ANNUAL SUMMARY REPORT ON MOLTEN METAL INCIDENTS IN 2022

September 2023

For the year 2022, 198 molten metal incident reports occurring world-wide were received as compared to 140 reports for 2021 and 147 reports for 2020. The attached figures summarize the reports for 2022 as well as the data for the years 1980 through 2022.

SUMMARY POINTS:

- For 2022, there were 198 explosion incidents reported. This not only reversed the downward trend in reported incidents over the previous five years but was also the highest number of incidents ever reported in the 42 years of the Molten Metal Incident Reporting Program initiated in 1981. The previous high was 195 in 2016.

- There were 175 Force 1 explosions, 23 Force 2 explosions and zero Force 3 explosions reported in 2022. Compared to 2021, Force 2 explosions were the same, while the Force 1 explosions increased significantly from 116 to 175. 2022 was the first year since 2017 with no Force 3 incidents reported. There was one reported in each of the last three years and two in 2018.

- The notable increase in Force 2 explosions that started in 2016 with an average of 21/yr. continued into 2022. This reversed a downward trend that was observed starting around 2008 and continued through 2014. However, when considering the record number of reported incidents, there was not a corresponding increase in Force 2 explosions, as may be expected.

- Of significant note, there were again no reported Fatalities in 2022, same as for the years 2015 through 2017 and 2019 through 2021. There have been 99 reported Fatalities for the entire length of the program.

- Also of note, there were no Serious injuries reported in 2022, only 13 Minor injuries from the record high of 198 incidents. This was the same injury rate per incident of 7% as was observed in 2021, with 10 injuries for 140 incidents.

- Since 2013 there have been only Minor injuries reported (zero Serious and zero Fatal) in three other years: 2013 (23 Minor), 2015 (56 Minor) and 2020 (7 Minor).

- Over the past ten years there were only two years with Fatalities: 2014 with one and 2018 with eight, which involved two major Casting incidents. The 0.9/yr. average Fatality rate for the past ten years is significantly lower than the 2.4 annual rate for the entire length of the program.
- In 2022, there were no injuries reported for Melting, which was the same in 2021. Over the past five years there have been only three Melting injuries (two Minor and one Serious).
- Three injuries occurred during Transfer operations and ten during Casting. Five of the ten Casting injuries occurred during VDC Casting Start-up.
- Reduction and Rolling operations each reported six Minor injuries, while one was reported from Extrusion and zero from Recycling. This is the second year in a row with Extrusion reporting only one Minor injury.
- As noted in recent annual incident reports, the sharp decrease in injuries starting in 2016 compared to historical values has continued through 2022. When comparing the average amount of injuries/year for the years 2001-2015 vs. 2016-2022, the latter time frame is significantly lower (13.9 vs. 48.1 injuries/yr.) for all categories: Minor, Serious, and Fatal. For these last seven years, the average Fatal/Yr. was 52% lower, the average Serious/Yr. was 71% lower, the average Minor/Yr. was 73% lower, and the average Total Injuries/Yr. was 71% lower.
- The injury rate per incident has been trending downward over the past 5-10 years for all three operations, Melting, Casting and Transfer, which was observed in the new charts added to the 2020 report. This metric has been very low (close to or at zero), especially for Melting, except for one year, 2015, when a major furnace bleed-out and Force 3 explosion occurred resulting in numerous Minor injuries.
- As stated in the past, this lower injury frequency can be attributed at least partially to 1) the increased use of primary and secondary PPE; 2) improvements in PPE materials and design; 3) an increased focus on hands-free Casting operations that remove personnel from high-risk Casting operations; and 4) possibly increased training and hazard awareness.
- As often in the past, 93 Casting incidents accounted for the highest number of explosions (84 Force 1 and 9 Force 2). Most explosions, 65, occurred during start-up, which included seven of the nine Force 2 explosions. Sow or mold Casting accounted for 47 incidents and there were 42 incidents during VDC slab and billet Casting.
- For Casting explosions starting in 2015 through 2022, by a factor of 4X, the highest number occur during sow or mold Casting due to wet, cracked or rusty molds. This compares to the next highest for VDC cast start explosions due to excessive curl, hang-ups and bleed-outs. When only Force 2 or Force 3 explosions are considered, then VDC cast start, for these same reasons, has the highest number (16) with VDC termination explosions due to wet and rusty drain pans being the next highest (14).
- Force 2 and 3 Transfer incident data from 2008 through 2022 indicate that wet/rusty drain pans account for 60% of all the explosions.
• For 2022, 23 of 115 (20%) Casting and Transfer explosions were related to wet/rusty drain pans.
• There were 74 Melting explosions, including nine Force 2 explosions. All but one of these nine Force 2 explosions were related to wet/contaminated scrap, sow or RSI.
• There were two Minor injuries reported from the 22 Transfer incidents. Wet hand and furnace tools or wet equipment were involved in 13 of the explosions and six involved wet/rusty drain or skim pans.
• Force 2 and 3 Transfer incident data from 2008 through 2022 indicate that wet/rusty drain pans account for 60% of all the explosions.
• 2015 and 2018 are two years in the past ten that stand out with a high number of injuries: 1) one 2015 Force 3 Melting explosion with 35 Minor injuries; and 2) two 2018 Force 3 Casting explosions with 25 injuries, including eight Fatalities.
• New “by plant type” (Reduction, Rolling, Extrusion and Recycling) data analysis of incidents, injuries and % injuries per incident for the past 11 years provided new statistics and charts, which indicate differences in the number of incidents and % injuries per incident between these four plant categories. Reduction plants have the highest number of incidents compared to the others, but with low injury rates. Additionally, the Rolling and Extrusion plants have approximately 2X higher rates of injuries per incident compared to Reduction and Recycling over the past seven years. Further investigation and data analysis would seem appropriate to understand these differences, which then could possibly lead to reducing injury rates further.
• New analysis and charts that were added last year were continued this year which display incidents per month for the three categories of Melting, Casting and Transfer. The additional year of data supported the previous results showing a higher Melting incident rate in the northern hemisphere for January through March, most likely related to the higher potential for charging materials to be contaminated with water, snow and ice. Very low Melting incidents in December continued with no correlation to similar results in Casting or Transfer.
The Aluminum Association classifies molten metal explosions according to **Force Level**, with **Force 1** being the least severe and **Force 3** being the most severe. Table 1 below provides information on the criteria used for rating **Force Level**. Figures 1 through 50, provided after the discussion below, display various charts and tables, including Table 1.

