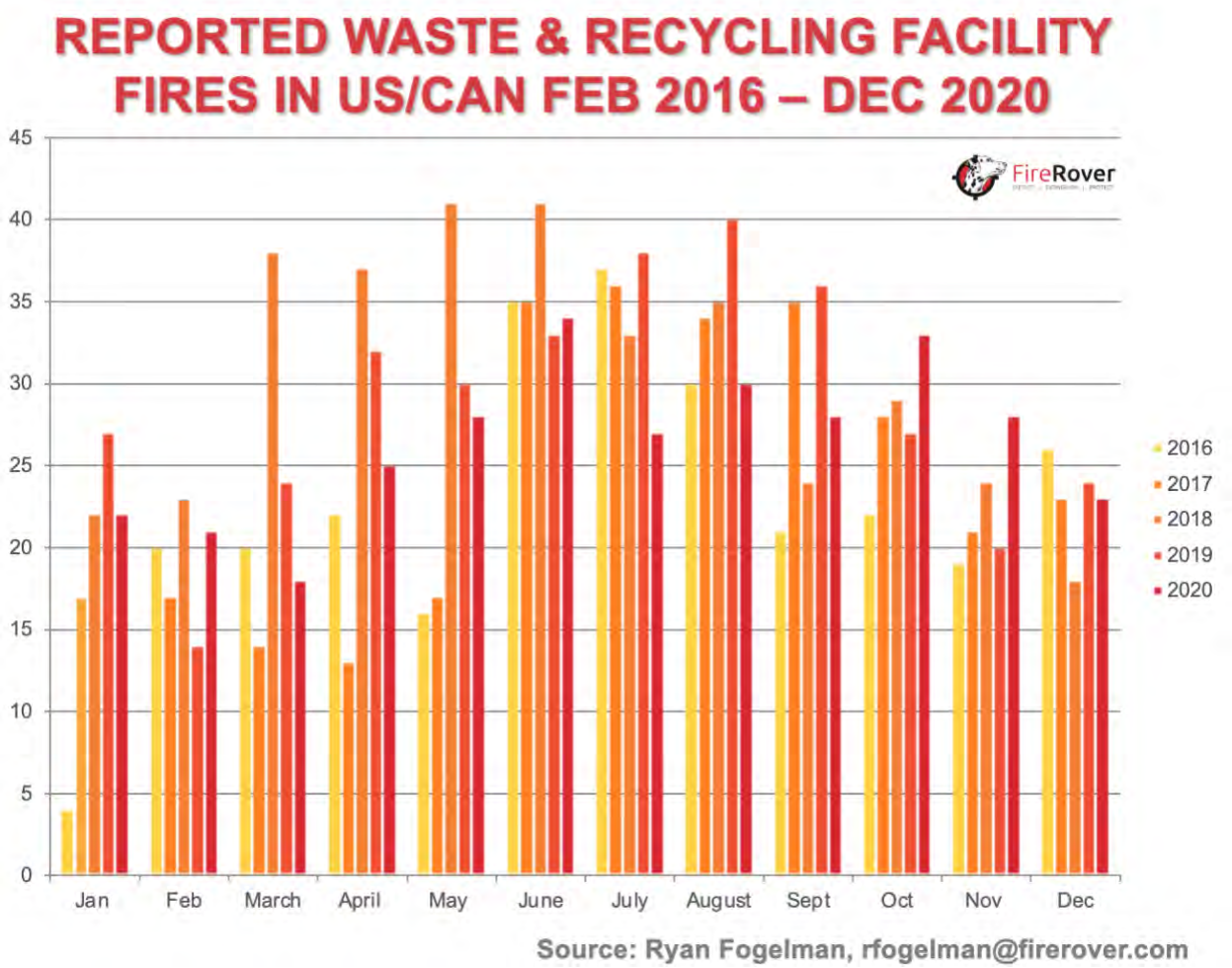
4th ANNUAL REPORTED WASTE & RECYCLING FACILITY FIRES US/CAN



2020 REPORT

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Prepared By:
Ryan "The Li-ion Tamer" Fogelman, JD/MBA
Fire Rover, LLC
rfogelman@firerover.com
614-327-3744

Executive Summary

I am sure you are sick of hearing that 2020 was a year like we have never experienced in human history. The global pandemic has forced “change” across the globe that has affected all aspects of our lives including waste and recycling. I could spend the entire report focused on the aberrations we experienced in the industry from a fire perspective in the past year. March saw a drop of incidents, and then we experienced a gradual increase each month until July, where we had the lowest level of fire incidents since 2016 during the traditional summertime spike. We also experienced two of the highest months for fires—October and November—that were likely due to the increase in residential tonnage versus commercial tonnage.

Instead of focusing on what was different in 2020, I want to take a more strategic view and focus on the trends we have seen since 2016. This report will highlight our collective experience in the waste and recycling industry, as well as our approaches to solving these problems. Additionally, it will outline what has worked, what hasn’t worked and how we are going to move forward.

When I was first introduced to the industry, fires were our dirty little secret. We had been having fire incidents since the beginning of time, but as an industry, the lithium-ion (Li-ion) battery wave really threw us for a loop. I saw the writing on the wall in 2016 and 2017, but in 2018, we experienced the crash of lithium-ion batteries in waste streams across the globe, from Japan, Austria, Sweden France, Germany, UK, Australia, Canada, and the U.S.

To say we were caught off guard is an understatement. Experts in disaster response typically prepare for the worst incident's society has experienced in our history. But we cannot look backward. We are seeing a transformation in how we as a society engage and interact with power. Just as the internal combustion engine drove our industrial revolution, lithium-ion battery technology is forcing us to reimagine how we can improve our lives by having power at our fingertips.

With this power evolution comes dangers, specifically to our industry, that are in the form of fires. And most of the dangers are unfairly falling on the waste and recycling operators, the local fire authorities and the public who have to deal with the issue without the help of government or, most importantly, the manufacturers that are making profits hand over fist as they continue to feed the beast driven by our never-ending appetite for cordless power.

In a recently published Austrian study called "Lithium-Ion Batteries as Ignition Sources in Waste Treatment Processes—A Semi-Quantitate Risk Analysis and Assessment of Battery-Caused Waste Fires," (See: https://www.mdpi.com/2227-9717/9/1/49) the research team developed the following table that separated the process activity by the possible threats and subsequent risk assessment. It is clear that the most fire incidents occur within the collection vehicles, on the tipping floors, during consolidating and processing and once in finished product storage.

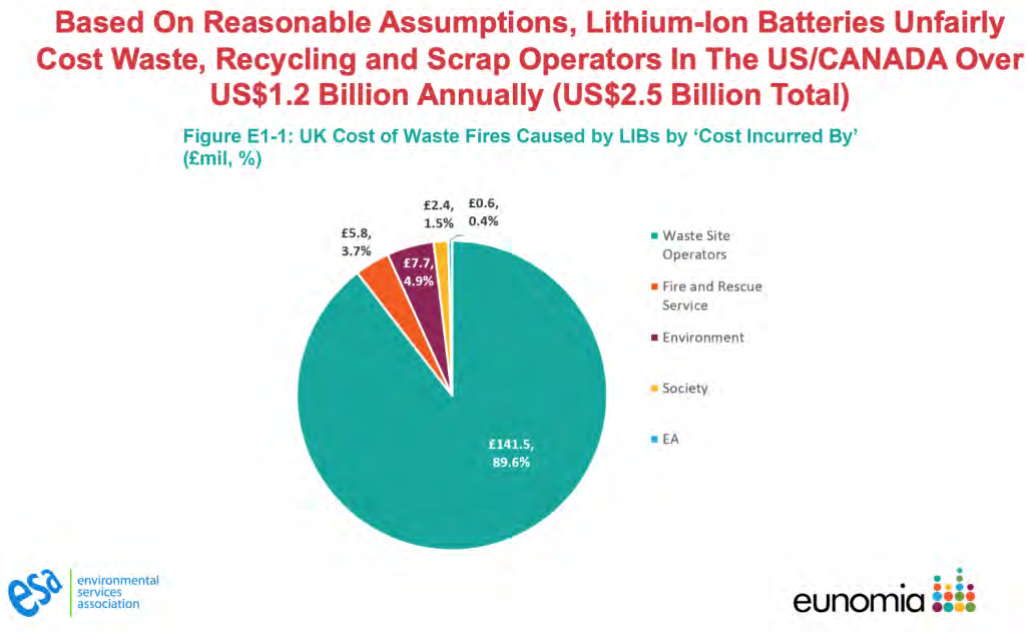
Table 5. Qualitative risk assessment of possible hazards and threats of portable batteries (waste stream: residual household waste).

Facility Area/Process	Possible Hazards and Threats	Risk Assessment
Collection bins	Damage due to external short-circuit	low
Loading activity	Damage due to external short-circuit	low
Collection vehicle	Mechanical damage due to compaction	medium
Unloading activity	Mechanical damage due to tip-off	low
Waste bunker/input storage	Damage due to external short-circuit Damage due to external heating (self-heating of waste)	medium–high
Waste transfer activity	Mechanical damage due to (wheel) loader or gripper	medium
Treatment facility	Mechanical damage due to pre-shredding process Mechanical damage due to post-shredding process Dangerous heat generation after damage Carry-over through the processing facility	high–very high
Output storage	Damage due to external short-circuit Damage due to external heating (self-heating of waste) Dangerous heat generation after damage	low–medium

The study concluded that “the risk of lithium-based portable batteries is significantly too high, which makes it difficult to maintain modern waste management in a sustainable way. Primarily, municipal solid waste treatment plants are at increased risk. The probability that treatment plants burn to the ground is far too high, according to the available assessment. The increased number of major fires in waste management in recent years is clear and undeniable evidence.”

Another risk of lithium-ion batteries fires that is known, but not fully understood is the dangers of fluoride gases releases during thermal runaway. In a 2018 study completed by Larsson, F., Andersson, P., Blomqvist, P. *et al.* called "Toxic fluoride gas emissions from lithium-ion battery fires", they found that "Significant amounts of HF, ranging between 20 and 200 mg/Wh of nominal battery energy capacity, were detected from the burning Li-ion batteries. The measured HF levels, verified using two independent measurement methods, indicate that HF can pose a serious toxic threat, especially for large Li-ion batteries and in confined environments. The amounts of HF released from burning Li-ion batteries are presented as mg/Wh." These dangers to fire professionals, fire brigades, and any employee fighting the fire reinforces the need for remote firefighting capabilities or proper firefighting equipment for those folks on the front lines protecting our facilities.

The manufacturers are spending a ton on lobbying governments based on their overall safety record (outside of the EOL and waste and recycling hazards) as well as providing funding for associations like Call2Recycle that focus on educating the public about the proper disposal of batteries. Although it is great to provide more recycling centers and do all we can to drive proper lithium-ion battery disposal, the producers stand silent on the most important issue: the cost batteries have on our waste and recycling stream.

