) stored in unlined sand trenches.

An in-house project team, headed by a project manager, carried out the project activities. Local contractors were hired for clearing the site (including blasting rock outcrops) and constructing the buildings and other support services.

2. SAFETY PRINCIPLES AND REQUIREMENTS

The general safety goal underlying the move to MAGS system is to keep radiation exposure to members of the public, operational staff and site personnel within prescribed limits [1], and as low as reasonably achievable during all operating conditions, with:

- no significant adverse effect on the environment during normal operations, and
- radiation releases and radiation exposure to the on-site staff and most exposed group in the general public resulting from abnormal events being prevented through design and training, and the use of operating procedure and administrative controls.

3. TYPES AND QUANTITIES OF WASTE

MAGS storage facility is suitable for almost all the types of LLRW that were previously placed in WMA C [2]. Only waste packages meeting the MAGS Waste Acceptance Criteria [3] are stored in MAGS. The following are the waste types and categories destined for storage in MAGS storage units:

1- Commercial Waste:

- Solid wastes received from commercial generators such as Canadian hospitals, universities and industry containing:
    - o Compacted low level waste in 45-gallon drums,
    - o Cleanup materials in 1.5 or 15 gallon pails, and
    - o Large piping, valves and other process equipment in wooden boxes.

2- CRL-generated waste:

- o Loose material consisting of instrument cabinets, glassware, and building materials,
- o Baled waste: bags consisting of laboratory cleanup materials, and
- o Bulk material such as contaminated soil, asphalt and pieces of concrete.

The anticipated total volume of waste to be stored in MAGS was estimated to be 1410 m^3 per year; however, volume reduction by waste compaction reduces that volume to 461 m^3 per year. The anticipated waste streams and yearly quantities are shown in Table 1.

4. ACTIVITY OF WASTE

The activity for the non-compacted waste is estimated at 1.9×10^9 $Bq{\cdot}m^{-3}$ of waste. When compacted, the waste in the storage buildings is concentrated by an average factor of 3. The average activity of the waste in the storage building is thus estimated to be approximately 3 times higher at ~ 6×10^9 $Bq{\cdot}m^{-3}$. The anticipated total activity in a storage building is calculated as 5.2×10^{12} Bq by multiplying the reference waste estimated activity (6×10^9 $Bq{\cdot}m^{-3}$) by the projected volume of waste in a storage building (866 m^3). When all the ten proposed storage buildings are full, it is estimated that there will be a total inventory of 5.2×10^{13} Bq, neglecting decay.

Table 1: Anticipated Waste Types and Quantities for MAGS storage

Waste Streams	Waste Description	Volume per Year (m^3)	Anticipated Volume Reduction	Compacted Volume
1	204 L drums containing laboratory clothing and cleaning materials	260	Non-Compactable	260
2	4.5, 23 and 68 L pails containing laboratory cleanup materials	32	2:1	16
3	Boxes and crates containing pieces of pipe and piping components	53	Non-Compactable	53
4	Loose material consisting of instrument cabinets, glassware, and building materials	429	10:1	43
5	Bulk material	28	Non-Compactable	28
6	Baled waste: Bags of waste consisting of laboratory cleanup materials	608	10:1	61
	Total	**1410**		**461**

<u>Note:</u> Due to the operational changes by the WMO, the current waste types and quantities destined for MAGS would differ from the above table.

5. THE MAGS PROJECT

The MAGS project had the following three major components:

1. Construct a new Waste Management Area (WMA) to house up to ten storage buildings (eventually) and an area for large steel storage containers (luggers) containing bulk wastes,

2. A Waste Handling Building to house a high force compactor for volume reduction of compactable waste,

3. Construction of the initial pre-engineered storage building with reinforced concrete floor, drainage and ventilation system for storing waste containers.

6. WASTE MANAGEMENT AREA H

Eleven sites were assessed [4] against a number of criteria including environmental, socio-economic, technical, land use and other factors, and a 3.4 hectare (159 m by 214 m) site was selected to create the new Waste Management Area H.