### Table 1: Explosion Rating Force Criteria

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Force 1</th>
<th>Force 2</th>
<th>Force 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property Damage</td>
<td>None</td>
<td>Minor</td>
<td>Considerable</td>
</tr>
<tr>
<td>Light</td>
<td>Minimal</td>
<td>Flash</td>
<td>Intense</td>
</tr>
<tr>
<td>Sound</td>
<td>Short cracking</td>
<td>Loud Report</td>
<td>Painful</td>
</tr>
<tr>
<td>Vibration</td>
<td>Short and sharp</td>
<td>Brief rolling</td>
<td>Massive structural</td>
</tr>
<tr>
<td>Metal Dispersion</td>
<td>&lt;15 feet</td>
<td>&gt;15 to 50 feet</td>
<td>&gt;50 feet</td>
</tr>
</tbody>
</table>

**Figure 1** displays by year from **1981** through **2022** the total number of reported incidents, **4537**. There was a record number of **198** explosions reported in **2022**, compared to **140** in **2021**. The highest previous record was **195** in **2016**. Additionally, 2022 reversed the downward trend of reports over the last 5 years.

**Figures 2 through 6** provide **Force Level** data for all years of the program, 1981 through 2022, in various formats, including the number of incidents and rates. **Figure 2** displays the reported incidents each year for all three Force Levels. **Figure 3** displays the same data but broken down by **Force Levels 1, 2 and 3** for each year. In 2022 there were **175 Force 1, 23 Force 2** and **zero Force 3** explosions. Compared to **2021**, **Force 2** explosions were the same, **23**, while the **Force 1** explosions increased from **116** to **175**. There were **two Force 3** incidents in 2018 and **one Force 3** explosion in each year from **2019 through 2021**.
From **2008 through 2022** there has been either zero or one Force 3 explosion reported annually with one exception in 2018 when two Force 3 explosions were reported. The average number of Force 3 explosions over the last **five and ten years** (1.0/yr. and 0.8/yr. respectively) continues to show a much lower level compared to the 2.9/yr. average for the entire reporting history from **1981 through 2022**. The notable downward trend of Force 2 explosions observed in Figure 3, starting around 2008 and continuing through 2014, was reversed beginning in 2016 and has continued through 2022 with an average of 21/yr. over the past seven years.

**Figures 5 and 6** display a comparison of all three Force Levels for the entire reporting history from 1981 through 2022 in two different formats: 1) bar graph and 2) pie-chart. Force 1 incidents account for **76.8%** of all incidents, which has been increasing slightly for the last four years since 2019 which was at **75.6%**. The Force 2 and Force 3 incident rate in 2022 both lowered slightly compared to 2021 from **20.9%** to **20.5%** and from **2.8%** to **2.7%** respectively.

**Figures 7 through 13** provide various formats of injury incident data (**Minor, Serious and Fatal**) for the years 1981 through 2022. There were a total of 1628 injuries reported over the entire lifetime of the program. The **Figure 7** bar chart shows **Minor, Serious and Fatal** injuries for each year. In 2022 there were a total of **13 injuries**, all **Minor**. Since 2013 there have been only **Minor** injuries reported (**zero Serious** and **zero Fatal**) in three other years: 2013 (**23 Minor**), 2015 (**56 Minor**) and 2020 (**7 Minor**).

There have been **99** reported Fatalities for the entire length of the program, starting in 1981. Over the past ten years there were only two years with **Fatalities**: 2014 with **one** and 2018 with **eight**, which involved two Force 3 Casting incidents. The **0.9/yr.** average Fatality rate for the past ten years is significantly lower than the **2.4/yr.** annual rate for the entire length of the program.

Of high significance, in **Figure 7** a green arrow indicates a sharp decrease in total injuries starting in 2016 compared to historical values. The reduction in injuries over the past seven years is displayed more clearly in **Figures 8 and 9**. Both charts present data from 2001 through 2022. **Figure 8** is a new chart and is also shown below (**Chart 1**). The chart displays % **Injuries per total annual incidents** and clearly shows the rate of injuries per incidents reported declining starting in 2016. **Figure 9** was started three years ago for the 2020 summary report. When comparing average injuries/yr. for the years 2001-2015 versus 2016-2022, the latter time frame is significantly lower for all categories of injury: **Minor, Serious and Fatal**. For these last seven years, the average Fatal/Yr. was 52% lower, the average Serious/Yr. was 71% lower, the average Minor/Yr. was 73% lower and the average Total Injuries/Yr. was 71% lower. Additionally, this data includes the two 2018 Force 3 explosions with **12** injuries (**8 Fatalities, 2 Serious and 2 Minor**).
From 1981 through 2022, there are now a total of 1628 Minor, Serious and Fatal reported injuries with Figure 10 showing the total injuries in these three categories. The Figure 11 pie chart breaks this down into percentages: 70.3% Minor, 23.6% Serious and 6.1% Fatal.

Figure 12 presents the likelihood of no injury per hundred incidents versus the likelihood of an injury in each injury category. This indicates that for every hundred incidents reported there is a 25.2% rate for Minor injuries, an 8.5% rate for Serious injuries and a 2.2% rate of Fatalities versus a 64.1% rate of No Injury. All three of these injury rates decreased in 2022 versus 2021 percentages. Since explosions are typically more likely to be reported when there is an injury of some degree, these numbers are certainly inflated compared to the actual data if all explosions were reported. However, this does provide an indication of the potential rate of an injury per incident.