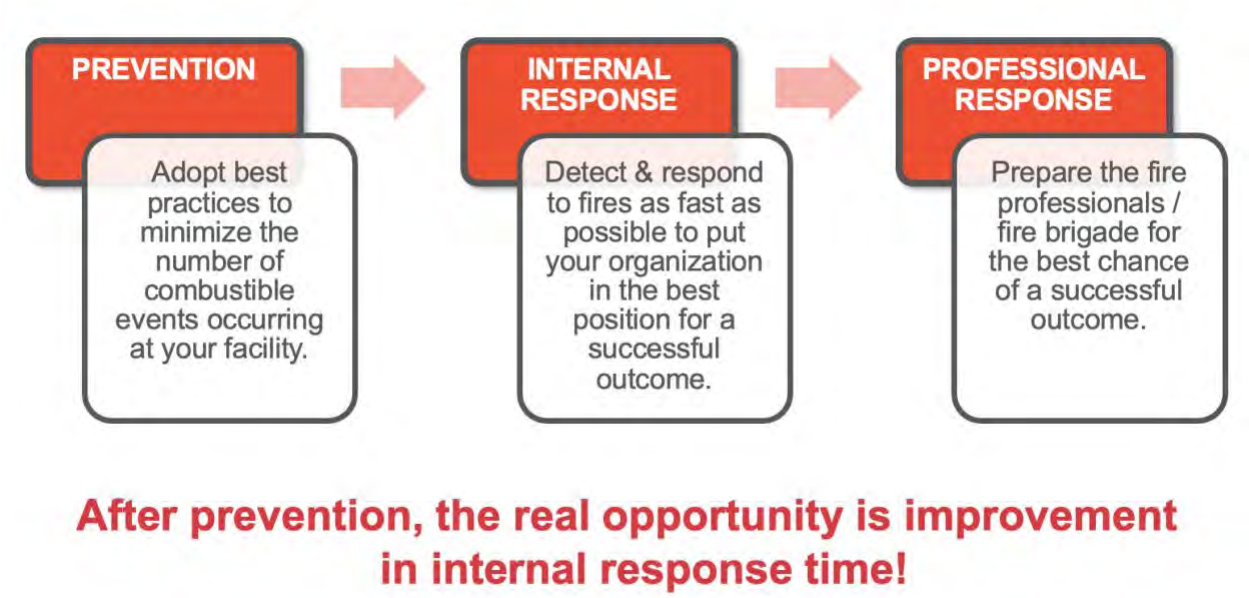


Putting a cost to this in years past has been difficult, but a study completed by Eunomia Research & Consulting for the UK estimated the cost of a fire based on the severity of an incident. Eunomia has estimated the cost of lithium-ion battery fires in the UK to be about 150 million-plus British pounds. If I use my same population assumption for the number of fire incidents, we are looking at the cost of lithium-ion battery fires in the U.S. and Canada to be a staggering US$1.2 billion annually. Add that to the cost of the traditional fire hazards we already are facing and the number doubles to US$2.4 billion annually.

That cost is overwhelming, and it's unfortunately being borne by our waste and recycling operators, society in general, our environment and the brave fire professionals forced to fight most of these events. I would love to be proven wrong, but I believe that I can safely say that none of this cost is being borne by the manufactures of this technology. The nominal investment they make in non-profits that teach proper recycling might be working, but more needs to be done to keep up with the increasing supply of lithium-ion batteries to come.

In addition to the burden of high costs, waste and recycling operators are faced with another challenge: insurers leaving the occupancy at a fast pace. This issue was brought to my attention a few years ago, and it's pretty clear that the waste and recycling operator bucket of costs, which makes up the majority of Eunomia's number, is mostly insurance companies. Insurance companies have been writing high risk hazards for years, but only, and I stress only, when the industry understands and controls that risk.

To bring more awareness to this issue, I wrote an article in *Waste360* in August titled, "August 2020 Fire Report: Hey, Insurance Companies! Not So Fast!" In this article, I sat down with Ryan Butler from Cottingham & Butler who explained that wholistically insurance companies are becoming more averse to their risk profiles. One thing he said really stuck with me: "Too often operators, insurance brokers and consultants in the sector view insurance coverage as the first line of defense." In reality, your insurance policy is the last line of defense. Today, it falls 100 percent on the operators to ensure they don't have fires. Let me rephrase that: It is not about the number of fire incidents we have but the severity of the fire incidents we experience! That being said, it's important to have proper policies and practices in place to deal with fires when they do occur.



Prevention. The most important part of fire prevention is to develop a plan of attack. Prevention is the basic blocking and tackling and should include all components of minimizing the potential number of events that can occur at your facility. In Appendix F, you will find a proven approach to safely fighting a waste and recycling operation fire. The approach was developed by me and Jim Emerson of Star Risk Technologies and has been published in *International Fire Protection Magazine* and a number of other education and learning outlets.

Across the pond, the Waste Industry Safety and Health Forum (WISH) aimed for a fire to be extinguished with traditional fire and prevention practices in a four-hour time period.

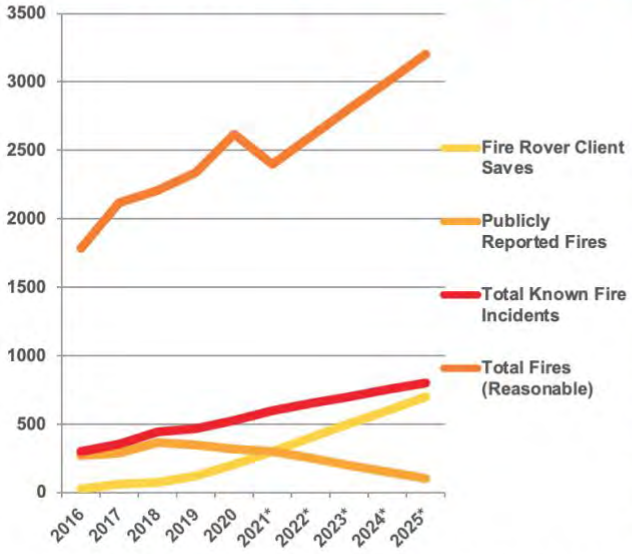
It is worth noting that WISH didn't mention a thermal detection in its guidance, but it did provide the following tip:

> Tip – thermographic cameras are becoming more economic to purchase and are also becoming more common in use on waste management sites. Such cameras can be used as part of routine inspections to identify electrical faults, over-heating equipment and other potential ignition sources. They can also be used during fire watches after hot works.

The Institute of Scrap Recycling Industries (ISRI) penned a guidance document on how to prepare a fire prevention plan, fight incipient stage fires and be prepared in the event of a crisis management scenario. ISRI did not mention early detection or solutions like our Fire Rover, a comprehensive firefighting solution that combats incipient fires and explosions within seconds from ignition, but these "best practice" documents and training materials are critical to ensure that we as an industry are seen by insurers and first-class operators.

Internal Response. This is key and where the opportunity for improvement in our fire responses is the greatest. I typically tell folks that early detection is the key to catching and mitigating a fire early. The goal is not just to catch a fire when there are flames but to understand that there are situations where hot spots can be cooled before they flame. The goal is to set the trip wire as early in the process as possible. This can be done through top-grade thermal detection in combination with smoke and other analytics and, most importantly, a highly trained agent who is able to weed through false positives in an effort to fight only the incidents that need fighting.

WASTE & RECYCLING FACILITY FIRES US/CANADA ACTUAL & FUTURE TRENDS



Source: Ryan Fogelman, rfogelman@firerover.com

Year (*Est)	Fire Rover Client Saves	Publicly Reported Fires	Total Known Fire Incidents	Total Fires (Reasonable)
2016	25	272	297	1782
2017	63	290	353	2118
2018	76	365	441	2205
2019	123	345	468	2340
2020	207	317	524	2620
2021*	300	300	600	2400
2022*	400	250	650	2600
2023*	500	200	700	2800
2024*	600	150	750	3000
2025*	700	100	800	3200

Our Fire Rover solution eliminated 207 fires in 2020 at high hazard areas we protect. We are making a dent in the number of fire incidents that are controlled and mitigated at waste and recycling operations in the U.S. and Canada. If we use Eunomia's estimates for the cost and severity of fires, we could have decreased costs from $30,000,000 to $248,000,000 in 2020 for our U.S. and Canadian clients, fire professionals, society and the environment.

Again, It's All About The Severity Of The Fire!

Table 2-4: Cost per Fire, by Severity Category

Fire Severity Category		Estimated Cost per Fire (£)
Most severe	1	£3,840,721
↕	2	£1,836,470
↕	3	£872,023
Least severe	4	£90,656

Almost 99% of fire incidents in the UK occur from the non catastrophic fires that take 4 hours or more to control the fire incident.

Table 2-5: UK Cost of Waste Fires Caused by Li-ion Batteries

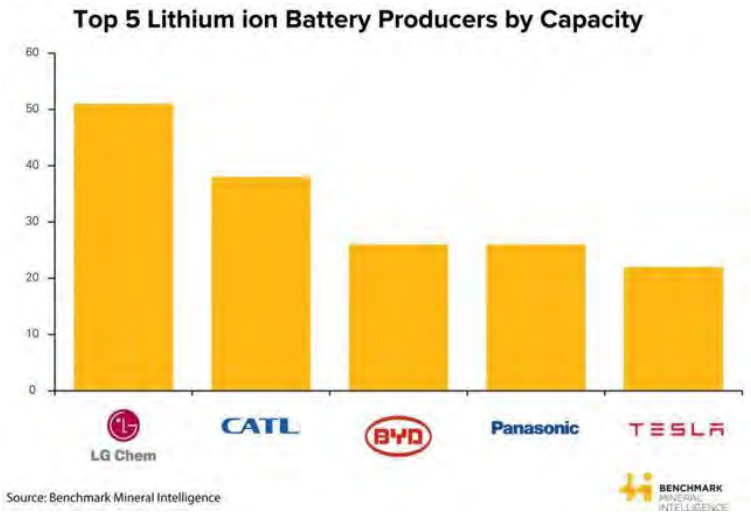
Fire Severity Category	% of Total Fires	Estimated Cost per Fire (£mil)	Annual number of waste fires attributed to Li-ion batteries	Estimated Annual Cost (£mil)
1	0.8%	£3.8	1.7	£6.6
2	5%	£1.8	10.4	£19.0
3	73%	£0.9	147.5	£128.6
4	21%	£0.1	41.8	£3.8
Total				£158

esa environmental services association

eunomia

Our solution of best practices and investments in technology is working. How do we know this is the case? Insurance companies have noticed. In 2018, insurance companies couldn't leave our occupancy fast enough. Since that time, we have been gradually gaining options for the best operators. I have personally fought and won favorable outcomes by proving that **our customers that have developed operational best practices, in combination with having our early thermal detection and fire elimination solution in place, have less fire risk than any point in history, which includes the time before the lithium-ion battery wave even began.**

Yes, there is a hard cost to installing and maintaining a Fire Rover system in your operations, as there is with most safety investments, but to more and more insurers, it is a cost of mitigating risk to make it more palatable to underwrite. The bigger question is who should pay for these types of investments?

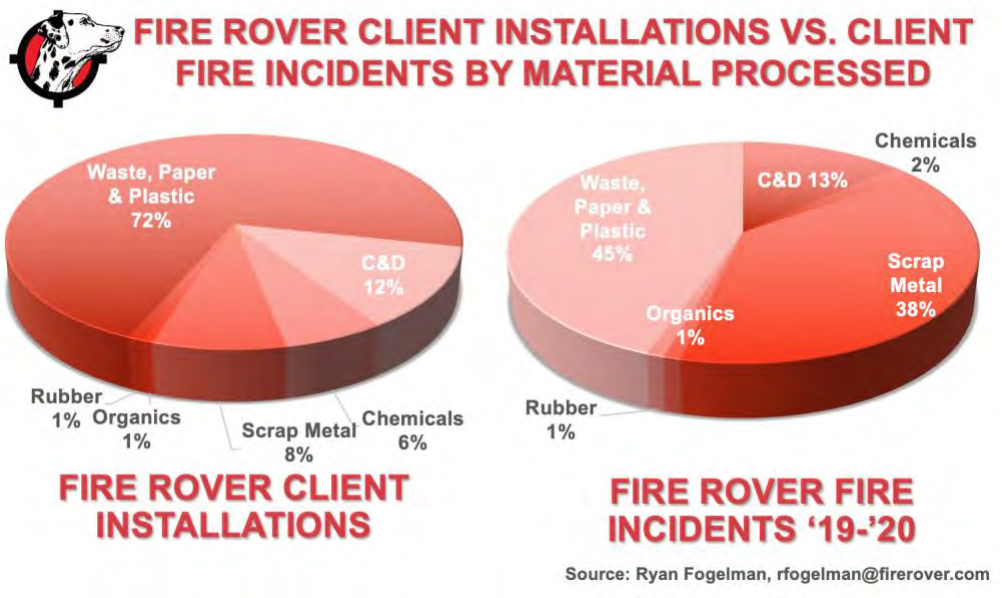


There are five main lithium-ion battery operators in the world (listed above). They are manufacturing a product that we need and that has many positive effects on our lives and society, so I don't view these companies as evil villains that are trying to deliberately cause harm to the public. It is simply about the allocation of risk, and it is typically our government's job to help distribute that risk fairly among all of the players in a product's supply chain.