The WMA H site (Figure 1) was cleared and graded and surface drains were constructed. After installing the perimeter fence and roads and, the lugger area, the first storage building was constructed.

Based on the current volume of waste generation, the WMA H site has enough capacity to receive waste for 20 years (ten storage units) including 560 m^3 of bulk waste stored in luggers. However, the construction of these storage units is being carried out in a phased approach. Only the first storage unit was included in the MAGS project scope of work. Figure 1 also shows the areas for the additional roads and storage buildings to be built in the future.

7. WASTE HANDLING BUILDING (WHB)

The WHB is a prefabricated (rigid frame) insulated steel building with a concrete floor and foundation walls. The building is constructed as an extension to the existing Waste Reception Centre in WMA B and meets the requirements of the National Building Code of Canada. The WHB is approximately 18 m wide by 15 m long by 6 m high, and was sized (see Figure 2) to meet the space requirements of the various features listed below:

- A high force compactor to volume reduce compactable waste into steel storage containers,
- The compactor exhaust system providing up to 2.5 air changes per hour in the WHB when the super compactor is operating,
- The building ventilation system to providing an additional 2.5 air changes per hour,
- Two thermostatically controlled propane space heating units designed to maintain a temperature of 18°C in the building during the heating season,
- The floor drain system connected to an inside sump,
- A dry pipe sprinkler system operating with water supplied by the CRL Fire Department trucks.

Air is supplied to the building via two heated sources. When the compactor exhaust fan is running, an air-handling unit (AHU) provides heated air to the building. An interlock is provided to shut down the AHU if the super compactor exhaust flow is lost. A second air-handling unit provides heated air when the building exhaust fan is running. The supply fan for this AHU is also interlocked to shut down if the building exhaust flow is lost. A flow diagram of the ventilation system is shown on Figure 3. The air from both AHUs is heated via propane-fuelled heat exchangers.

8. HIGH FORCE COMPACTOR

The model B-l000 twin cylinder hydraulic “Compactor” from Container Products Corporation (CPC), shown in Figure 4, was installed in the WHB. This machine can produce about 2.2 MN of force when both cylinders are operating in unison. Much higher local forces can be generated if the cylinders are operated separately in a rocking mode. The machine is fitted with an integral air evacuation/filtration system that incorporates a negative pressure closure chamber of stainless steel construction that totally encloses the compaction ram, container and hydraulic cylinder rods. The waste-loading door is 1.93 m wide by 0.76 m high.

In the first year of operation, a fairly wide variety of material was compacted, with the majority (66%) as bagged waste, and the remaining waste made of filters, scrap metal drums, glass, metals, and plywood truck box liners. By 2004, a few of the waste streams were diverted from the compactor such as plywood truck box liners, while others like dry baler-type waste were added. In addition, bagged tritium waste from a bunker was removed and sent for the compactor. As a result, the portion of the bagged waste increased to about 94% of the total waste for the first 8 months [5].

9. STORAGE BUILDINGS IN WMA H

Each storage building comprises a prefabricated metal building on a reinforced concrete floor The buildings have a floor drains connected to an outside sump to collect any liquids that could accumulate in the buildings (such as condensed moisture from the air, precipitation, or possibly liquids tracked in by heavy equipment).

As part of MAGS surveillance activities, the sump level is monitored quarterly. Any liquid collected will be sampled at the first evidence of accumulation and transferred to steel drums with a portable pump. However, during the past two years of operation, no appreciable amount of liquids was collected at the sump.

Ventilation intake is provided by a continuous ridge vent and by four 0.9 m × 1.2 m louvers installed on the side of the building (two on each) at a height of 1 m from the ground. Each building is equipped with two dual speed exhaust fans.

Routine visual inspection of the buildings and accessible waste storage containers is conducted quarterly. Given the dry nature of the waste, it is not expected that there will be any corrosion failure of the waste containers. The Safety, Environmental and Radiological Protection (SERP) personnel perform radiological monitoring of the storage buildings on a monthly basis.

A layout of the storage building is shown in Figure 5. Figure 6 shows a cross section of the building.