Figure 13 displays data only related to Fatalities for the entire reporting program from 1981 through 2022. There have been nine Fatalities over the past 10 years, with eight of the ten reported in 2018, as previously noted, due to the two Force 3 Casting explosions. The 0.9/yr.
average Fatality rate for the past ten years is significantly lower than the 2.36/yr. annual rate for the entire length of the program.

Figures 14 through 48 provide more detailed information regarding the 198 reported explosions in 2022 along with similar charts comparing this year’s data with the entire database from 1980 through 2022. Additionally, there are newer charts, first presented in the 2020 report, which provide additional insight into: 1) Recent trends in reported explosions and injury rates for Melting, Casting and Transfer operations (Figures 16-21); and 2) Summaries of the major causes of Casting and Transfer incidents over recent years (Figures 27, 28, 31 and 32).

Figure 14 shows the 2022 data by Force Level for each of the four major categories of operations: Melting, Casting, Transfer and Other. This can be compared to the same data for the years 1980 through 2022 in Figure 15. In 2022, most explosions occurred in Casting (93), with Melting (74), Transfer (23) and Other (8) being the lowest as in the past. All Other explosions occurred in the Reduction Process. There was almost an equal number of Force 2 explosions for Casting (10) compared to Melting (9). Transfer and Other each had two Force 2 incidents. Most Force 2 and Force 3 explosions for the entire reporting period continue to be related to Melting operations by a wide margin as shown in Figure 14.

As reported in previous years and shown and discussed above, when reviewing Figures 7 through 9, there is a general decrease in the number of injuries, especially when comparing the last seven years to the previous 15 years. Figures 16 through 22 provide injury and incident data for each Melting, Casting and Transfer operations in two different formats: 1) Injuries and Incidents; and 2) # Injuries per Incident or Injury Rate. Data is displayed by year from 1990 through 2021, excluding 2011. Unfortunately, the data is not available for program years prior to 1990 and 2011.

In general, the data shows an upswing in incidents in the early 2000’s and a higher incident volume for the last eight years. In contrast, however, there appears to be a downward trend in Injuries per Incident or Injury Rate over the last seven to ten years. Melting Injuries and Injury Rate (Figures 16 and 17) have been very low for the last ten years (< 0.05), except for 2015 (>0.7), which had 35 Minor injuries resulting from one Force 3 explosion when a furnace bled-out into a casting pit. For Casting and Transfer operations, the Injury Rate has been very low but variable over this time period (Figures 19 and 21).

For the Injury per Incident Rate charts (Figures 17, 19 and 21) a best fit line is provided along with R² values, which are very low due to data scatter. It is a positive sign that the Injury Rate is trending in this direction over the past several years. There are probably numerous reasons for this trend including: 1) improvements with primary and secondary PPE materials, design, and
use; 2) movement toward ‘hands-free’ casting removing personnel from the Casting pit during cast starts; and 3) increased training and hazard awareness.

Figure 22 provides 2022 data regarding the type of charge materials involved in the 74 Melting incidents. The leading cause of the explosions (66 of the 74) was wet scrap, sows, RSI or T-Bar. Eight of the nine total Force 2 Melting explosions occurred in these 66 incidents. Wet alloy material (Mg) accounted for four Force 1 explosions.

A compilation of the Melting explosion data over the years 1980 through 2022 for the various types of charging materials involved is shown in Figure 23. Wet or contaminated scrap continues to be the reason for most of the Melting explosions. The second highest area is related to wet alloying materials. By a high margin, most of the Force 2 and Force 3 Melting explosions have been related to Scrap charging. After Scrap, the next leading cause of Force 2 and Force 3 explosions occurred when charging various types of sows (primary and RSI) and T-bar.

Figure 24 provides a breakdown of the 93 Casting incidents in 2022 in two different ways: by stage in the process and by type of Casting process. There were nine Force 2 and zero Force 3 explosions in 2022. As typically seen in the past, most of the explosions occurred during the Start-up (65), with seven being Force 2. At cast Termination there were 19 explosions, with two of the 17 being Force 2. There were nine Steady-State incidents, all Force 1. Most of the Casting explosions (47) occurred during the Casting of sow or mold Casting, with two being Force 2. Slightly less, (42) incidents, occurred with VDC Slab and Billet Casting, but this Casting category accounted for seven of the nine Force 2 explosions. There were five strip/coil Casting incidents, all Force 1.

Figure 25 shows DC Casting incidents by drop segment for years 1980 through 2022. The historical data is similar to the 2022 data shown in Figure 24 in that most explosions occur during Start-up. Starting in 2021, the total End-of Cast explosions outnumber the total Steady-state explosions.

For 2022, Figure 26 provides the major causes of the 93 Casting incidents. They are listed by cast stage for DC Casting and for mold or sow Casting. For DC Casting, the main start-up issues were related to wet starting blocks, wet equipment or launders, butt-curl, hang-ups, bleed-overs, and equipment failures. The main DC Casting termination issues were wet/rusty drain pans, ingot head under water and metal on the floor. The main sow and mold Casting incidents were due to wet or cracked molds, wet refractory and wet equipment or tools. Wet/rusty drain pans were the main reason for Termination issues for strip/coil Casting.
Figures 27 and 28 were new charts started in 2021 that provide additional analysis of the primary causes of Casting explosions, looking at the last eight years of data, 2015 through 2022. Figure 27 shows the major causes for all Force Levels, while Figure 28 is data for only Force 2 and 3 Casting explosions. By a factor of 4X, the highest number occur during sow or mold Casting due to wet, cracked or rusty molds compared to the next highest, VDC Cast Start explosions due to excessive curl, hang-ups and bleed-outs. When only Force 2 or Force 3 explosions are considered, Figure 28, then VDC Start, for these same reasons, has the highest number (16) with VDC Termination explosions due to wet and rusty drain pans being the next highest (14). These are followed by DC Cast Start due to wet/rusty bottom blocks (9) and sow and mold Casting with wet/cracked/rusty molds (8).

