

## AL20 - Smart Tools and QuickConnect for Enhanced Safety of Casthouse Operations

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### Abstract

Today, there is an increased awareness of safety in aluminium casthouses. Molten metal explosions remain an industry concern. Over the years, many safety measures were put in place, starting with better fitting personal protective equipment (PPE). However, a brief overview of the latest incidents reveals that we still need further improvements. Safety in casthouse operations is Mecfor's battle horse. Twenty years ago, it was bold to think that one sturdy vehicle, coupled with dedicated tools, could perform all casthouse operations and auxiliary tasks. Over time, Mecfor Casthouse Solution concept has proven its efficiency by increasing safety and optimizing the fleet. This approach addresses many of the high-risk factors found in a casthouse that can be much reduced: co-activity, exposures to molten metal splashes, and visibility. Today, the equipment can safely charge 42 tonnes of aluminium into a melting furnace in less than 20 minutes, using a single machine offering versatility for other tasks. Using a very efficient hydraulically-powered QuickConnect system coupled with the right tool for a task brings many benefits such as: reducing the operation time and associated energy loss, causing less refractory damage, and most of all, ensuring the safety of operators. In addition, Mecfor Smart Tool option allows to limit the speed and power of the machine functions depending on the tool that is in use. Sequencing and programming of a tool can help control the human factor and limit the risk of incidents. Monitoring and analysis are also key to understand how to alleviate risks. To that effect, Mecfor offers an array of technologies such as operator ID, 360-degree camera recorder, and MecforLink telemetry system. For decades, Mecfor has been perfecting its complete casthouse solution concept: applied technology for better safety and productivity, no room to compromise.

**Keywords:** Casthouse productivity, casthouse safety, Mecfor Casthouse Solution, Mecfor Smart Tool, casthouse efficiency.

### 1. Challenges Found in Aluminium Casthouse

Back in September 1967, it took a major accident in the USA to trigger awareness to safety in a casthouse. Still today, the Aluminum Association monitors molten metal explosions, which remain an industry preoccupation. Over the years, many safety measures were put in place, starting with better fitting personal protective equipment (PPE) and pedestrian dedicated walkways. Most recently, co-activity in casthouses raises concerns.

#### 1.1. Ideas Brought to Life

Safety in casthouse operations is Mecfor's battle horse. Twenty years ago, it was bold to think that one sturdy vehicle, coupled with dedicated tools, could safely perform all casthouse operations and auxiliary tasks. Over time, Mecfor team has visited many casthouses, participated in numerous customers' safety reviews and has heard all ins and outs aiming for one objective: designing the most complete and optimal Casthouse Solution. In numbers, this translates into:

- More than 100 different Casthouse multipurpose vehicles designed and manufactured since 2003 offering a wide range of lifting capacity (from 6750 kg to 15 750 kg);

- 525 different tools designed and built;
- 915 furnace tending blades, from which 64 different designs are available.

## 1.2. Proven Efficiency: from Past to Future

Mecfor's Casthouse Multipurpose Vehicle (MVR) Solution is the result of expertise from solutions implemented over time from which we have learned and we are always improving (see Figures 1 and 2). With new coming technologies, we are adapting the equipment to make operations easier, safer, and more constant. Mecfor's strength and sustained presence in this sector is positioning the company ahead to think and design the 'Casthouse of the Future' integrating more robotization and auto guided vehicles (AGV), leading the industry into a fully computerized monitored Industry 4.0 environment.



**Figure 1. Mecfor Casthouse Solution - MVR and tools.**

Mecfor Smart Casthouse Solution has proven its efficiency. Nowadays, optimized processes, increased safety, and production rate are of great concerns. Is it possible to design a machine that can perform all casthouse tasks safely and efficiently? Mecfor equipment can safely charge 42 tonnes of aluminium into a melting furnace in less than 20 minutes, using a single machine offering versatility for other tasks from the bottom cleaning to the alloys mixing. This approach addresses many of the high-risk factors such as molten metal splashing hazards and interactions with pedestrians. In fact, using Mecfor's Casthouse Multipurpose Vehicle Solution allows all operations without having anyone walking in the furnace area.

Managing casthouse operations implies co-activity and many aspects that must be taken into consideration. Changing tool or equipment from prime to scrap charging, alloy charging, dross removal, stirring, crucible handling, dross bin handling, furnace cleaning, spout cleaning and more. Could it be possible to use the same machine for all these tasks without having to leave the driver's seat?