Currently, our waste and recycling operators are unfairly bearing the brunt of that risk. I believe a good case can be made that the government needs to step in with grants, loans and policies that help educate the public on how to properly recycle their batteries. Additionally, investments in the form of grants, low interest loans, beneficial tax incentives, etc., need to be made in technology to ensure safety on the frontlines.

Professional Response. The other extremely important part of the internal response is to prepare the professional response. Investing in having the proper equipment for the fire department onsite can be a huge timesaver. Even going as far as attached and rollout hoses so the firefighters can immediately start applying suppressant to the affected area can make a huge difference. Most importantly, having an active relationship with your local fire department is imperative.

All of these efforts can help prevent fires, but after six years of putting our patented Fire Rover solution to use in the industry, I can confidentially say that our solution can and is the only solution on the market today that can lower the risk profile of a good operator to levels seen before the lithium-ion hazards hit our industry.



As we look at the results from our approach, the Fire Rover has protected transfer stations, materials recovery facilities (MRFs), construction and demolition (C&D) operations and others. Additionally, clients that have installed our solution in their high hazard areas have been able to secure better rates with insurance companies.

As we continue to share this positive news with insurers across the globe, we are being asked to bring our solution to other countries. Our focus remains on protecting our clients in the U.S. and Canadian industry and getting us back to a healthy insurance level so we can focus on what is most important: keeping our cities clean and sanitary and reusing our materials to lessen the amount going to landfills.

Getting the Numbers the Waste and Recycling Industry Needs

When I started working for Fire Rover in 2015, I noticed a massive void in the waste and recycling industry: fire incident data. I searched high and low for data on fire incidents at waste and recycling facilities across the U.S. and Canada. I browsed online sources such as Statista and spoke with facility owners and operators, safety and insurance personnel and investors—all without success.

I knew this data was much needed, and I became determined to uncover and share this data, not only to provide the industry with important information but to prove that Fire Rover is a fire suppression system as well as a business continuity solution.

By 2016, I had gathered enough data to begin producing a report called "Reported Waste & Recycling Facility Fires In The US & CAN," which is now published monthly in *Waste360*. The report provides updated data each month for the U.S. and Canada; the 1,800-plus actual facility fire number that I use for this data is based on the assumptions from the data that the U.K. Environment Agency (EA) collected in the table below.

CFOA Reported Fires 2001-2014

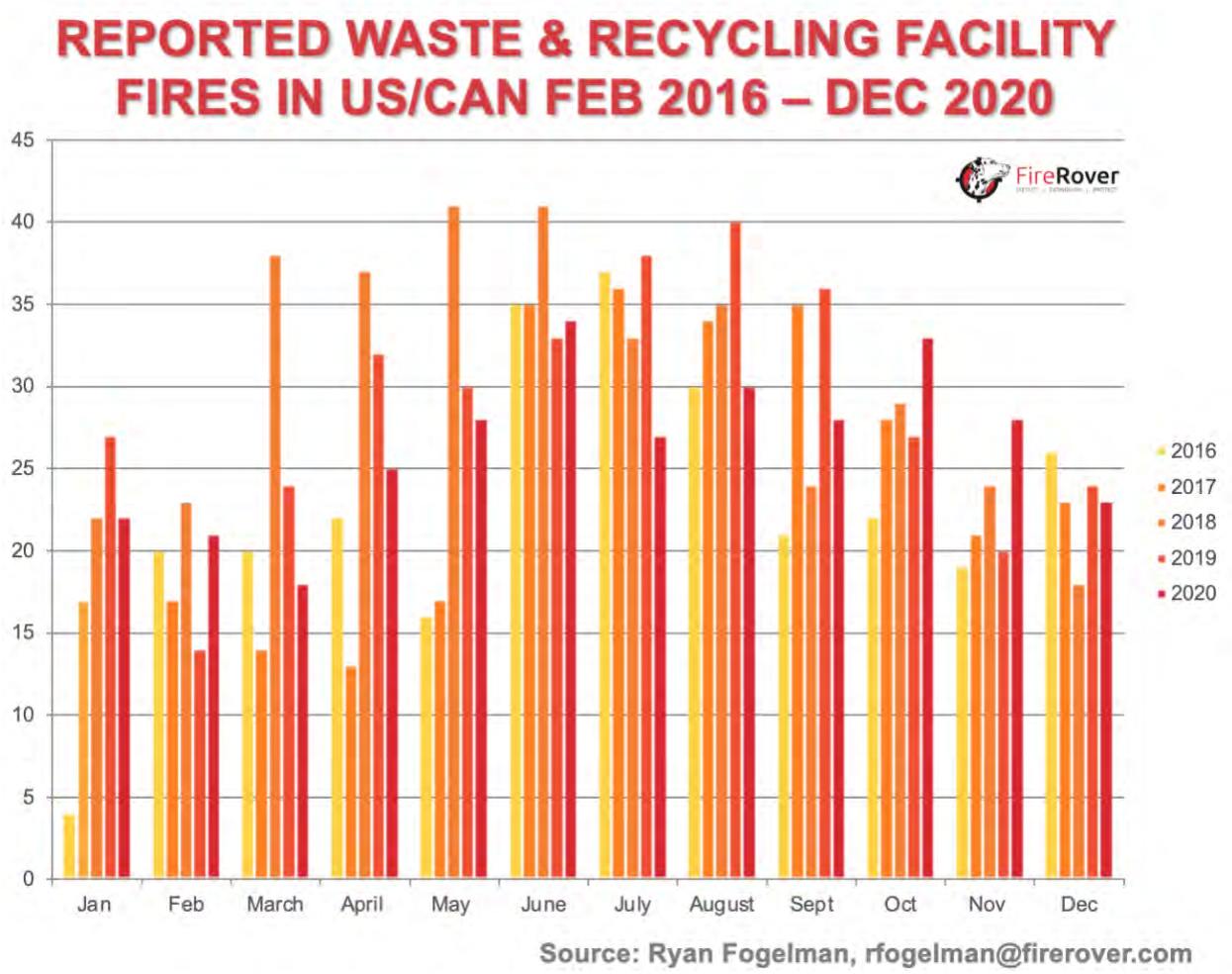
The latest statistics, from the Environment Agency, show the incidence of Waste Fires from 2001 to 2013.

Year	Regulated[1] Sites	Unregulated[2] Sites	Total fires
2001	154	92	246
2002	203	140	343
2003	288	110	398
2004	254	83	337
2005	239	107	346
2006	284	95	379
2007	236	54	290
2008	227	48	275
2009	282	55	337
2010	286	59	345
2011	348	77	425
2012	247	55	302
2013	248	50	298

Data is for all categories of incident recorded.

1. Regulated – where a permitting regime specific to the source has been identified, eg waste operations and waste installations.
2. Unregulated – where no permitting regime specific to the source had been identified.

The monthly reports help us identify trends and where we need to make improvements to operate more safely and efficiently. To get a taste of what my data looks like, see the chart below that features the latest data from February 2016 to December 2020:



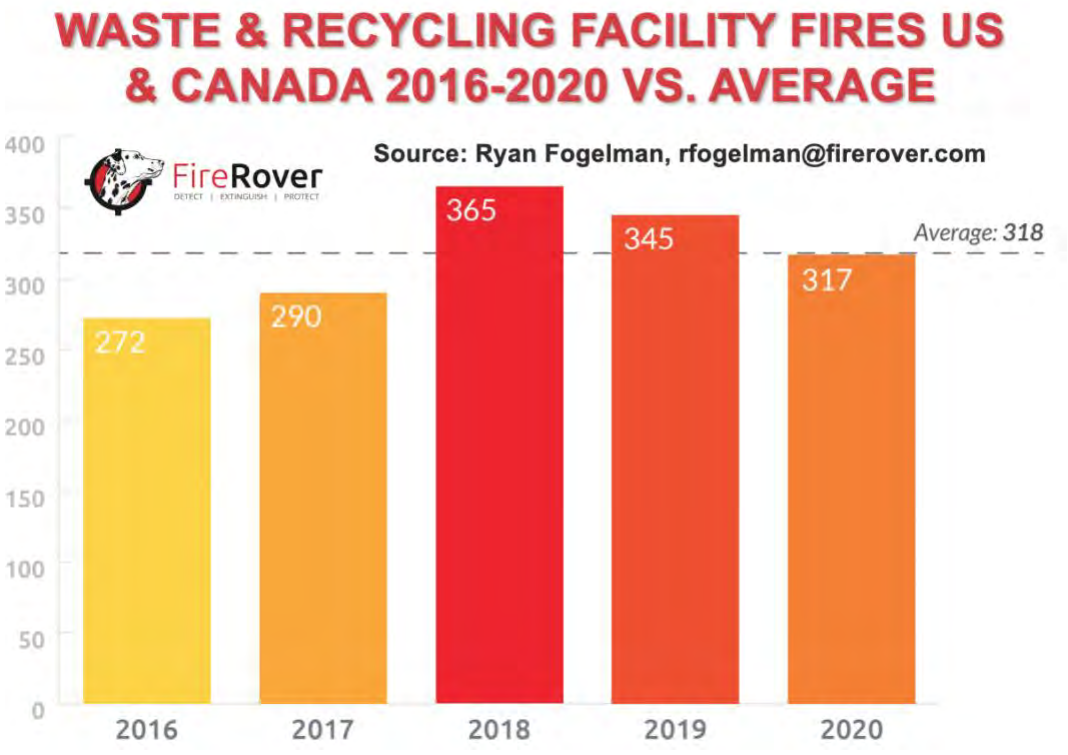
Tracking Reported Fires in the U.S. and Canada

Over the years, I've been able to collect important data on reported facility fires. I define "reported facility fires" as any fire that has been reported by the media that occurs at a waste or recycling facility in the U.S. and Canada. Typically, the fires that are reported

by the media are larger fires that require fire professionals to arrive on scene and where there are affects that the public can witness.

Some industry professionals suggest that the majority of fires related to waste and recycling are not reported. Others disagree. One thing the industry can agree on, however, is that any fire is one too many.

According to my research, **in 2020, waste and recycling facilities in the U.S. and Canada experienced 317 fires, three deaths and 23 direct and indirect injuries.** These fires ranged from small incidents to complete burnouts and occurred in all types of operations including those for metals, rubber, paper, C&D material, plastics, waste, compost, hazardous materials, chemicals and fuels.



Based on my research, information made available in published news stories and other published reports, I believe we can assume that the number of non-reported fires that occur at waste and recycling operations across the U.S. and Canada is significantly higher.

In a 2016 report entitled "Municipal Solid Waste Management in the U.S.: 2010 & 2013," for example, the Environmental Research & Education Foundation (EREF) suggested that in 2013, there were 3,913 recycling facilities and 81 waste-to-energy facilities. This means more than 40 percent of facilities across the country experienced a fire incident in the 12 months previous.

More recently, in 2018, the California Products Stewardship Council (CPSC) released survey results from 26 waste facilities located in California. According to the results, 83 percent of the surveyed facilities experienced a fire in the two years previous.

Based on reports such as these, I believe the number of waste and recycling facility fires that occurred in 2020 in the U.S. and Canada is more than 2,620. **That's almost seven times the reported number of 317, which includes the Fire Rover reported client incidents.**

A Global Problem

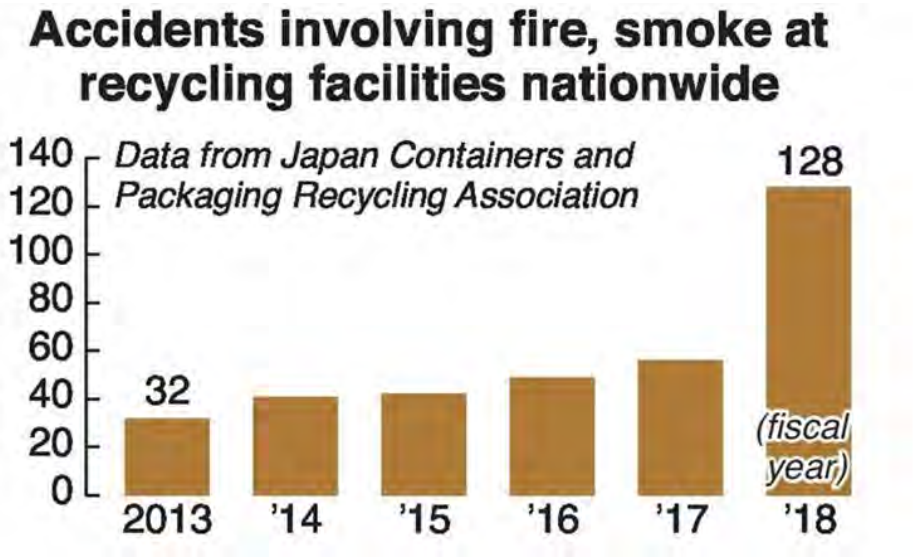
While my research focuses on data from facilities within the U.S. and Canada, fires at waste and recycling facilities and in industry vehicles is a global problem.