There were 23 Transfer explosions (21 Force 1 and 2 Force 2) in 2022, as shown in Figure 14. The reasons for these explosions are provided in Figure 29 with wet hand, furnace tools or other equipment accounting for 13 of these incidents. Nine incidents were the result of wet/rusty skim or drain pans.

Figure 30 provides a bar chart showing the equipment involved in the 884 Transfer explosions for the years 1980 through 2022. The highest number of Transfer explosions are related to Drain Pans, followed by Trough and then Other.

Like Figures 27 and 28 presented above for Casting, Figures 31 and 32 were first presented in 2021, providing further detail regarding the major causes of Transfer explosions. Figure 31 provides the data regarding the major causes of all Transfer explosions for the years 2008 through 2022 (excluding 2011), while Figure 32 provides this information for only Force 2 and 3 explosions. Figure 31 indicates that the highest number of Transfer incidents are related to wet/rusty drain pans (134) followed by wet tools (116). Wet/rusty drain pans are the leading cause of Force 2 and 3 explosions (15) with wet refractory or equipment second (6).

When combining Casting and Transfer 2022 incident data for wet/rusty drain pans, this source of explosions accounts for 20% (23 of 115) of all the explosions.

Injuries by Operation (Melting, Casting, Transfer and Other) resulting from the 198 explosions in 2022 is provided in Figure 33 showing that there were 13 injuries, all Minor. Casting accounted for ten and three occurred in Transfer. There were zero Melting injuries in 2022, which was the same in 2021. Over the past five years there have been only three Melting injuries (2 Minor and 1 Serious).

Figure 34 provides Injury by Operation data for 1980 through 2022. The highest number of Minor and Serious injuries have occurred in Casting operations. Melting operations account for the
highest number of Fatalities, as well as the highest number of Force 3 explosions as seen in Figure 15. It should be noted that a significant number of injuries have occurred in relatively straightforward Transfer operations, including 81 Serious and seven Fatalities.

As noted above, the highest number of Fatalities and Force 3 explosions occur during Melting operations. Presented initially in the report last year was new data analysis investigating if there was a correlation between the “time of year” vs. the number of incidents. Figure 35 provides this Melting incident data for the last six years (2017 through 2022). All causes of Melting incidents were part of the analysis, which primarily included wet or contaminated charge materials and wet equipment and tools.

The additional 2022 data continued to support the analysis presented last year that showed higher explosion rates in some of the “winter months”, especially February and March and to a lesser extent in January. This result would be expected since at this time of the year in the northern hemisphere, where most of the incident reports originate, there is a higher potential for winter weather of snow, ice, and rain to contaminate scrap and sows. The data, however, continued to show a low number of incidents in November and especially December, which may not be anticipated. The very low December incidents may be explained by more maintenance and holiday shutdowns/slowdowns occurring.

This data may be worthwhile sharing with plant personnel to emphasize the need for increased emphasis and attention to storage, drying and charging procedures especially during the months of January through March, which may have relaxed during the summer months.

Incident frequency by month is also provided in Figures 36 and 37 for Casting and Transfer in the same format to evaluate if there is a similar correlation to time of year for explosions occurring in these process categories. Correlation to “winter months” or any other time of the year is not evident with this data. Also, December does not show the same lower frequency as was observed in the Melting data. Conversely, for Transfer, the highest number of incidents occur in December. The lowest Transfer incidents occur in May through July, which cannot be easily explained with this being a high vacation time of year. For Casting, the lowest number of incidents occur in February with the highest months being September and November.

It should be noted that the incident database used for these charts does not include month of the year data for all reported incidents, since not all reports contain this information. “Month of the Incident” is a requested item on the Aluminum Association Incident Report form, but it is not necessarily provided, especially when the incident data is provided via spreadsheet format by some companies.

Figures 38 and 39 provide incident data versus the type of Process Plant (Reduction, Extrusion, Rolling and Recycling) for 2022 and for 1980 through 2022 respectively.
In 2022, the highest number of incidents occurred in Reduction operations (78), compared to the next highest in Recycling operations (49). Extrusion and Rolling each reported seven Force 2 explosions, followed by Recycling (5) and Reduction (4). For the entire reporting period, 1980 through 2022, the highest number of incidents have occurred in Reduction and the second highest are in Rolling, which by far has reported highest number of Force 3 explosions.

The main causes of the 79 Reduction facility explosions in 2022 are presented in Figures 40 and 41. They are listed by Melting, Casting, Transfer and Reduction incidents. Melting incidents were related to wet tools and wet charging materials, scrap, RSI and Mg. Most of the Reduction facility incidents occurred during Casting, primarily sow or mold Casting. The primary reason in sow Casting was for cracked, wet or rusty molds. Start-up VDC Casting incidents were related to wet refractory and equipment and wet starting blocks. Termination VDC Casting incidents occurred due to wet/rusty drain pans and over-flow onto a wet floor. Transfer and Reduction incidents were primarily related to wet/rusty equipment, tools and drain pans as well as tap-outs onto a wet floor.

Figure 42 provides the main causes for the 49 Recycling incidents reported in 2022. Most incidents occurred in Melting (30) due to wet charge material: scrap, RSI sow and dross. Transfer incidents were primarily related to wet/rusty drain pans and wet tools while and Sow Casting incidents were primarily the result of wet/rusty molds or drain pans.

In Reduction facilities there were 6 Minor injuries in 2022 as shown in the Figure 43 bar chart with zero Serious injuries. Three occurred in Casting and three in Transfer operations. Casting injuries were the result of wet sow molds and a wet starting block. The three Transfer injuries were all related to wet sampling molds.

All six Rolling plant Minor injuries occurred during Casting (Figure 44). Three occurred during Start-up bleed-outs, two at Termination due to wet/rusty drain pans and one at Start-up with excessive curl.