The storage units were designed to facilitate easy retrieval of waste containers for the eventual decommissioning of the facility in the future [6].

10. CONTAINERS

Wastes from various CRL generators are collected, volume reduced if possible, and stored in lidded containers of the following types:

1- B-1000 compactor boxes for volume reduction and storage:

- Size - 1.2 m (W) x 1.8 m (L) x 1.3 m (H), (2.5 m^3 nominal capacity),
- Material - carbon steel, 2.5 mm thick,
- Painted with rust inhibitive primer on interior and exterior, plus alkyd enamel exterior coat, and
- Pockets for forklift on bottom.

2- Luggers for contaminated bulk materials:

- Size - 1.6 m (W) x 3.6 m (L) x 1.8 m (H) (9 m^3 nominal capacity),
- Material - carbon steel, 4.7 mm thick. Reinforced floor, front and back gusseted at all corners,
- The lid is crowned to promote shedding of water and snow. It overhangs the container by 25 mm, and
- Primed and painted with enamel paint.

3- Waste Collection Containers:

These containers are used to collect compactable and non-compactable waste on the CRL site.

3a- Bins for compactable waste:

- Size – 0.5 to 0.75 m^3 capacity,
- Material - heavy gauge metal,
- Pockets for forklift on bottom,
- Hinged front to allow easy access to waste for manual emptying, and
- Hinged aluminium lid with hasp and lock.

3b- Steel boxes (Blue Bins) for storage of non-compactable waste:

- Size - identical to super compactor boxes,
- Material - heavy gauge metal,
- Removable and lockable metal lid, and

– Pockets for forklift on bottom.

3c- 204 L drums containing waste are also stored in MAGS.

Note: Wooden boxes, crates were banned from MAGS for fire safety reasons.

11. MAGS COMMISSIONING

The commissioning of the equipment and building systems of MAGS involved inspecting and testing various components to make sure that the facility was working as per the design and operational intent. All safety-related equipment such as the compactor, ventilation systems, heating units, radiation monitors and building drains were tested for their integrity and efficient operation [7]. Defects and shortcomings were noted and non-conformance reports were issued for corrective action. The project carried out the necessary repairs and the facility was turned over to the Waste Management Operations group.

12. WASTE HANDLING AND STORAGE OPERATIONS

The MAGS system was brought into service November 2002 (see Figures 7,8,9, and 10). The facility has operated in a satisfactory manner and no major operating issues were identified. Waste packages were accepted as per the Waste Acceptance Criteria (WAC). Waste generally included cell waste in 5-gallon cans, boxes and bags containing trash, lab waste and filters. Waste streams also contained glassware, pieces of metal and wood. The overall quantity of waste emplaced in the storage building is given in the table below in cubic metres [8]:

Year	CRL waste	Commercial	Nordion	Total
2002	71.1	82.3	11.3	164.7
2003	631.4	68.7	147.2	847.3

WMO staff dealt with the following field issues:

- **Failure of spring backs:** During compaction, “spring backs”(locking horizontal beams) were added to keep the material down and prevent the waste material from expanding back to its original shape due to memory. Some spring backs failed during this operation (see Figure 10). This problem was corrected by modifying the spring backs and the channels holding the spring backs in place.
- **Liquids in the compactor box.** During the initial stages of operation, the compactable waste material also contained wet mop heads. During compaction the mop heads released liquids into the compactor box. WMO is in the process of implementing a solution to address this issue. Pending development of a method to dry mop heads, this waste stream is no longer directed to the compactor.
- **Material selection:** The high force compactor operation required careful selection of material for compacting. Certain materials such as chunks of wood, and heavy metal pieces did not compact well and also caused damage to the compactor boxes. These materials were avoided to correct the problem.

The table below gives the high-force compactor operations summary. As can be seen from the table, the compaction ratio improved with modestly in 2004 compared to 2003. It is believed that the lower than expected compaction ratio is due to the unfamiliarity with the high force compactor and operations.

Year	Volume of packages	Compacted volume	Compaction Factor
2003	291.6	91.8	3.2
2004	560.2	137.7	4

13. MAGS 2 PROJECT

Construction of a second storage building was initiated in the 2003, as the first storage building was getting full. This building was put into service in August 2003.