In the UK, for example, the waste industry faces an estimated 201 waste fires caused by lithium-ion batteries each year, according to a 2021 report entitled "Cutting Lithium-ion Battery Fires in the Waste Industry" published by Eunomia and the Environmental Services Association (ESA).

According to the report, of the 670 fires recorded by ESA waste management members across the UK in 2019-2020, 38 percent were either recorded as caused by Li-ion batteries or “suspected” to have been. This is higher than the percentages recorded in the previous three years by the body (21 percent in 2016-2017, 25 percent in 2017-2018 and 22 percent in 2018-2019).

It’s not that surprising, however, since Veolia UK stated in 2020 that the average UK resident throws away around 24.5 kilograms of electronics annually, and only 43 percent of the public is aware that lithium-ion batteries can spark fires. Additionally, fires in waste vehicles have increased by 37.5 percent since 2017, which is a major concern because anyone who operates a waste and recycling fleet knows the high price tag that comes along with downtime, repairs, replacement vehicles, etc.

In other areas of the world like Japan, there has been an increase in incidents of smoke or fires, according to an article published by *The Asahi Shimbun* in 2019. The article shares survey results from the Japan Containers and Packaging Recycling Association, which reveals that in fiscal year 2019, recycling facilities for plastic containers reported 230 incidents of smoke or fires. This is up from 128 incidents in 2018 and less than half that number from 2013 to 2017. See the table below, which clearly shows that something has changed in the waste stream—and that “something” is likely lithium-ion batteries based on global trends and data.



Noticing these trends, some countries like Australia are making an effort to help prevent and reduce fire incidents. The Victoria State Government, for example, established the Resource Recovery Facilities Audit Taskforce chaired by the Australian Environmental Protection Agency (EPA) to inspect resource recovery facilities and tackle stockpiles that might pose a fire risk.

By 2017, according to that year's Australian Fire Preparedness Report, about 73 of the 500 recycling centers and tipping floors across Victoria had been inspected. Perhaps not surprisingly, most lacked the planning and resources to deal with a fire event.

"While some operators are considered to be at best practice, the audit program identified that the resource recovery sector is generally poorly prepared and ill-equipped when it comes to managing fire risks at their facilities,'' stated the Australian EPA on its website.

These are just some examples of what's happening around the globe, and to no surprise, we are all challenged with the dangers of fires and working toward fire prevention and reduction.

The Causes

What Is Causing The Fires?

1. **Traditional Fire Hazards:** Unknown hazards of combustibles (i.e., aerosols, butane cans, chemicals, hot ashes, paints, fireworks).
2. **Lithium-ion Batteries**: The issue is not only the shire number of these batteries being manufactured and placed incorrectly in waste and recycling bins, but also the size makes them almost impossible to remove from the processing streams.
3. **Heat/Dry Environments**: We have seen an increase in fires during the summer months, but when we see weather patterns that are dry and hot, we see spikes during other times of the year.
4. **Inherent Risk**: Recycling chemicals and hazardous materials has explosive and combustible risk built in, especially when increased temperature is required as part of the recycling process.
5. **Sparks/Hot Works**: As buildings/equipment age or volumes increase, more work is required to maintain the equipment.
6. **Arson:** Competitive and desperate operators.

Lithium-ion Batteries

Storing large amounts of energy, whether it's in larger rechargeable batteries or smaller disposable batteries, can be inherently dangerous. When the two electrodes come in contact with one another, the battery can short circuit, leading to a chemical chain reaction known as thermal runaway.

During thermal runaway, temperatures can climb to more than 1,000 degrees Fahrenheit, which creates intense pressure that causes the flammable liquid electrolyte to combust. Contrary to what the media coverage implies, lithium-ion batteries do not typically just explode for no reason. The causes of lithium battery failure can include puncture, overcharge, overheating, short circuit, internal cell failure and manufacturing deficiencies.

In a report developed by Consolidated Edison (Source: *Report No.: OAPUS301WIKO(PP151894), Rev. 4, February 9, 2017),* there was a great question that outlines the true risks dispelling the media's approach of overhype to these incidents:

> **Question: Are the commonly cited battery fires in the media due to spontaneous ignition events?** Finding: No. The Literature Review (an addendum to this report) covers several incidents in detail. In the context of fire risk and firefighting for batteries, it is helpful to summarize the abuse tests that are performed in United Nations (UN) 38.3, the required testing scope in order to ship and transport Li-ion batteries. The eight separate tests in UN 38.3 are a checklist of nearly all physically conceivable abuses that could cause a Li-ion battery to catch fire. **These abuse events are: 1. Low ambient pressure 2. Overheating 3. Vibration 4. Shock 5. External short circuit 6. Impact 7. Overcharge 8. Forced discharge**
>
> All of the safety incidents commonly reported in the general media can be traced to one of these abuse mechanisms. **In some cases, contaminants in the battery (as a result of manufacturing defects) weaken the ability of the battery to withstand instances of these eight abuse factors.** In general, it is good practice to avoid any scenario that may introduce the threat of any action on the above list.

In the waste and recycling industry, we are tough on our trash. Try telling those in our industry to "avoid any scenario that may introduce the threat of action in the above list." This is an impossible task. Yes, we can do all we can to educate the public on proper disposal of lithium-ion batteries, but we would be naïve to assume that this is not a hazard we are going to continue to face for the foreseeable future. Specific risks that I have seen in our clients' fire incidents include loaders driving over batteries; shredders mincing batteries; batteries exploding on tip floors; and deep-seated fires that started from one of the traditional risks of charcoal, fireworks, fertilizers and other materials that start the reaction near a battery.

Example pictures for damage classes of portable batteries:

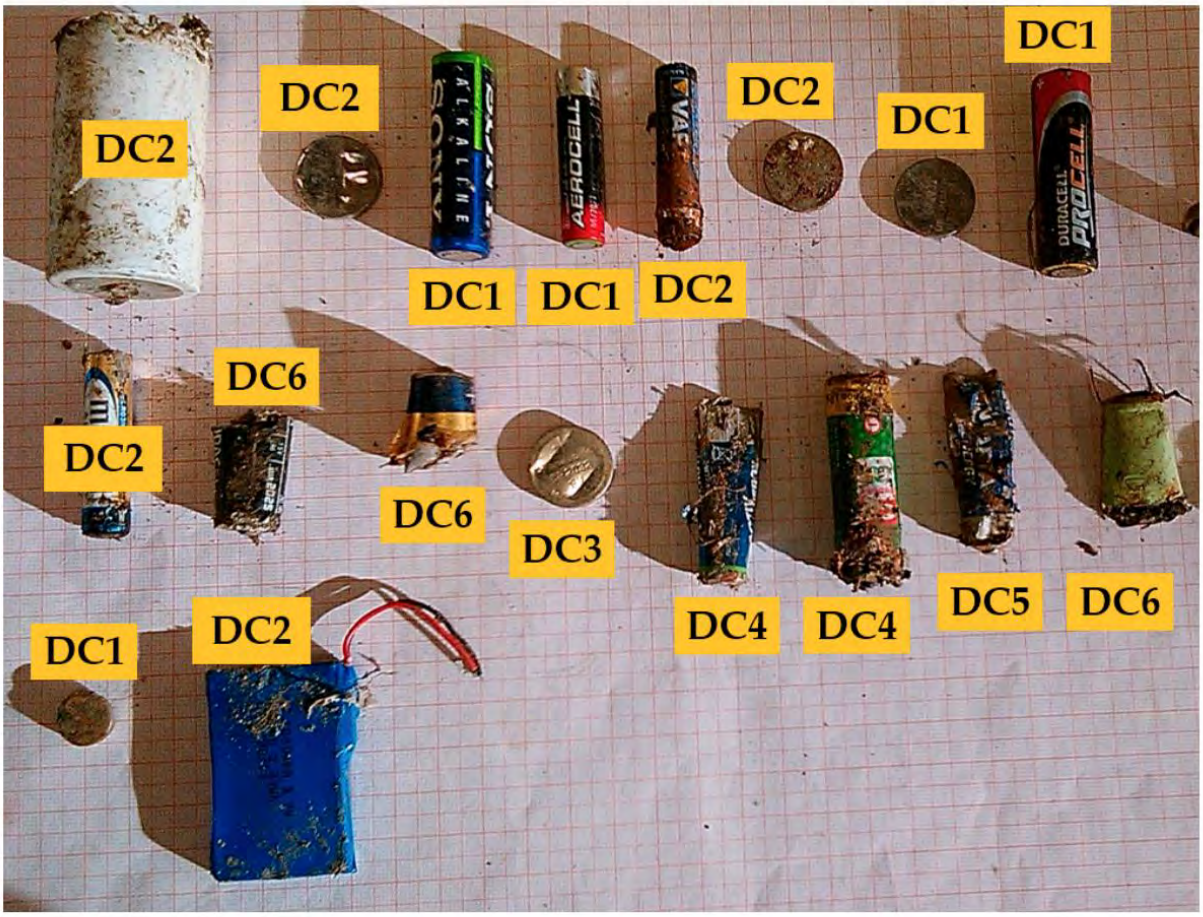


Figure S1. Damage classes of end-of-life portable batteries (after sampling campaign).

In a recently published Austrian study called “Lithium-Ion Batteries as Ignition Sources in Waste Treatment Processes—A Semi-Quantitate Risk Analysis and Assessment of Battery-Caused Waste Fires,” (See: https://www.mdpi.com/2227-9717/9/1/49) the research team developed the following table that separated the processing activity by the possible threats and subsequent risk assessment. It is clear that the most lithium-ion fire incidents occur within the collection vehicles, on the tipping floors, during consolidating and processing and once in finished product storage.

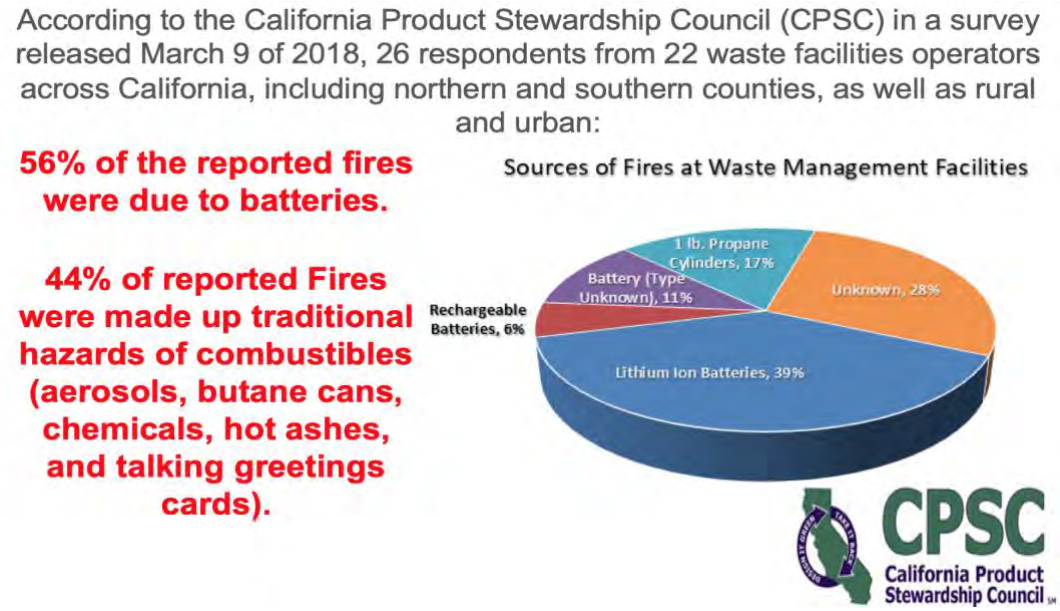
Table 5. Qualitative risk assessment of possible hazards and threats of portable batteries (waste stream: residual household waste).