For Extrusion in 2022, Figure 45, there was only one Minor injury from the 25 explosions, 18 Force 1 and seven Force 2. The injury occurred during a cast Start-up due to a hang-up. This is the second year in a row with Extrusion reporting only one Minor injury.

As shown in Figure 46, there were no Recycling injuries in 2022 from 49 incidents.

Figure 47 summarizes the 2021 injury data by type of Process Plant and Figure 48 shows this same data for 1980 through 2022.
This year, for the first time, there was further incident and injury data analysis of the four Process Plants (Reduction, Extrusion, Rolling and Recycling). Charts 2 through 5, below, provide incident, injury and injuries per incident data for these four plant categories for the past 11 years (2012 through 2022). Severity of injury (Minor, Serious and Fatal) was not investigated separately in this analysis. These four charts are also provided in Figures 49 and 50.

**Chart 2**
*Reduction Plant Incidents, Injuries & % Injuries/Incident*
*2012 to 2022*
Chart 3
Extrusion Plant Incidents, Injuries & % Injuries/Incident
2012 to 2022

Chart 4
Rolling Plant Incidents, Injuries & % Injuries/Incident
2012 to 2022
From the above charts and Figures 49 and 50, there is a significantly higher number of Reduction plant incidents compared to the other three plant types. However, starting in 2016 there was a large drop in the number of Reduction plant injuries and the incident per injury rate. Both the number of injuries and injury rate remained low since that time. Reporting of Recycling plant incidents increased significantly starting in 2016 from approximately five per year to an average of 37 per year over the past six years. Along with the higher number of injuries in this time frame, the injury rate variability has increased with some years being 5%, but other years at 0%. In comparing Reduction and Recycling plant injury rates over the last seven years, they averaged 6% and 4% respectively, with significantly more incidents in Reduction plants.

Both the Reduction and Recycling plant injury rates are lower than the Extrusion and Rolling plant rates, as shown in Charts 3 and 4 above and Figure 50. The number of reported incidents is approximately 3-4X higher in Rolling plants compared to Extrusion plants. The Extrusion injury rate is often the highest of the four plant types and is extremely variable, ranging from 0% to 87%. This may be related to the very low number of Extrusion incidents that are reported compared to the other three plant types. Rolling plant injuries and injury rates are high compared to Reduction and Recycling. The number of Rolling incidents were very low for the years 2012 through 2014, averaging ten per year in that time frame, similar to
**Extrusion.** From 2015 through 2022 the average number of **Rolling** incidents increased to 24 per year with an average injury rate of 11%. This is approximately 2X higher than the **Reduction** and **Recycling** injury rates noted above.

This new plant incident and injury data indicates that further investigation, analysis and discussion should be pursued to determine why higher injury rates are observed in **Rolling** and **Extrusion** compared to **Reduction** and **Recycling**. This may be related to the higher application of the billet and slab VDC Casting processes in these plants compared to **Reduction** and **Recycling**. This additional understanding could lead to reducing injury rates.

The last page of the report after the figures provides an Aluminum Association Molten Metal Incident Report Form. You can also link to the form at:

[https://www.aluminum.org/health-safety](https://www.aluminum.org/health-safety)

R T Richter – September 28, 2023
# Explosion Rating Force Criteria

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Force 1</th>
<th>Force 2</th>
<th>Force 3</th>
</tr>
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<tbody>
<tr>
<td>Property Damage</td>
<td>None</td>
<td>Minor</td>
<td>Considerable</td>
</tr>
<tr>
<td>Light</td>
<td>Minimal</td>
<td>Flash</td>
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<td>Short and sharp</td>
<td>Brief rolling</td>
<td>Massive structural</td>
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<tr>
<td>Metal Dispersion</td>
<td>&lt;15 feet</td>
<td>&gt;15 to 50 feet</td>
<td>&gt;50 feet</td>
</tr>
</tbody>
</table>

**TABLE 1. Explosion Rating Force Criteria**

Sep. 2023
Incidents by Year
1981 – 2022 (Total 4537)

FIGURE 1. Incidents Reported For The Period 1981 – 2022  Sep. 2023
Incidents by Force Level
1981 – 2022 (Total 4537)

FIGURE 2. Incidents By Force Level 1981 – 2022
Sep. 2023
Incidents by Force Levels 2 & 3
1981 – 2022

FIGURE 3. Incidents By Force Levels 2 & 3 For 1981 – 2022

- Force 2
- Force 3
- Avg.# Force 2/yr - 20.5
- Avg.# Force 3/yr - 2.7

Sep. 2023
Force 3 Incidents Only
1981 – 2022


9
8
7
6
5
4
3
2
1
0

1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021

Sep. 2023

Red: Force 3
Black dashed: Avg # Force 3 Explosions/Yr

5 Yr. Avg.: 1.0
10 Yr. Avg: 0.8

2.7
Incidents by Force Level
1981 – 2022 (Total 4537)

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<thead>
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<th>Force 1</th>
<th>Force 2</th>
<th>Force 3</th>
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<tbody>
<tr>
<td>3487</td>
<td>929</td>
<td>121</td>
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</table>

FIGURE 5. Incidents By Force Level 1981 – 2022

Sep. 2023
All Force Levels by Percentage 1981 – 2022

20.5%  
2.7%  
76.8%

FIGURE 6. All Force Levels By Percentage 1981 – 2022

Sep. 2023
Injuries from Incidents 1981 – 2022 (Total 1628)

% Injuries per Total Annual Incidents
2001 – 2022 (Total 856 Injuries)

FIGURE 8. % Injuries/Total Annual Incidents 2001 – 2022  Sep. 2023

121%
Average # of Injuries / Year from Explosions

Injuries by Severity – Total 1628
1981 – 2022

<table>
<thead>
<tr>
<th>Minor</th>
<th>Serious</th>
<th>Fatal</th>
</tr>
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<td>1144</td>
<td>385</td>
<td>99</td>
</tr>
</tbody>
</table>