14. CONCLUSIONS

The MAGS project was completed successfully within the budget even with the additional scope of work to upgrade the WHB ventilation as per regulatory input. The project had to resolve a few issues such as site contamination (due to a historic lead shielding casting operation), additional ventilation requirements in the WHB, and some construction non-conformances. In March 2002, at the completion of the project, the project turned over the facility to the Waste Management Operations group.

The ensuing two years of operating experience of the MAGS system indicates that all systems are working well. The volume reduction by the high force compactor provides substantial savings in storage capacity needs.

15. ACKNOWLEDGEMENT

Author acknowledges the contribution to this paper by the WMO staff and the input and technical editing by Michael Stephens.

16. REFERENCES

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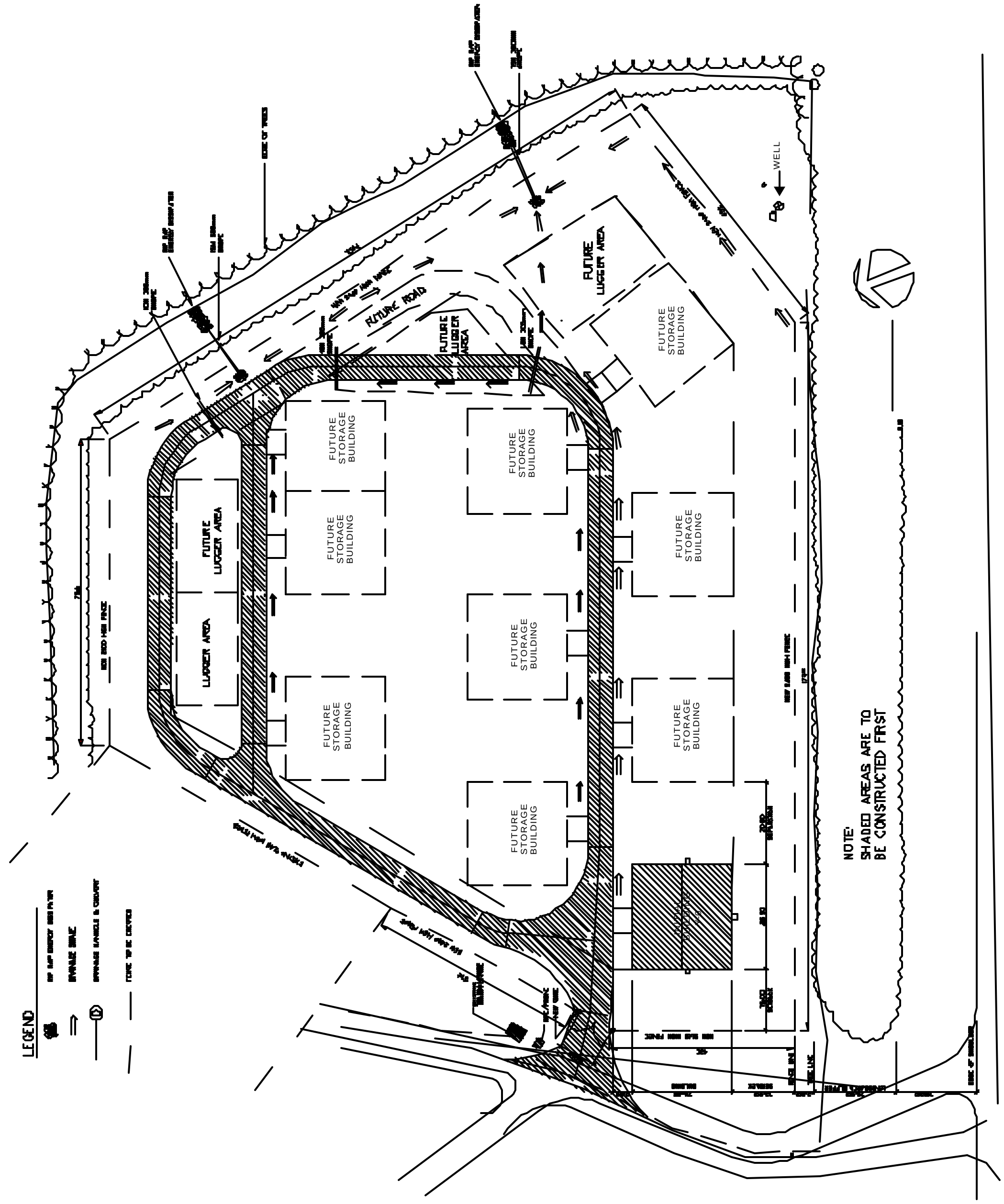