Facility Area/Process	Possible Hazards and Threats	Risk Assessment
Collection bins	Damage due to external short-circuit	low
Loading activity	Damage due to external short-circuit	low
Collection vehicle	Mechanical damage due to compaction	medium
Unloading activity	Mechanical damage due to tip-off	low
Waste bunker/input storage	Damage due to external short-circuit Damage due to external heating (self-heating of waste)	medium–high
Waste transfer activity	Mechanical damage due to (wheel) loader or gripper	medium
Treatment facility	Mechanical damage due to pre-shredding process Mechanical damage due to post-shredding process Dangerous heat generation after damage Carry-over through the processing facility	high–very high
Output storage	Damage due to external short-circuit Damage due to external heating (self-heating of waste) Dangerous heat generation after damage	low–medium

The same study concludes that:

> No other substance or material has ever comparably endangered the whole waste industry. Hence, besides research and development activities for investigating and under-standing the hazards and risks of lithium-base portable batteries, **increased technological development and innovation efforts** are indispensable for reducing the risk potential of end-of-life portable batteries.
>
> In order to reduce risk, the waste sector has to aim to collect as many batteries as possible in the separate collection systems and take-back schemes, as only this collection system guarantees a damage-free return system. That requires increased effort in public relation and consumer awareness-raising. However, a 100% separate collection rate for portable batteries is highly unrealistic without a comprehensive deposit system. Hence, operators of treatment facilities have to find ways to … protect critical infrastructure and treatment processes (e.g., including new detection and extinguishing methods) or … detecting and separating portable batteries in the course of their treatment processes.

For many years, I've forecasted fire danger will rise because of the increased volumes of lithium-ion batteries in our waste stream. And in 2018, my prediction was realized. That year, the CPSC released a survey indicating that 65 percent of the reported fires in California were due to batteries.



In 2019, there was an explosion at the APS McMicken Energy Storage facility in Surprise, Ariz., where a number of fire professionals responding to the scene sustained chemical and chemical-inhalation burns. The facility housed utility-sized batteries used in the storage and distribution of solar energy. Although this incident did not occur in a waste and recycling facility, the implications for first responders in facilities that store and house lithium-ion batteries have been far-reaching.

According to the same report by Consolidated Edison (Source: *Report No.: OAPUS301WIKO(PP151894), Rev. 4, February 9, 2017),* first responders had very similar training when it comes to fighting any fire, including battery fires.

9.7 Project Development Considerations for Interaction with First Responders and AHJs DNV GL surveyed several handbooks for fire

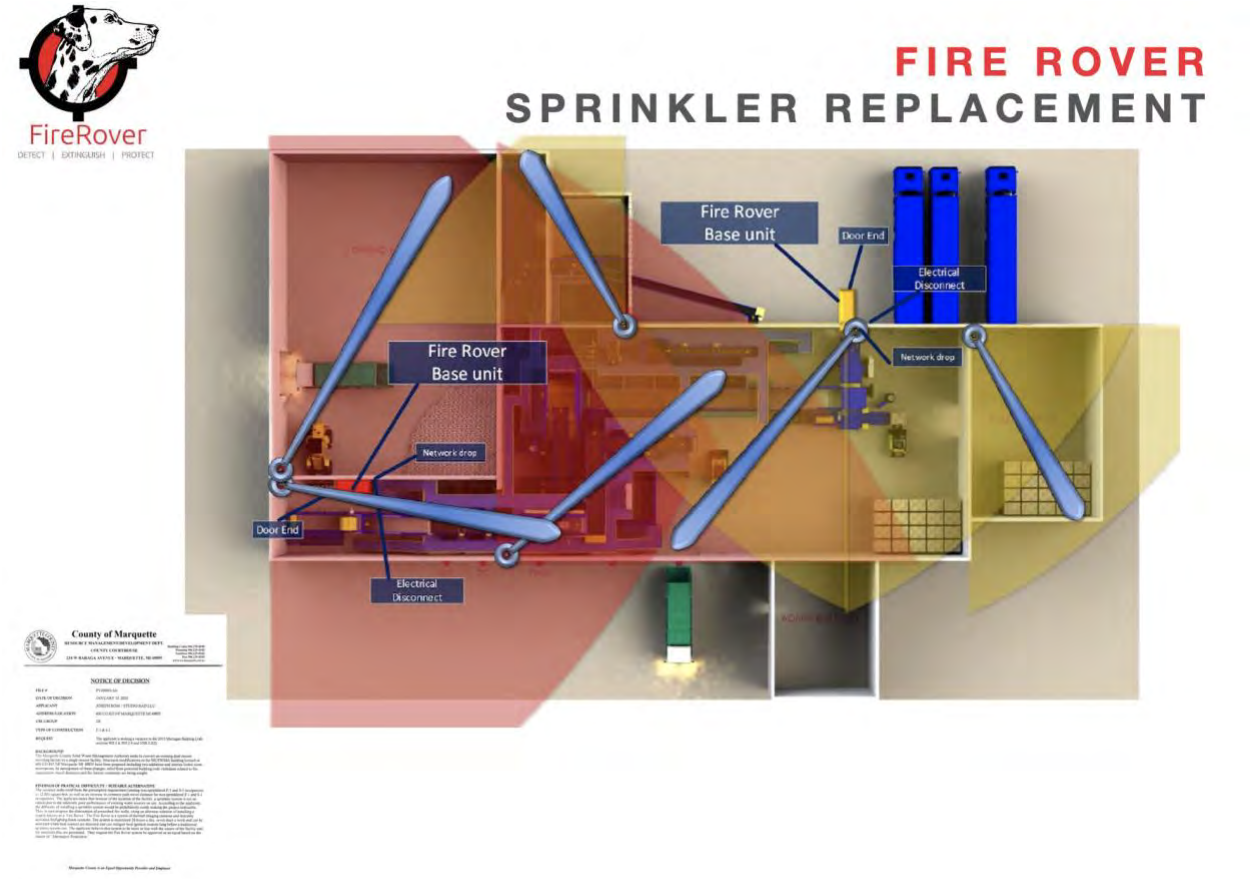
> departments in large cities across the country and found a universal theme in firefighter training concerning extinguishing. **Firefighters are trained to achieve the following objectives when arriving at the scene: Objective 1: Remove endangered person(s) and treat the injured. Objective 2: Stabilize the incident and provide for life safety. Objective 3: Provide for the safety, accountability and welfare of personnel (this priority is ongoing throughout the incident). Objective 4: Protect the environment. Objective 5: Property conservation.** Note that Objective 5 is often the primary concern of the property owner. It is on the priority list of the first responder, but safety of life at the scene takes precedence.

This is a truly important point for those who deal with the lithium-ion battery risk. The first responders are not to come on scene to put their lives at risk in order to save the property. On the contrary, their role is to protect the lives of any employees who are inside the building. If there is no one in the building, the first responders will take a defensive approach to fighting these fires.

There are additional risks of lithium-ion batteries fires that remain known and are not fully understood that include the dangers of fluoride gases releases during thermal runaway. In a 2018 study completed by Larsson, F., Andersson, P., Blomqvist, P. *et al.* called "Toxic fluoride gas emissions from lithium-ion battery fires", they found that "Significant amounts of HF, ranging between 20 and 200 mg/Wh of nominal battery energy capacity, were detected from the burning Li-ion batteries. The measured HF levels, verified using two independent measurement methods, indicate that HF can pose a serious toxic threat, especially for large Li-ion batteries and in confined environments. The amounts of HF released from burning Li-ion batteries are presented as mg/Wh." These dangers to fire professionals, fire brigades, and any employee fighting the fire reinforces the need for remote firefighting capabilities or proper firefighting equipment for those folks on the front lines protecting our facilities.

With this in mind, Fire Rover developed a solution and it is currently protecting lithium-ion battery recycling operations to help fire professionals and property owners get the

best chance at not only protecting their employees but their property as well. Along with our early thermal detection and remotely operated fire suppression, we added a quick connect that allows fire professionals to safely add an additional water supply from outside of the building. This solution has received variances in some jurisdictions as a replacement solution for traditional fire sprinkler equipment.



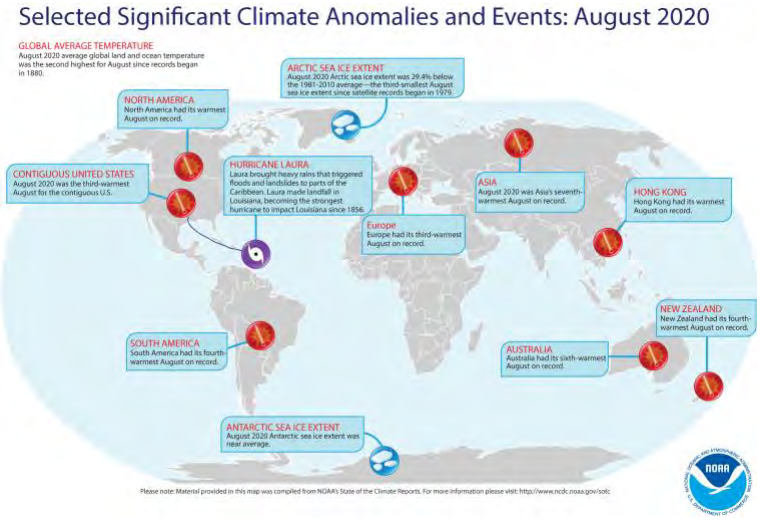
This solution, which received the National Waste & Recycling Association's 2020 Innovator of the Year – Recycling Equipment award, allows for continued remote-operated targeted suppression to the source of the material. Combined with our thermal monitoring, we can continue to apply water until the heat level is safe for professionals to enter the building. **Our solution also protects employees and fire professionals**

from exposure to unknown gases that release from these batteries during an incident. Depending on the risk factors, lithium-ion battery fires do not reignite. “Upon extinguishing, great care must be taken to assure that all electrical, thermal and mechanical abuse factors are neutralized. If any remain, it poses a hazard for continuing (not reigniting) the fire.” (Source: *Report No.: OAPUS301WIKO(PP151894), Rev. 4, February 9, 2017*)

As we look to the future, I believe the problem of batteries is poised to get worse. The fact is that lithium-ion batteries are being cemented as our main power source for portable electronics, cars, storage and more. This is due to their small footprint, power capabilities and relatively safe technology when handled properly. However, we are rough on our waste and recycling materials, which can turn that relatively safe technology into a hazard with serious consequences. We need to continue to educate the public regarding this risk, develop the proper fire planning and increase fire protection infrastructure in order to protect these mission-critical facilities from fire incidents and their harmful effects.

Heat and Dryness

Over the past five years, there has been an increase in fires during the hotter months. According to a climate report published by the National Centers for Environmental Information (NOAA), the 2020 Northern Hemisphere meteorological summer (June through August) was the Northern Hemisphere’s hottest meteorological summer on record, surpassing both 2019 and 2016, which were previously tied for hottest.



Additionally, July 2020 tied with July 2016 for the second-hottest July on record for the globe. The July 2020 global temperature was 62.06 degrees Fahrenheit—1.66 degrees Fahrenheit above the 20th century average. The combined land and ocean surface average temperature for the Northern Hemisphere, the highest ever recorded for July, was an unprecedented 2.12 degrees Fahrenheit above average.