FIGURE 10. Injuries By Severity For 1981 – 2022

Sep. 2023
Injury Levels by Percentage 1981 - 2022

FIGURE 11. Injuries Levels By Percentage For 1981 – 2022

- **Minor**: 70.3%
- **Serious**: 23.6%
- **Fatal**: 6.1%
# Injury Risk per 100 Explosions

1981 - 2022

![Injury Risk Chart](chart.png)

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>% Injury / 100 Explosions</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Injury</td>
<td>64.1%</td>
</tr>
<tr>
<td>Minor</td>
<td>25.2%</td>
</tr>
<tr>
<td>Serious</td>
<td>8.5%</td>
</tr>
<tr>
<td>Fatal</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

**FIGURE 12. Injury Risk Per 100 Explosions For 1981 – 2022**

Sep. 2023
Fatalities from Explosions
1981 - 2022

FIGURE 13. Fatalities From Explosions For 1981 – 2022

Avg. # of Fatalities / Yr.- 2.36

Avg # Fatals Last 10 Yrs – 0.9

Fatalities

Fatals

Sep. 2023

FIGURE 13. Fatalities From Explosions For 1981 – 2022
FIGURE 14. Force Level Incidents By Operation For 2022

<table>
<thead>
<tr>
<th></th>
<th>Melting</th>
<th>Casting</th>
<th>Transfer</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force 1</td>
<td>65</td>
<td>83</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td>Force 2</td>
<td>9</td>
<td>10</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Force 3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Sep. 2023
Force Level Incidents by Operation
1980 – 2022

![Bar chart showing force level incidents by operation from 1980 to 2022. The chart compares incidents in Melting, Casting, Transfer, and Other categories for Forces 1, 2, and 3.]

FIGURE 15. Force Level Incidents By Operation For 1980 – 2022 Sep. 2023
Melting Injuries and Incidents
1990 – 2022 (Total 334 Injuries)

FIGURE 16. Melting Injuries and Incidents 1990 – 2022

Sep. 2023
Melting Injuries per Incidents
1990 – 2022

2007 Rate – 3.4
Due to Force 3
China Explosion w/ 84 Total Injuries,
Including 16 Fatalities

R² = 0.0227

FIGURE 17. Melting Injuries Per Incidents 1990 – 2022  Sep. 2023
Casting Injuries and Incidents
1990 – 2022 (Total 358 Injuries)

FIGURE 18. Casting Injuries and Incidents 1990 – 2022
Casting Injuries per Incidents
1990 – 2022

R² = 0.2728

Transfer Injuries and Incidents
1990 – 2022 (Total 238 Injuries)

FIGURE 20. Transfer Injuries and Incidents 1990 – 2022

Sep. 2023
FIGURE 21. Transfer Injuries Per Incidents 1990 – 2022

R² = 0.175
**Major Causes**

Wet & Oxidized: Scrap, Sows, RSI
Wet Alloy Additions: Mg
Induction Furnace Failure – Force 2

---

**FIGURE 22. Melting Explosions By Cause For 2022**

<table>
<thead>
<tr>
<th>Cause</th>
<th>Force 1</th>
<th>Force 2</th>
<th>Force 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrap Charge</td>
<td>42</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Sow Charge</td>
<td>8</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>RSI Charge</td>
<td>8</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>T-Bar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alloying Mg / Other</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tools / Pans</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

**74 Melting Explosions – 2022**

**Sep. 2023**
Melting Explosions – Charge Material Involved
1980 – 2022

# 93 Casting Explosions – 2022

**FIGURE 24. Casting Explosions For 2022**

<table>
<thead>
<tr>
<th>Force</th>
<th>Start-up</th>
<th>Steady State</th>
<th>Termination</th>
<th>DC Slab &amp; Billet</th>
<th>Rod</th>
<th>Sow or Mold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force 1</td>
<td>58</td>
<td>9</td>
<td>17</td>
<td>35</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>Force 2</td>
<td>7</td>
<td>0</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Force 3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Sep. 2023
DC/HDC/EMC Explosions by Cast Segment
1980 – 2022

FIGURE 25. Casting Explosions By Cast Segment 1980 – 2022

<table>
<thead>
<tr>
<th>Segment</th>
<th># of Explosions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-up</td>
<td>872</td>
</tr>
<tr>
<td>Steady State</td>
<td>131</td>
</tr>
<tr>
<td>End of Cast</td>
<td>144</td>
</tr>
</tbody>
</table>
Major Causes of 93 Casting Incidents – 2022

- **DC Start-up Issues**: Wet Starting Blocks, Wet Equipment / Launder, Butt Curl – Hang-ups, Bleed-outs, Equipment Failures
- **DC Steady State Issues**: Bleed Out – Surface Tears
- **DC Termination Issues**: Wet / Rusty Drain Pan, Ingot Head Under Water, Metal on Floor
- **Strip / Coil Casting Termination Issues**: Wet / Rusty Drain Pan
- **Sow / Mold Casting Issues**: Wet / Cracked Molds, Wet Refractory, Equipment & Wet Tools

**FIGURE 26. Major Causes of Casting Incidents For 2022**  Sep. 2023
Major Causes of Casting Explosions 2015 – 2022

- Ingot Head Under Water: 10
- Wet Refractory or Equipment: 32
- DC Cast Start - Wet / Rusty Bottom Block: 33
- End of DC Cast & Aborts - Wet / Rusty Drain Pan: 44
- Equipment Failure / Maint. Issue / Set-up: 44
- DC Cast Start - Excessive Curl / Hang-up / Bleed-out: 55
- Sow Casting - Wet / Cracked / Rusty Molds: 202