Figure 1: Site Plan of the WMA 'H'

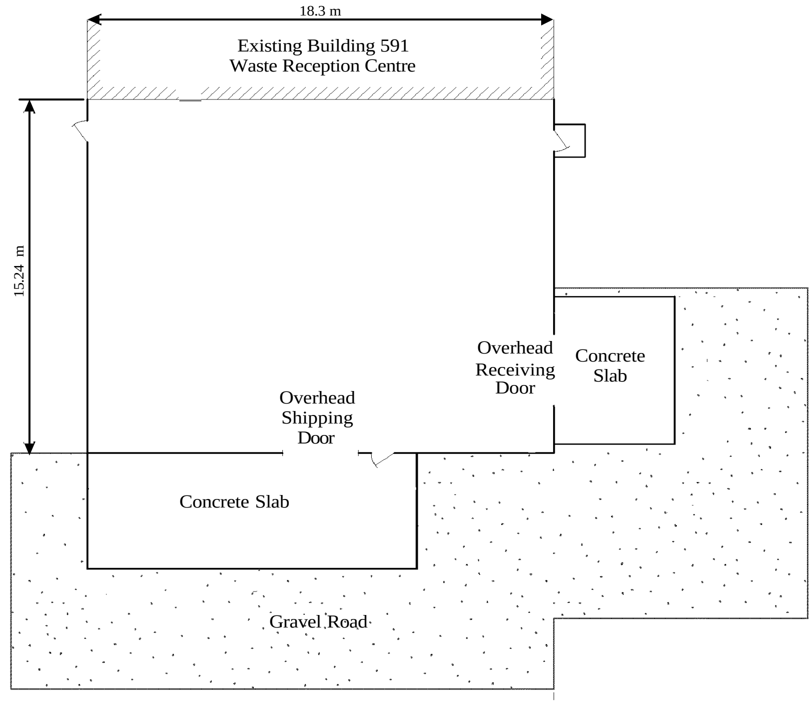

Figure 2: Waste Handling Building (WHB)