Seasonal Spikes

In previous years, we experienced a seasonal spike of fire incidents during the summer months and the holiday season. This is in large part due to the hazards we see during those times. During the summer months, we have more propane tanks, fireworks, charcoal and other hazards. During the holiday season, we see an increase in the number of lithium-ion batteries in our toys, gadgets and other electronics we receive as gifts. This trend, however, did not completely hold true in 2020.

From a fire incident perspective, 2020 was unique in that we experienced two months with the highest number of reported fire incidents (October and November) and two months with the lowest number of reported fire incidents (July and August). Strangely enough, the spike occurred when we traditionally see lower fire incidents in the back half of the year gearing up for the holiday spike. While the lower fire incident months

occurred in the middle of the summer, which has traditionally been in the heart of the summertime spikes.

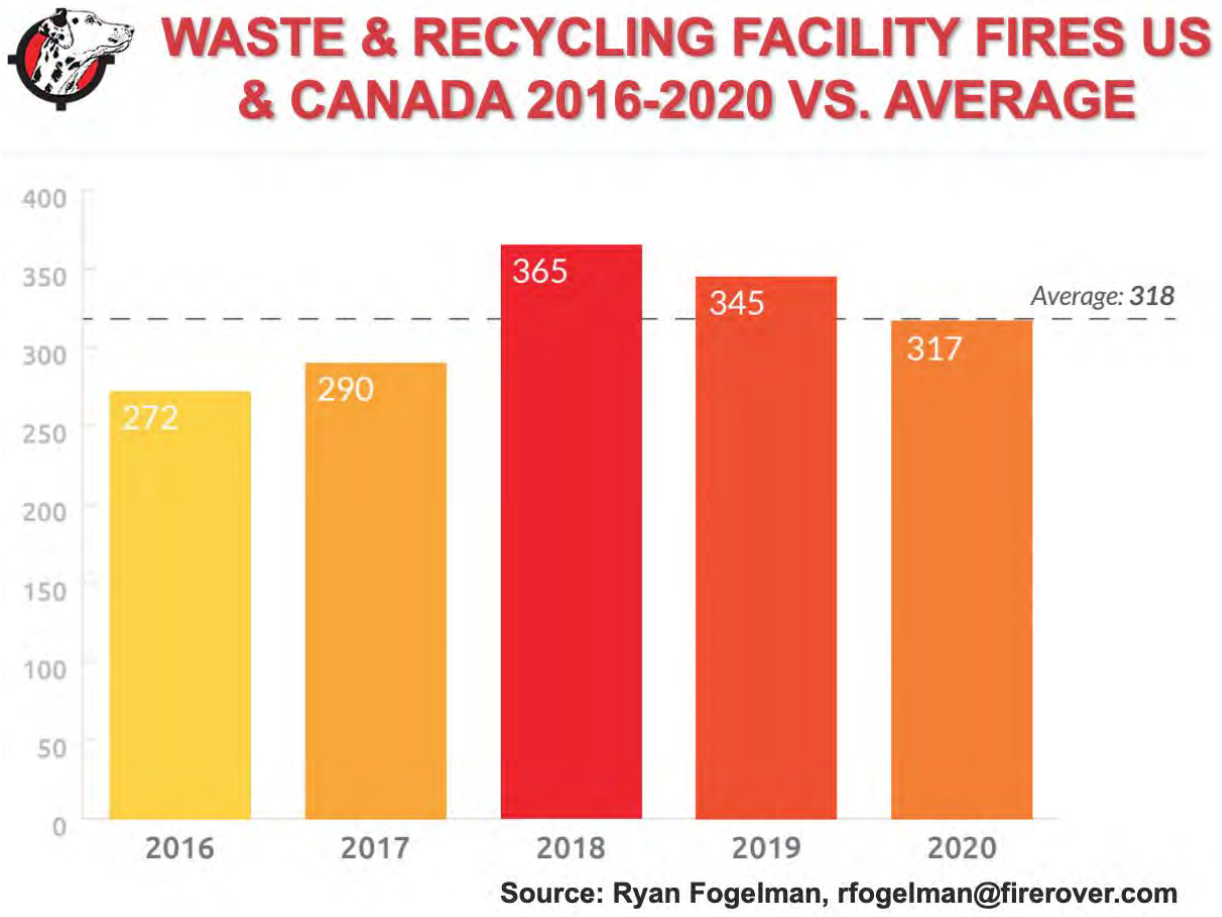
Due to COVID-19, stay-at-home orders and other factors, the summer get-togethers were reduced. This means there were less fireworks, less charcoal used for barbecues, less hazardous materials being disposed of improperly and ultimately less fires—For the month of July, the industry only experienced 27 waste and recycling facility fire incidents.

In September, however, we saw the second-highest number of fires at scrap metal facilities than we have experienced in the past five years I have been tracking the reported fire data. And in October, things took a turn for the worse. We experienced 33 fires at our waste and recycling facilities—the second-highest month of fires at our waste and recycling facilities in 2020.

November and December also saw a surge, with 25 fires and 23 fires, respectively. This upward trend for the second half of the year is mostly in line with previous yearly trends, as the holidays tend to generate more waste and recyclables.

Fire Causation Trends

When I started consolidating the reported waste and recycling facility fires in 2016, I was realistic that the first few years would drive the baseline data defining the scope of the problem, providing us with a basic understanding of the consequences and finding and evaluating the effectiveness of solutions available to address the problem. Now that we have officially completed year five, it is time to take the next step and highlight the trends we've seen over the years.



According to the data, 2020 was an average year. We experienced 317 reported fire incidents in our waste and recycling facilities, which is slightly lower than the average number of 318. So, why does 2020 seem anything but average? In a nutshell, 2020 was atypical. We saw a gradual increase in fire incidents from March to June along with a virtual cliff in July and August where our typical summertime spike did an about-face with the lowest numbers ever. Then in October and November, we experienced the highest rate of fire incidents we had faced since 2016.

In 2020, the waste and recycling industry experienced 317 reported facility fires in the U.S. and Canada. Additionally, we incurred 23 reported injuries and three deaths that

can either be directly or indirectly attributed to these fire incidents. Based on reasonable assumptions, we can extrapolate that 1,800-plus facility fires have occurred during that time, which, based on the number of facilities reported by EREF, is more than 40 percent of the industry.

Evaluation of Fire Incidents Based on Material Type

REPORTED WASTE & RECYCLING FACILITY FIRES BY MATERIAL US/CANADA

Incidents By Type Of Material Processed	2016	2017	2018	2019	2020	Total	Average	% of Total Incidents 2016-2020	2020 % Change v. Average	2020 % Change v. 2019
Waste, Paper & Plastic	146	147	154	177	158	782	156	49%	1%	-12%
Scrap Metal	72	89	145	100	108	514	103	32%	5%	7%
Organics	16	18	31	29	20	114	23	7%	-14%	-45%
Chemicals	12	13	15	10	4	54	11	3%	-170%	-150%
C&D	11	8	11	10	8	48	10	3%	-20%	-25%
Rubber	11	10	6	10	7	44	9	3%	-26%	-43%
E-Scrap	4	5	3	7	12	31	6	2%	48%	42%
Total	272	290	365	343	317	1587	317	100%	0%	-8%

Source: Ryan Fogelman, rfogelman@firerover.com

If you read last year's Annual Report, you know that I was not comfortable with the material "buckets" I had been using in my reporting. Simply put, fires that were occurring at paper and plastic recycling facilities were not properly represented due to media reports and the fact that I had a hard time knowing which materials actually caused a fire. Because of this, I believe it makes sense to include all waste, paper and plastic fire incidents in one bucket. This bucket makes up the MRF and transfer station operations across the U.S. and Canada. The major distinction in the material is that these are traditionally the channels where hazards like lithium-ion batteries, chemicals, gasoline

and propane tanks are improperly placed into the waste and recycling stream. These reported fires are down 12 percent year-over-year.

I had also been placing C&D, scrap metal and e-scrap into another bucket but found that C&D operations have been historically underrepresented by the media as they often share facilities with other recycling operations. After a year of using this bucket, I have concluded to keep scrap metal, e-scrap and C&D separated. While it is true that they all share a similar pattern where their material has risks that can be alleviated on the front end, each of these occupancies has unique aspects that have led me to this decision.

Decrease in Waste, Paper and Plastic Fires: Municipal solid waste (MSW), paper and plastic recycling fires decreased in 2020 but are still in line with the five-year average. This occupancy has been the hardest hit from the wave of lithium-ion batteries that are improperly placed into the waste and recycling stream.

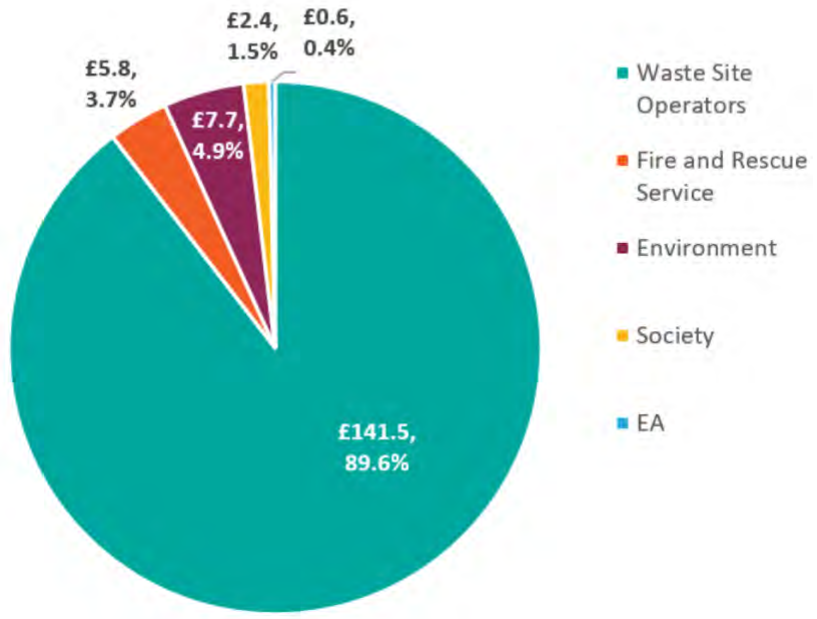
This issue is a global issue and its cost to the industry was recently outlined in a report based on research conducted by Eunomia. According to the report, this problem is only set to get worse, with more and more Li-ion batteries placed onto the market each year. Of the 670 fires recorded by ESA waste management members across the UK in 2019-2020, 38 percent were either recorded as caused by Li-ion batteries or "suspected" to have been. This is higher than the percentages recorded in the previous three years by the body (21 percent in 2016-2017, 25 percent in 2017-2018 and 22 percent in 2018-2019).

The positive news is that those that have focused on safety, proper fire prevention planning and investments in technology solutions have experienced less fires. The survey results by Eunomia outline its recommended best practices for risk reduction to

the industry, such as getting lithium-ion batteries out of the waste stream through education, fines, deposit programs and more, but it does not single out technology innovations like Fire Rover, which has proven to be key to mitigating these risks in the U.S.

The real problem in both the U.K. and the U.S. is that the cost for these fire incidents is unfairly borne by the operators. Producers get off scot free in this equation where they manufacture these batteries, distribute them across the board and leave the operators, fire professionals and society to deal with their problems.