# Major Causes of Force 2 & 3 Casting Explosions 2015 – 2022

<table>
<thead>
<tr>
<th>Cause</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingot Head Under Water</td>
<td>3</td>
</tr>
<tr>
<td>Equipment Failure / Maint. Issue</td>
<td>5</td>
</tr>
<tr>
<td>Sow Casting - Wet / Cracked / Rusty Molds</td>
<td>8</td>
</tr>
<tr>
<td>DC Cast Start - Wet / Rusty Bottom Block</td>
<td>9</td>
</tr>
<tr>
<td>End of DC Cast &amp; Aborts - Wet / Rusty Drain Pan</td>
<td>14</td>
</tr>
<tr>
<td>DC Cast Start - Excessive Curl / Hang-up / Bleed-out</td>
<td>16</td>
</tr>
</tbody>
</table>

*FIGURE 28. Casting Explosions by Major Causes 2015 – 2022*
Major Causes of 22 Transfer Explosions – 2022

13 - Wet Hand or Furnace Tools, Equipment
9 - Wet / Rusty Drain or Skim Pan
1 – Metal on Floor

FIGURE 29. Causes of Transfer Explosions For 2022
Transfer Explosions by Equipment
1980 – 2022 (Total 884)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Number of Explosions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain Pan</td>
<td>357</td>
</tr>
<tr>
<td>Trough</td>
<td>208</td>
</tr>
<tr>
<td>Crucible</td>
<td>126</td>
</tr>
<tr>
<td>Other</td>
<td>193</td>
</tr>
</tbody>
</table>

Major Causes of Transfer Explosions
2008 – 2022 (w/o 2011)

- Wet Floor / Spill: 22
- Wet Refractory or Equipment: 86
- Wet Tools: 116
- Wet / Rusty Drain Pan: 134

Major Causes of Force 2 & 3 Transfer Explosions 2008 – 2022 (w/o 2011)

- Wet Floor / Spill: 4
- Wet Refractory or Equipment: 6
- Wet / Rusty Drain Pan: 15

FIGURE 33. Injuries By Operation For 2022

<table>
<thead>
<tr>
<th></th>
<th>Melting</th>
<th>Casting</th>
<th>Transfer</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>0</td>
<td>10</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Serious</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fatal</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

FIGURE 33. Injuries By Operation For 2022  Sep. 2023
1625 Injuries by Operation:
1980 – 2022

<table>
<thead>
<tr>
<th>Operation</th>
<th>Minor</th>
<th>Serious</th>
<th>Fatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting</td>
<td>283</td>
<td>117</td>
<td>59</td>
</tr>
<tr>
<td>Casting</td>
<td>392</td>
<td>164</td>
<td>30</td>
</tr>
<tr>
<td>Transfer</td>
<td>270</td>
<td>81</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>213</td>
<td>16</td>
<td>3</td>
</tr>
</tbody>
</table>

FIGURE 34. Injuries By Operation For 1980 – 2022 Sep. 2023
Melting Explosions By Month 2017 – 2022

FIGURE 35. Melting Explosions By Month 2017 – 2022
Casting Explosions By Month
2017 – 2022

FIGURE 36. Casting Explosions By Month 2017 – 2022
Transfer Explosions By Month
2017 – 2022

FIGURE 37. Transfer Explosions By Month 2017 – 2022
FIGURE 38. Force Level By Process Plant Reported For 2022 - Sep. 2023

<table>
<thead>
<tr>
<th>Process</th>
<th>Force 1</th>
<th>Force 2</th>
<th>Force 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction</td>
<td>74</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Extrusion</td>
<td>18</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Rolling</td>
<td>39</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Recycling</td>
<td>44</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Forging</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
## Force Level By Process Plant
### 1980 – 2022

![Bar chart showing force level by process plant from 1980 to 2022.](image)

<table>
<thead>
<tr>
<th>Process</th>
<th>Force 1</th>
<th>Force 2</th>
<th>Force 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction</td>
<td>1959</td>
<td>297</td>
<td>26</td>
</tr>
<tr>
<td>Extrusion</td>
<td>333</td>
<td>137</td>
<td>20</td>
</tr>
<tr>
<td>Rolling</td>
<td>934</td>
<td>485</td>
<td>212</td>
</tr>
<tr>
<td>Recycling</td>
<td>394</td>
<td>169</td>
<td>38</td>
</tr>
<tr>
<td>Foundry</td>
<td>28</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>Atomizing</td>
<td>11</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Alloying</td>
<td>10</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>BRW</td>
<td>12</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>37</td>
<td>13</td>
<td>0</td>
</tr>
</tbody>
</table>

**FIGURE 39.** Force Level By Process Plant Reported For 1980 – 2022  Sep. 2023
Reduction Plant
Main Causes of 79 Incidents – 2022

<table>
<thead>
<tr>
<th>Melting Incidents</th>
<th>Casting Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 – Wet Tool</td>
<td>Sow Casting:</td>
</tr>
<tr>
<td>1 - Wet Charge: Scrap / Sow</td>
<td>33 - Cracked, Wet or Rusty Molds</td>
</tr>
<tr>
<td>1 - Wet Mg</td>
<td>4 - Undocumented</td>
</tr>
<tr>
<td></td>
<td>3 - Wet Tool, Equip, Refractory</td>
</tr>
<tr>
<td></td>
<td>1 - Termination - Overflow on Wet Floor</td>
</tr>
<tr>
<td></td>
<td>1 - Thermite w/ Rust</td>
</tr>
<tr>
<td></td>
<td>VDC – Billet &amp; Slab</td>
</tr>
<tr>
<td></td>
<td>3 - Termination - Wet/Rusty Drain Pan</td>
</tr>
<tr>
<td></td>
<td>3 – Start-up – Wet Refractory / Equip.</td>
</tr>
<tr>
<td></td>
<td>2 - Termination - Overflow on Wet Floor</td>
</tr>
<tr>
<td></td>
<td>1 – Start-up – Wet Starting Block</td>
</tr>
</tbody>
</table>

FIGURE 40. Reduction Plant Incidents Summary 2022   Sep. 2023
### Reduction Plant
**Main Causes of 79 Incidents – 2022**