## 2. Increased Safety and Productivity: No Room to Compromise

Safety is a necessity; no one will work his best if he risks injury or death. How many times a day does your operator need to climb in and out of its vehicle between each task? Are some requiring longer preparation to hook tools properly? Is he safe at all time? Safety is a culture of continuous improvement often based on lessons learned.

At Mecfor, we bear this in mind and offer an ergonomic work environment so that the operator could focus on the job that needs to be done. Mecfor has designed a built-to-last vehicle that is supremely versatile. The vehicle can be coupled easily to specially-engineered customized smart tools to perform specific operations. The operator can switch from one tool to another in less than 15 seconds, using a push button to rigidly lock it onto the mast apron. The hydraulic-

powered QuickConnect system opens a range of possibilities to develop tools to better fit today's casthouse realities and challenges.



**Figure 2. Mecfor Multipurpose Vehicle Casthouse solution - MVR and tools.**

### **2.1. Co-Activity**

It goes without saying that reducing the number of equipment and pedestrians reduces co-activity events. This is one of the many advantages of Mecfor's Casthouse Multipurpose Vehicle Solution that works with dedicated zones (parkways, tooling storage area, loading preparation) helping to better control pedestrian/vehicle interactions.

### **2.2. Mitigating the Human Factor**

The human factor can be defined as: 'all operations that rely on the skills, the experience, the judgement, and the state of mind of the operator'.

To that effect, Mecfor Smart Tool option brings technology for repetitive tasks such as loading, tending, and skimming of furnaces. It allows a limit to be set on the speed and power of the machine functions, according to the tool in use. This helps to control the human factor, limits the risks of incidents, and reduces breakages. Any travel speed may be interrelated with the task to be achieved and the specific tool for that task, to ensure a safer operation. Adding IA to perform operations with customized programming offers flexibility and numerous possibilities of settings of the equipment. It can even force the operator to comply with the safety procedures in place, though without reducing the performance of the equipment.

### **2.3. Operational Training and Data Analysis: Ways to Identify Best Practices**

Proper training is the key to success in welcoming on-board new employees. That is why Mecfor offers an approved trainer seat (available in option) for all Mecfor vehicles. This seemingly innocuous option does, however, make it possible to train and coach new employees. The first hours of operation are so striking, what better than an instructor or an experienced employee beside the trainee when he drives through the plant for the first time. At each commissioning of equipment, a training is given to operators by one of Mecfor's qualified technicians. This ensures good practice and gives the right understanding on how to work with Mecfor Smart Casthouse Vehicle.

Operator ID is another option that helps to better supervise a junior operator by limiting his access to certain tools and/or reducing the speed of the machine in certain areas. This ensures that he will gradually get accustomed to the equipment, minimizing the risk of accidents. The 360-camera recorder option and MecforLink telemetry system can follow step-by-step each unit and each operator in their operational habits.

These technological features are very useful to develop risk prevention measures because they offer a complete history of situations when an analysis is deemed necessary. MecforLink information (who does what, in what machine, with what tool, at what time of the day) can be combined with the ability trace an operation at a specific moment and to review a recorded video of an event, which makes it easier to understand the circumstances. In terms of modern connectivity, Mecfor safety package offers the ability to trace an operation at a specific moment.

Mecfor link by telemetry can report hundreds of customizable time-related parameters such as operators ID, impact meter, machine in operations, speed, engine load, tool in action, alarms, preventive maintenance info, etc.

### **3. Designed to Protect**

Mecfor's team of experts pay close attention to the design of the QuickConnect furnace charging and tending tools design.

#### **3.1. Molten Metal Splashes**

A near miss accident caused by a metal splash is a serious concern. Our studies show that a lot of metal splashes occur due to inadequate tool use and/or bad operations. In most cases, vehicles take the hit. The right tool brings the right way of operation. Being able to control motion, speed, and tool functioning in accordance with a given task prevents load to fall off too quickly into the furnace. In addition, the shape of each tool is designed to fit the interior of the furnaces, taking into account the level of metal present and the type of material to be loaded; this for a maximum risk control. The tool can be designed to suit round induction melting furnaces, allowing for horizontal or vertical charging.