Figure E1-1: UK Cost of Waste Fires Caused by LIBs by 'Cost Incurred By' (£mil, %)



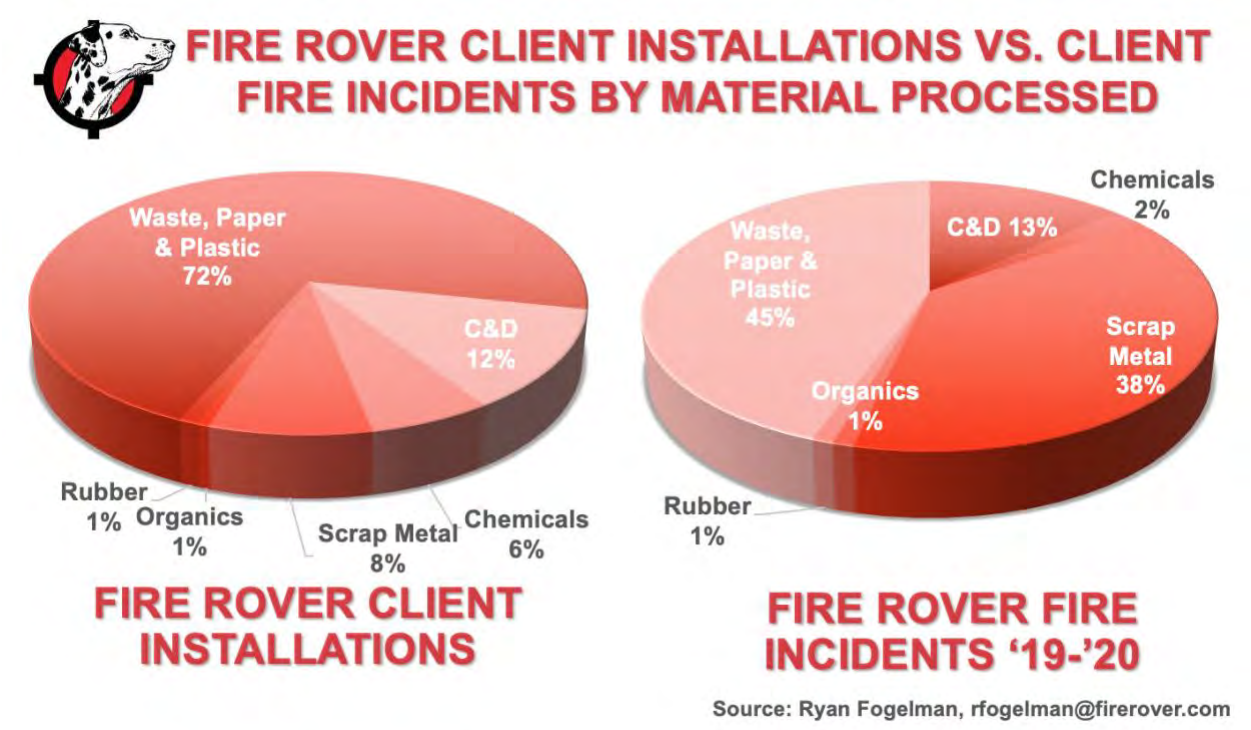
Eunomia has estimated the real cost of lithium-ion battery fires in the U.K. to be about £158 million. If we use the same assumptions I use in my reasonable assumption for

unreported fire incidents and take into account the current exchange rate, **the cost to the U.S. and Canada due to lithium-ion battery fires is unfairly more than US$1.2 billion.** Since Eunomia's study only blamed lithium-ion batteries for about 50 percent of fires, which is in line with past U.S. surveys, the real cost borne by our waste and recycling operators is realistically and conservatively about US$2.5 billion annually.

Our solution of best practices and investments in technology is working. How do we know this is the case? Insurance companies have noticed. In 2018, insurance companies couldn't leave our occupancy fast enough. Since that time, we have been gradually gaining options for the best operators. I have personally fought and won favorable outcomes by proving that **our customers that have developed operational best practices, in combination with having our early thermal detection and fire elimination solution in place, have less fire risk than any point in history, which includes the time before the lithium-ion battery wave even began.**

Increase in Scrap Metal Fires: In 2020, scrap metal fires started to increase from their large drop in 2019, or depending on your interpretation, their huge spike in 2018. My belief is that if you take out 2019, we are on an upward trend that will continue, especially since there were a couple of big months in 2020 like September when fires at scrap metal facilities were the highest ever.

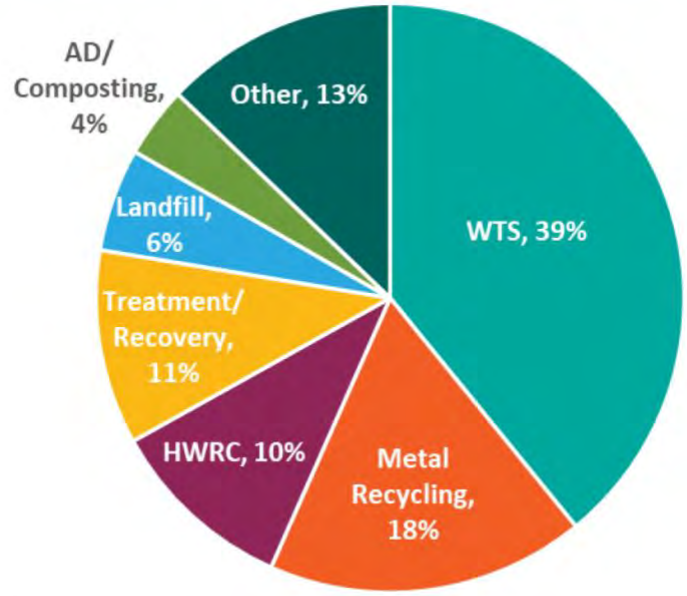
How is the scrap industry responding? It has spent a ton of time and effort on implementing "best practices" developed by traditional industry fire experts, but in my opinion, this occupancy could benefit the most from investment in new fire technology and evaluation and recommendations from fire experts outside of the space.



Take a look at the latest numbers from fire incidents we have detected and eliminated at our clients' operations in the past two years. As you can see, scrap metal fire incidents account for 38 percent of our total fire incidents even though they account for only 8 percent of our client installations. In addition, the Eunomia report has scrap metal fires at only 18% of their total fire incidents.

However, these are great operators that understand that they need to invest in proven technologies to help them mitigate their specific risks. The truth is that insurance companies are willing to provide policies to all types of high fire-prone industries. Insurance companies only leave when they feel that the risks are not able to be controlled or there is no end in sight.

Figure 1-4: Waste Fires in England by Facility Type (2014-2019)



Source: EA data, provided by the EA on 15.10.20 (2020) Waste fires reported for England 2014 - 2019

Looking at England's data provided in Eunomia's report, only 18 percent of its fires occur at metal recycling operations. This data looks at all waste fires, not just fires caused by lithium-ion batteries. According to my data, scrap metal fire incidents make up 32 percent of all reported fires in the U.S. and Canada; 34 percent if you include e-scrap fire incidents. In the same data, waste, paper and plastic fires make up 49 percent of all fires. If you add HWRC (household waste recycling centers) and WTS (waste transfer stations) in England, the number accounts for 49 percent of all reported fires.

After seeing this data, the question we must ask is why are the scrap metal operators in the U.S. experiencing almost double the number of fire incidents than in England?

There is no easy answer to this question, but I can confidently state that any of the scrap operators that have added our technology to their operational best practices have not had a major or catastrophic fire incident while our solution has been in place. Only time will tell whether the fire prevention planning strategy that ISRI has developed and rolled out to its members is enough to stem the tide of these fires alone, or if the investment in technologies will be required in the future.

C&D Fire Incidents are Underrepresented: C&D fire incidents were down from 10 to 8, or 25 percent, year-over-year. This number has remained consistent, and I believe that there is some ignorance from reporters who tell the story of "recycling fires" and share the material that caused the fires, so I would say this number is unrepresented. Additionally, a number of MRFs are hybrid and able to accept C&D materials as well as MSW. There also isn't a true list of C&D operators that I know of, and in my opinion, the number of C&D outfits are growing. I personally know of five new facilities opening in 2020 and most industry insiders would say the same. The operations do have fires, but a large number have invested in the proper technology and processes to detect and eliminate these fires early. Another benefit is that C&D operations are typically located further distances from the public, which has a direct effect on whether a fire gets reported by the media.

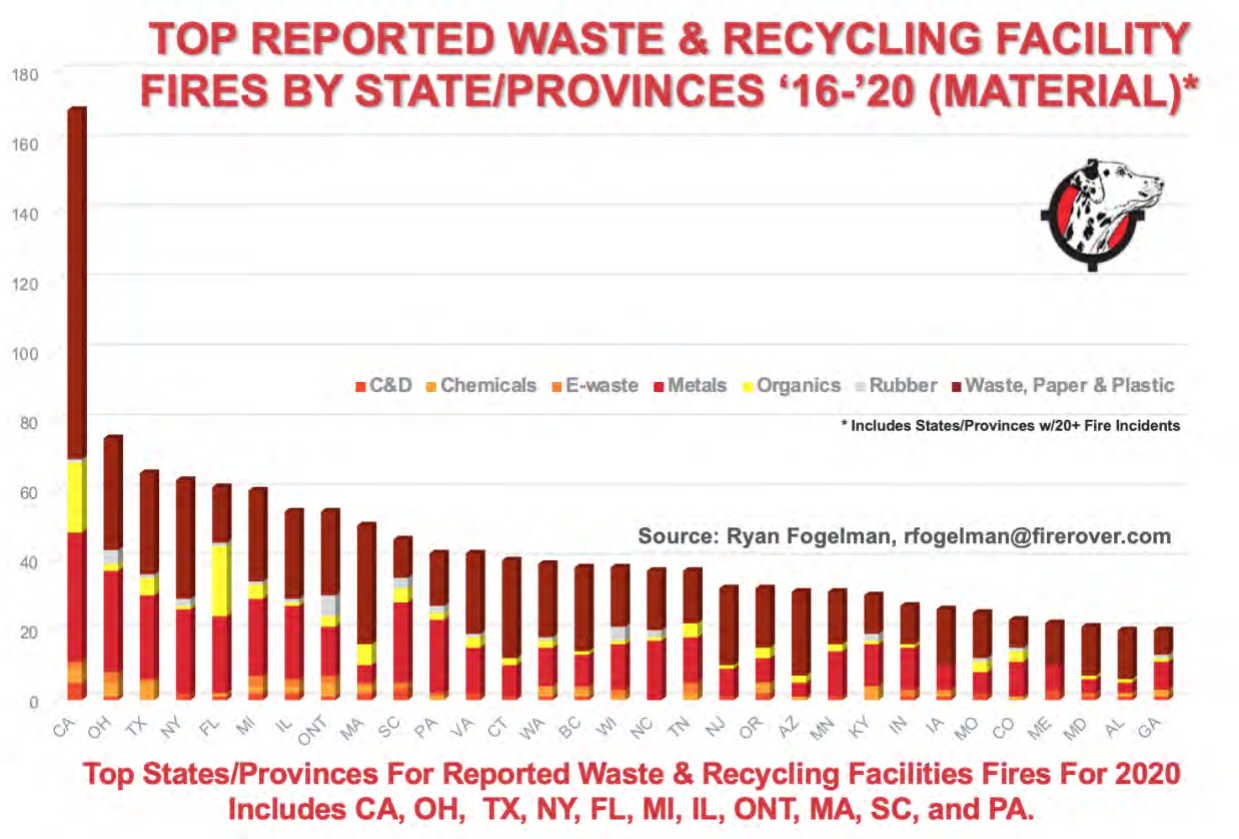
The Burgeoning E-scrap Market: A new concern I have been tracking is fire hazard incidents with an e-scrap specialty. Recycling personal electronics and personal storage is in its infancy from a historical perspective. The public push to recycle these materials has two very positive effects: (1) less personal storage and/or electronics get into our waste and single-stream recycling, and (2) we are able to better recycle and reuse all of the components including rare earth metals we so desperately need. The issue is that anyone with pliers and a garage can hang a shingle and claim to recycle electronics. There are some great operators out there, but the process is custom and different than

RMA (return merchandise authorization) programs, which have been in existence for years and allow a specific manufacturer to control how they disassemble and reuse or dispose of their products' components, specifically batteries.

Recycling general electronics comes with many different processes, such as for disassembly and removal of lithium-ion batteries in products, and unfortunately, operators performing this very necessary function for society are often left to hold the bag with most of the risk and cost of fire dangers.