<table>
<thead>
<tr>
<th>Transfer Incidents</th>
<th>Reduction Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - Wet Tools &amp; Equipment</td>
<td>4 – Wet Tools</td>
</tr>
<tr>
<td>2 – Wet / Rusty Drain Pan</td>
<td>3 - Tap-Out on Wet Floor</td>
</tr>
<tr>
<td></td>
<td>1 - Wet Tabular</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1 – Wet Tabular</td>
<td>1 - Wet Tool</td>
</tr>
<tr>
<td></td>
<td>1 - Water Bottle</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1 – Water Bottle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1 – Anode into Wet Tub</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1 – Bath into Wet Tub</td>
<td></td>
</tr>
</tbody>
</table>

**FIGURE 41. Reduction Plant Incidents Summary 2022**
Recycling Plant
Main Causes of 49 Incidents – 2022

<table>
<thead>
<tr>
<th>Melting Incidents</th>
<th>Casting Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 - Wet Charge: Scrap, RSI, Sow, Dross</td>
<td>Sow Casting:</td>
</tr>
<tr>
<td>1 - Oxidized Mg</td>
<td>3 - Wet or Rusty Molds</td>
</tr>
<tr>
<td>4 - Wet Drain Pan</td>
<td>4 - Wet Drain Pan</td>
</tr>
</tbody>
</table>

Transfer Incidents

<table>
<thead>
<tr>
<th>Transfer Incidents</th>
<th>Casting Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - Wet / Rusty Drain Pan</td>
<td>VDC – Billet:</td>
</tr>
<tr>
<td>3 - Wet Tools &amp; Sample Mold</td>
<td>1 - Start-up – Wet Starting Block</td>
</tr>
</tbody>
</table>

FIGURE 42. Recycling Plant Incidents Summary 2022 Sep. 2023
Reduction Plant Injuries & Incident Causes – 2022

FIGURE 43. Reduction Plant Injuries By Operation 2022  Sep. 2023

6 Minor Injuries
- 3 – Wet Sampling Tools
- 2 – Wet Sow Molds
- 1 – Wet Starting Block; Billet

<table>
<thead>
<tr>
<th></th>
<th>Melting</th>
<th>Casting</th>
<th>Transfer</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Serious</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fatal</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
### Rolling Plant Injuries – 2022

<table>
<thead>
<tr>
<th>Category</th>
<th>Minor</th>
<th>Serious</th>
<th>Fatal</th>
<th>Melting</th>
<th>Casting</th>
<th>Transfer</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Minor Casting Injuries</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3 – Start-up - Bleed-outs</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2 – Termination - Wet / Rusty Drain Pan</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1 – Start-up - Excessive Curl</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**FIGURE 44. Rolling Plant Injuries By Operation 2022**

Sep. 2023
Extrusion Plant Injuries – 2022

1 – Minor Casting Injury Due to Ingot Hang-up at Start

FIGURE 45. Extrusion Plant Injuries By Operation 2022 Sep. 2023
No Injuries from 43 Force 1 & 5 Force 2 Incidents!

FIGURE 46. Recycling Plant Injuries By Operation 2022

<table>
<thead>
<tr>
<th></th>
<th>Melting</th>
<th>Casting</th>
<th>Transfer</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Serious</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fatal</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Sep. 2023
FIGURE 47. Injury Severity By Process Plant – 2022
Injury Severity by Process Plant
1980 – 2022

FIGURE 48. Injuries Severity By Plant Reported For 1980 – 2022  Sep. 2023
Reduction & Recycling Plant Incidents, Injuries / Incident Rate 2012 – 2022

FIGURE 49. Reduction & Recycling Incident, Injury & Injury Rate 2012-2022  Sept. 2023
Rolling & Extrusion Plant Incidents, Injuries / Incident Rate 2012 – 2022

FIGURE 50. Rolling & Extrusion Incident, Injury & Injury Rate 2012-2022 Sept. 2023
ALUMINUM ASSOCIATION
MOLTEN METAL INCIDENT REPORT

Date of Incident: ________________  Predominant Plant Activity: SELECT ONE:
(month/year)

Explosion Force – Mark One:  
Force 1 Characterization:  
Force 2 Characterization:  
Force 3 Characterization:  
For definition of force, click arrow to see a description

Alloy  
Metal Temperature  
°F  °C  
Approximate Amount of Metal Involved  
lbs kilograms

OPERATION:

Charging / Melting  Type of Furnace  SELECT ONE:
Furnace Capacity  
lbs mt  % Full  
Materials Charged  
Outside Storage? Yes No  
Preheat? Yes No  
Preheat Time/Temp:  hrs  °F °C

Transfer  Type  SELECT ONE:

Casting  Type  SELECT ONE:  
Type of Product being Cast: SELECT ONE:
Stage of Operation:  SELECT ONE:

Other  Describe

Number of Injuries by Type:  Minor  Severe  Fatal

Provide a brief description of the incident and its root cause(s):

If Charging/Melting Incident, please select appropriate Primary and Secondary cause(s):
Other
Other
If Contaminations (other than moisture) was selected, please specify:
SELECT ONE:

If Transfer Incident, please select appropriate Primary and Secondary cause(s):
PRIMARY CAUSE:
SECONDARY CAUSE:

If Casting Incident, please select appropriate Primary and Secondary cause(s):
PRIMARY CAUSE:
SECONDARY CAUSE:
If Bleed-out/Bleed-over is selected above, describe reason for Bleed-out or Bleed-Over:

If Explosion due to Bleed-out/Bleed-over was selected above, where was the location of Explosions:
SELECT ONE:
If Metal Level Control Problem was selected above, please specify location of problem:
SELECT ONE:

Please return to:
Andrew Smith
Manager, Regulatory Affairs
The Aluminum Association.
1400 Crystal Drive, Suite 430
Arlington, VA 22202

When you have completed the form please send it as an attachment asmith@aluminum.org.