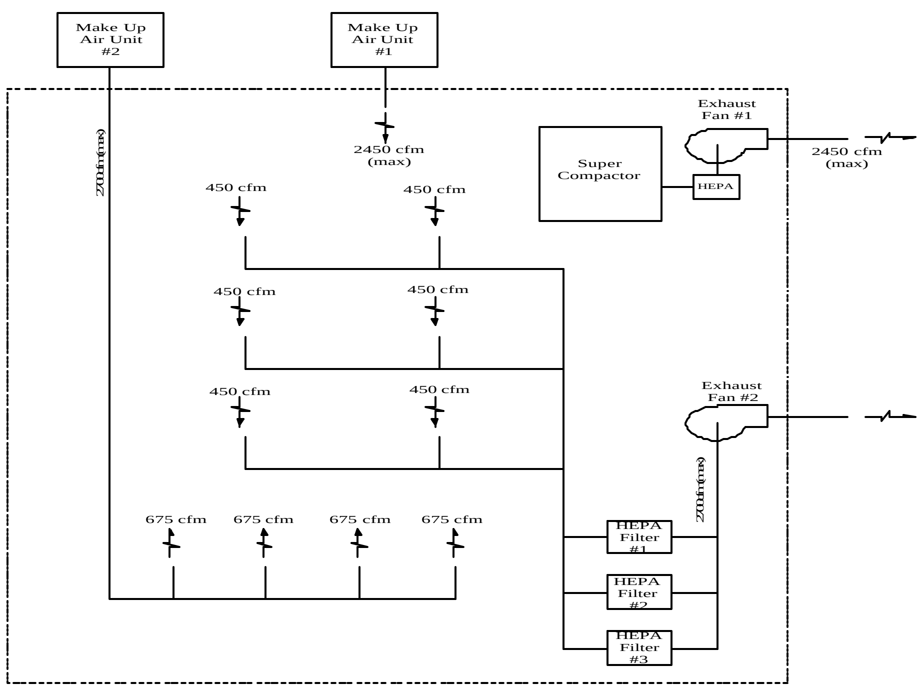

Figure 3: WHB Ventilation Flow Sheet

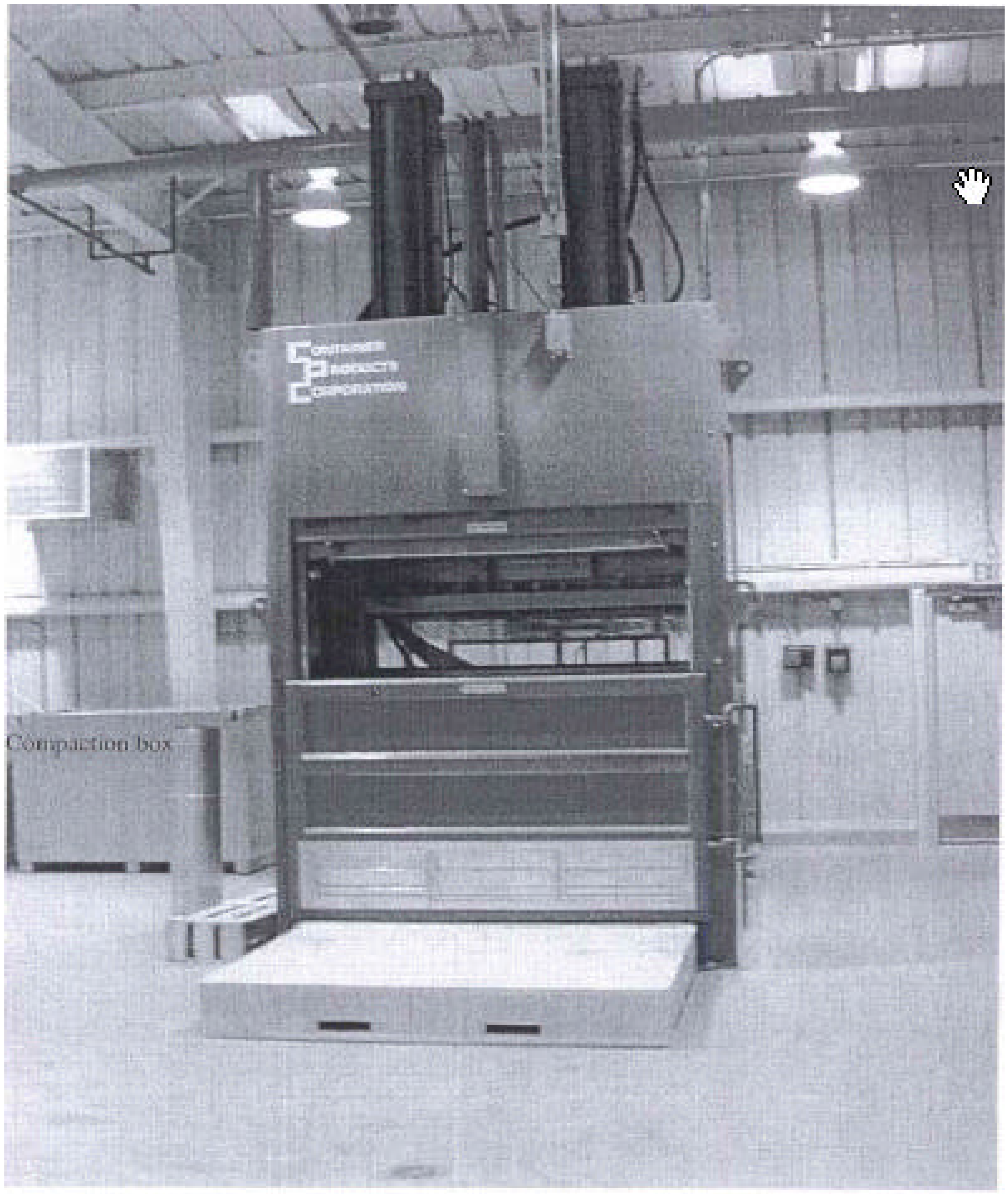

Figure 4: Container Products Corporation's B1000 High Force Compactor

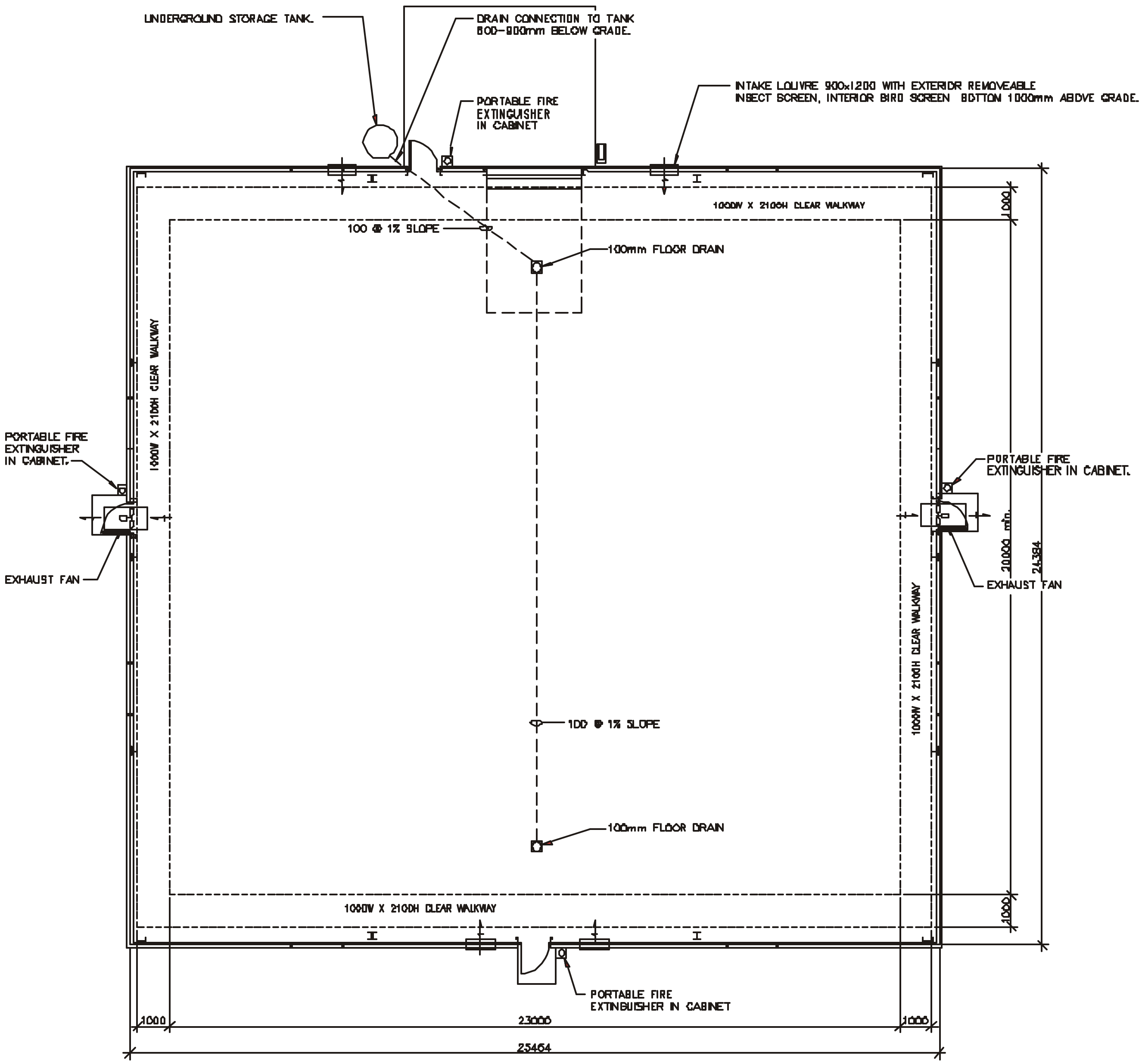