#### **3.2. Increased Protection**

##### **3.2.1. Special Glass Assembly**

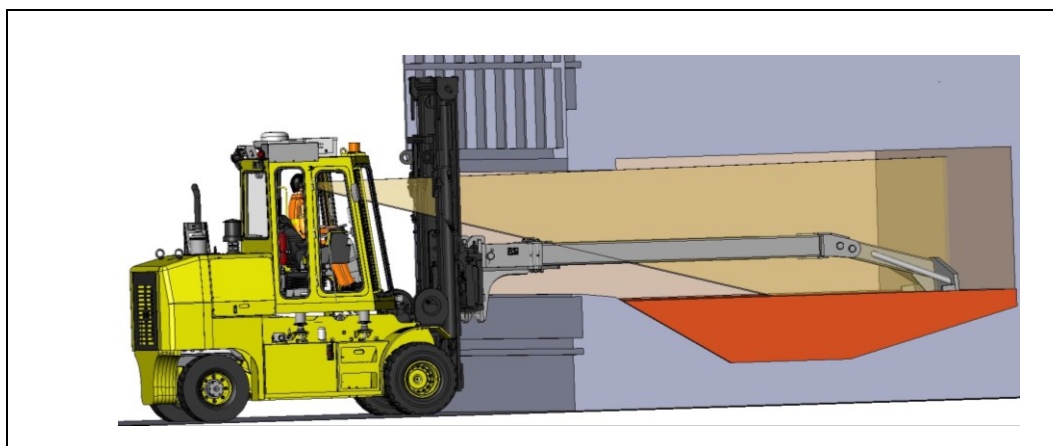
Mecfor vehicle provides increased protection against explosion during loading and tending of furnaces: a triple protection glass assembly resists the impact of an explosion, the heat of molten metal splash, and glass bursting (see Figure 3). This advanced protection is at the top of Mecfor's range of built-in protection, such as the tempered glass offering scratch and heat-resistance, or the classic poly- carbonate synthetic glasses that can easily be replaced.

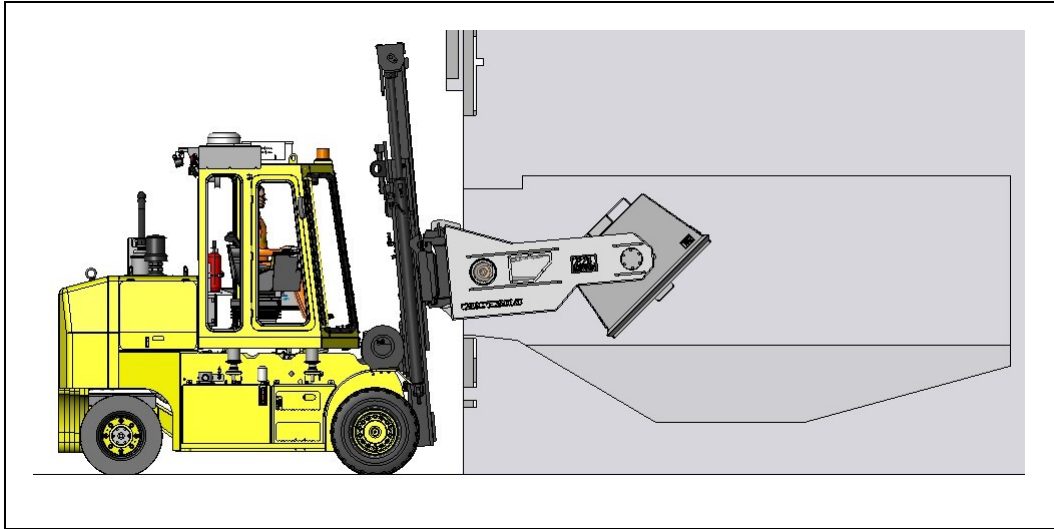


Figure 3. Special glass assembly for better protection.

### 3.2.2. Vision Above the Tool and Mast Apron Shield

Always having a good vision over the tool with the mast in lowest position as possible is a must. Due to their tool's design and the way that the operator has to couple them with the forks, industrial forklift trucks offer open visibility area only under the tool forcing the operator to work with the mast apron in high position, thus exposing the machine directly to metal splashes. Mecfor's Casthouse Multipurpose Vehicle provides a view above the tool, the mast apron acting as a shield when working near molten metal (see Figure 4). Charging boxes serves the same purpose. Therefore, this provides the maximum protection in case of metal explosion caused by hazardous materials that could accidentally be loaded into the furnace.





**Figure 4. Top: Vision above the tool; Bottom: Mast Apron acting as a shield.**

Furthermore, it also greatly reduces the operator's risk of occupational back and neck injuries by promoting a relaxed and natural position of the operator during the task. If the operation requires, a hydraulic lifting cab can be offered in addition to the installation of fixed, made-to-measure spacers under the cabin, so as to set the operator's vision in the right angle/axis for safety and comfort.

### 3.3. Quality of Air and Perfect Vision

With Mecfor Smart Casthouse Solution, the operator steps into a healthy and comfortable environment right from the beginning. The air quality of the cab is controlled to provide positive pressure and active filtration. The 360-degree vision is optimized by the surrounding windows. The rotating seat (available as an option) will allow driving without blocking the vision, which is convenient when moving bulky loads. In addition, a 360-degree camera system, along with proximity scanners, will help to see a danger that would otherwise be out of the field of view. Improved comfort will sharpen the operator's level of concentration (see Figure 5).



**Figure 5. Left - MVR22 with rotating seat for optimal vision, facing forward, while driving. Right – Industrial forklift carrying a molten metal ladle.**

### 3.4. Limit Losses and Damages

It is important to prevent, even eliminate if possible, damages to the refractory in a furnace. This represents major savings for an organization. Using a very efficient hydraulically-powered QuickConnect system coupled with the right tool for a task brings many benefits.

#### 3.4.1. Reducing Energy Losses

By using pre-loaded charging boxes and efficient charging tools, energy losses can be reduced by having the furnace door stay open during a shorter time lapse (see Figure 6). Also, there is a gain by reducing the time required to execute an operation.



Figure 6. MVR22 carrying a pre-loaded bin of scrap.

#### 3.4.2. Limiting Refractory Damages

Eliminating bad operational habits will not only help reduce refractory damages, but also ensure the safety of operators. By cutting down operational damages, Mecfor's Casthouse Multipurpose Vehicle Solution can bring savings for refractory:

- a. **Ceiling damage**  
With the intelligent system, Mecfor equipment detects the length of the tool, the angle of the mast and the elevation of the apron. Knowing these factors, preset functions apply limitations to prevent contact with the furnace ceiling.
- b. **Side wall damage**  
Managing the traction speed according to the steer angle in relation with the tool in place controls the traditional strike caused by a long skimming boom.
- c. **Bottom damage**  
Controlling the motion speed of a large load to be pushed into the furnace or to be placed directly onto the bottom instead of dropping it from the door sill or by slipping it out from the forks helps reduce the bottom damage.
- d. **Doors damage**  
An alignment assistance system guides the operator of the vehicle using magnetic stripes. At that moment, Mecfor intelligent system takes over to control the steering function to perfectly align the machine in the furnace door. That feature combined with pre-set height and mast angle will ease the operations and eliminate any door/vehicle collision, time losses, and expenses.

In addition, Mecfor Smart Tool option allows to limit the speed and power of the machine functions depending on the tool that is in use. Technology-assisted operations (sequencing and

programming), monitoring, and analysis are also key elements to understand how to alleviate risks.

#### 4. Other Collateral Benefits

Uptime and availability of equipment are increased by sturdiest design of construction and predictive maintenance, thus ensuring an increased uptime of the fleet and reducing the number of spare equipment units needed for contingency plan. Mecfor has put in place a predictive maintenance (PM) program that covers by monitoring: vehicles and tool hours of operation, alarms, distance meter, service alarms for filters, lubricants, wear parts, and tire replacement follow-up. This allows planning maintenance ahead of time based on operating hours instead of using weekly or monthly periodic maintenance schedule

Getting an equipment that is 100 % designed for the reality is possible. This equipment will offer flexibility, have a small footprint and high lifting capacity. It will fit with today's workplace in terms of manpower skills and safety requirements (see Figure 7).



Figure 7. MVR - lifting cab with array of tools.

#### 5. Mecfor's Casthouse Multipurpose Vehicle Solution in Real Life

In 2016, Eurofoil Smelter in Luxembourg was looking to increasing operator's safety during furnace loading operations. At the time, they experienced recurrent metal splashes because the industrial forklift had to get too close to the furnace sill.

The client was searching for a vehicle with a lifting cab giving greater visibility during the operation. Also, the equipment needed to maintain a safe distance of 2-meter from the furnace sill. Finally, the solution had to be compliant with *Inspection du travail des mines Luxembourgeois* (ITM). Mecfor understood its client's needs and presented its Smart Casthouse Solution, using the MVR22 model. The results met all requirements bringing major positive impacts on production.

## **6. Conclusion**

For decades, Mecfor has been perfecting its Smart Casthouse Solution. By identifying the root cause with its customer, Mecfor team designs a Smart Casthouse Solution tailored for that customer. The goals are: restricting bad practices, reducing number of equipment required, limiting co-activities between pedestrians and vehicles, thus lessening risks of accident. Mecfor Smart Casthouse Solution with QuicKconnect technology provides a quick return on investment and a safer workplace for the workers.