Figure 5: MAGS Storage Building Layout

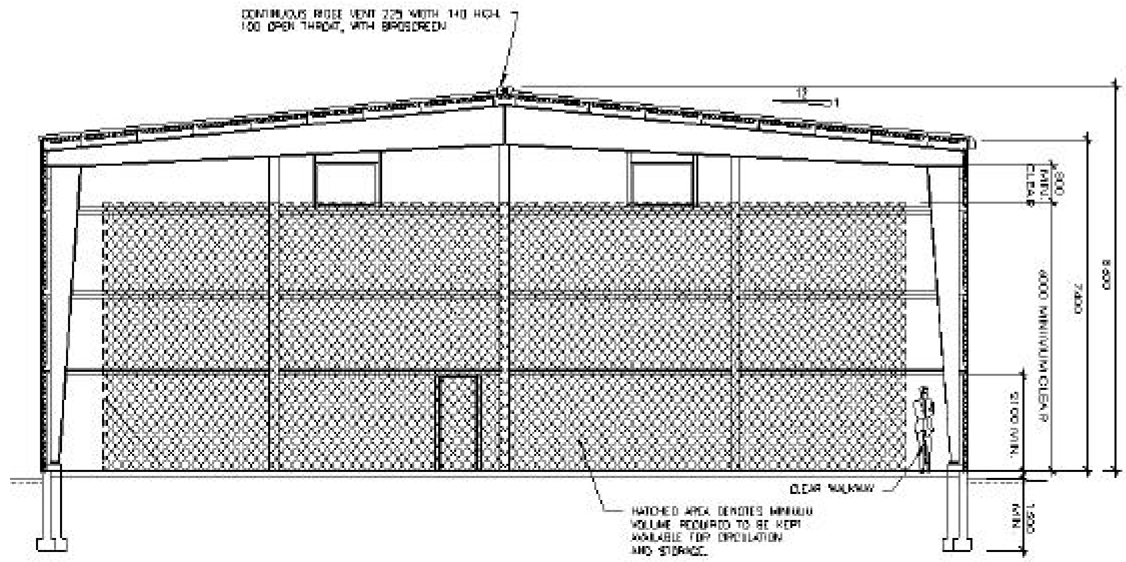

Figure 6: MAGS Storage Building Cross-Section

Figure 7: The MAGS Storage Building.

Figure 8: Interior of the first MAGS building at WMA H site with the waste containers shown in the background

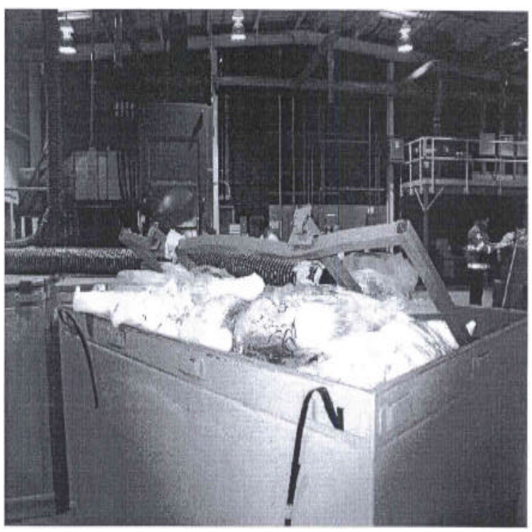

Figure 9: B-1000 compactor box, showing a failed anti-spring back during Initial operations.

Figure 10: An empty 45-gallon drum is compacted to a 'pancake' by the high force compactor during a test.