State and Province Breakdown

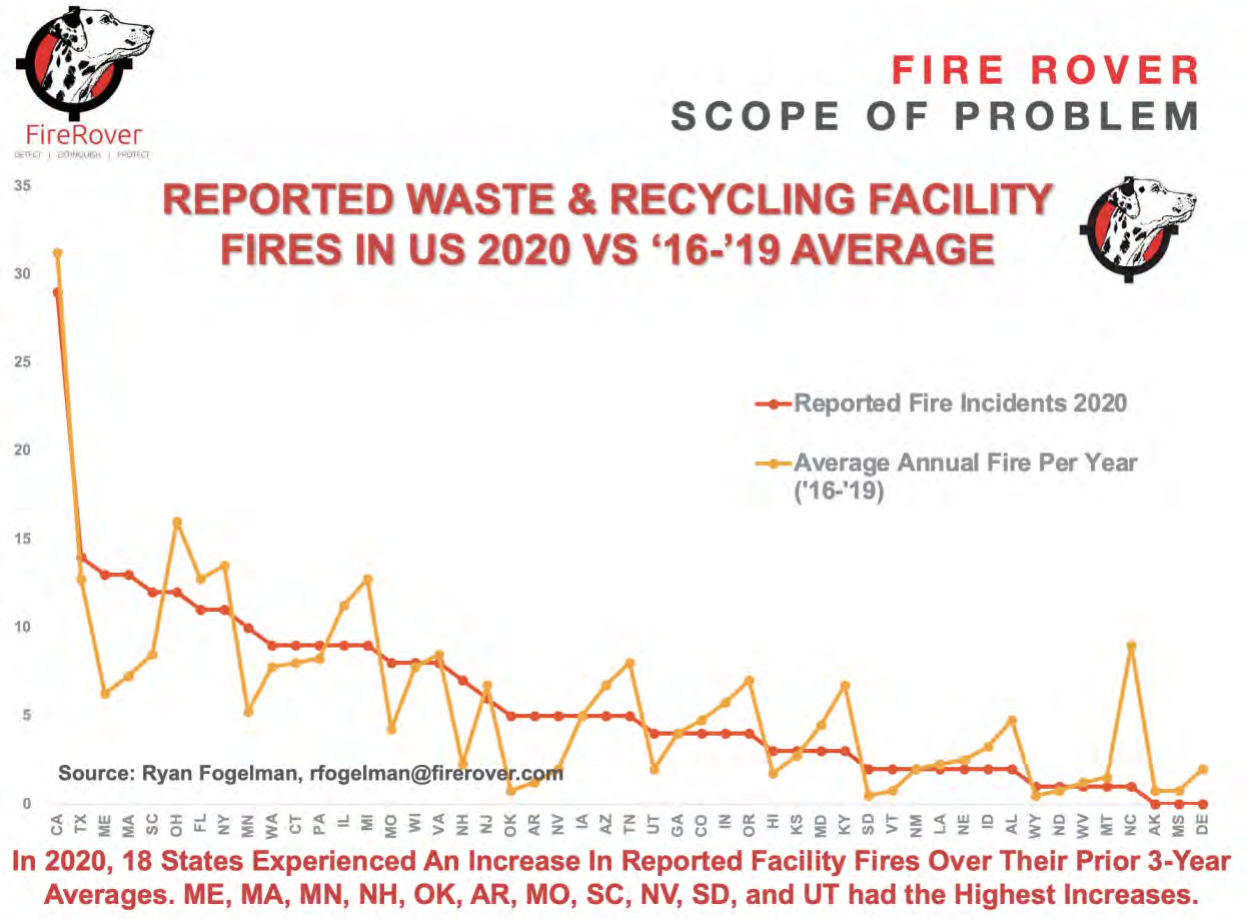
Here are the waste and recycling facility fires by U.S. state and Canadian provinces, from 2016 to 2020:



As expected, the top states and provinces for reported waste and recycling facility fires for the past five years are those with higher populations: California; Ohio; Texas; New York; Florida; Michigan; Illinois; Massachusetts; South Carolina; Pennsylvania; and Ontario, Canada. However, Texas, despite a high population and number of recycling facilities, only has a limited number of news articles about waste and recycling facility fires over the past few years. I believe that some or most waste and recycling facilities in Texas may be more distanced from the public, and incidents therefore are less "newsworthy."

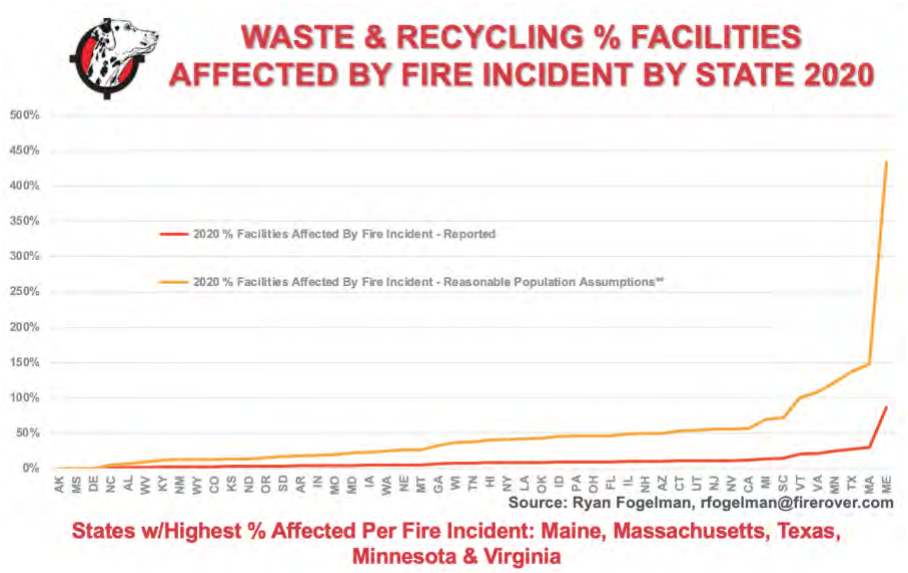
Year-Over-Year Comparison

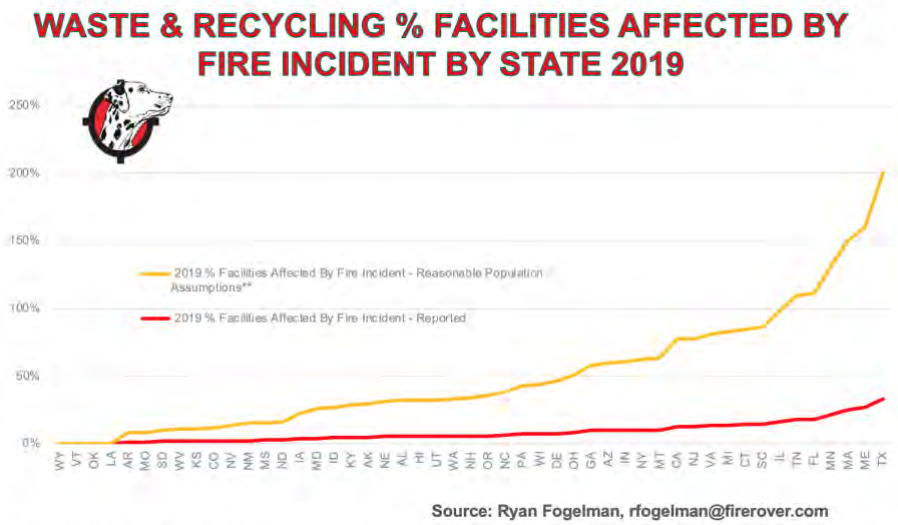
Reported waste and recycling facility fires in the U.S. in 2020 compared to previous years' average:



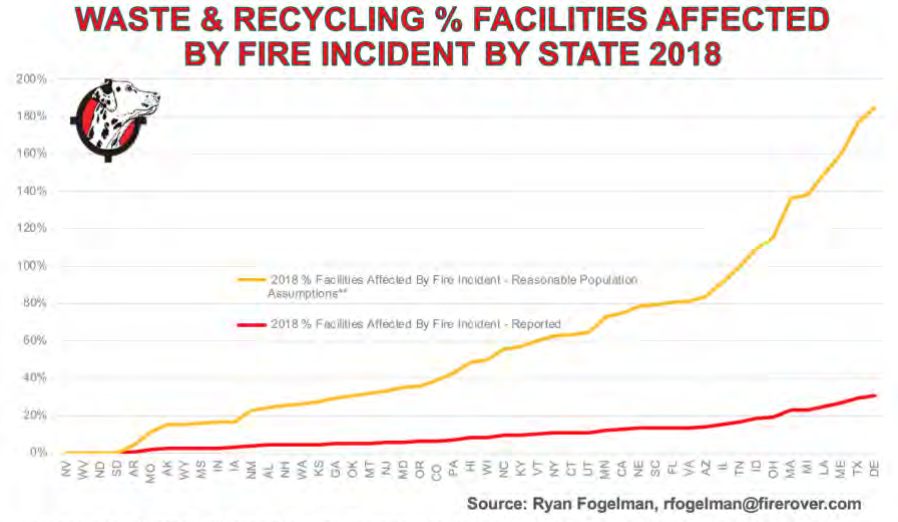
With the overall decrease in fire incidents in 2020, I decided to compare the year with previous years' average incidents incurred by each state. Surprisingly, 18 states experienced an increase in reported facility fires over their prior three-year averages.

In the following graphs, I provide the percentage of each state's waste and recycling facilities that have likely been affected by a fire incident, utilizing both the reported number of fire incidents and reasonable assumptions outlined earlier:

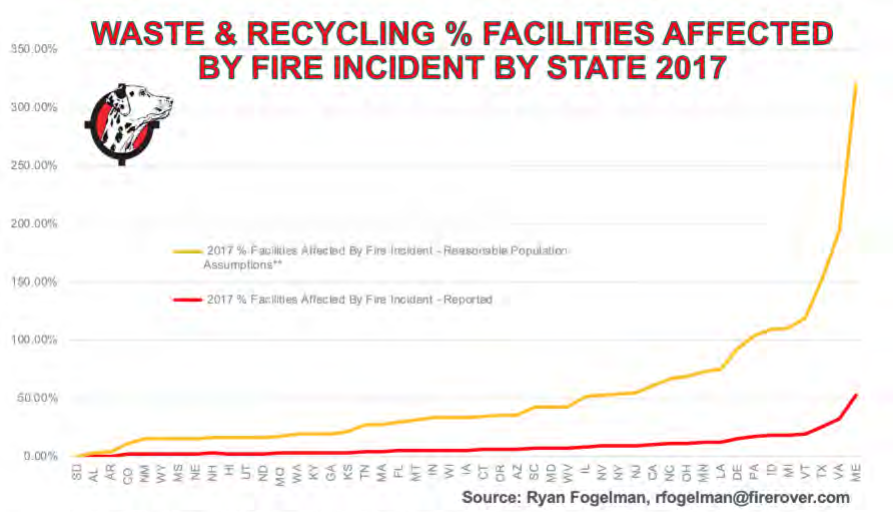




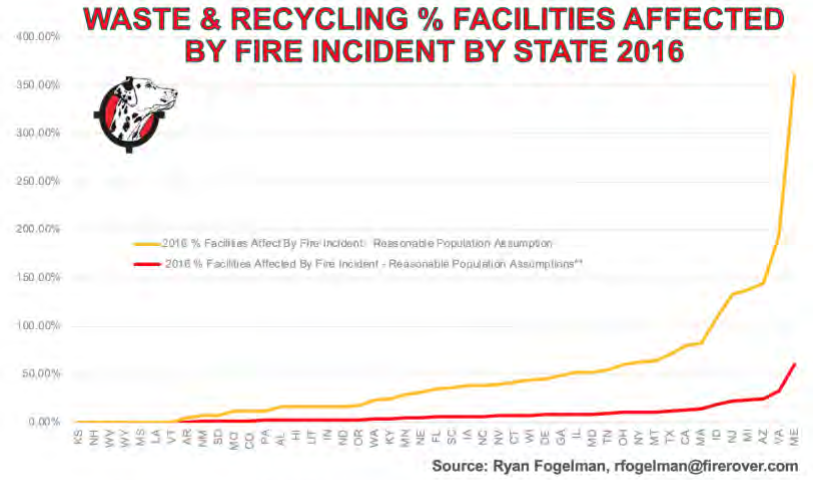
States w/Highest % Affected Per Fire Incident: Texas, Maine, Massachusetts, Minnesota & Florida



States w/Highest % Affected By Fire Incident: Delaware, Texas, Maine, Louisiana & Michigan

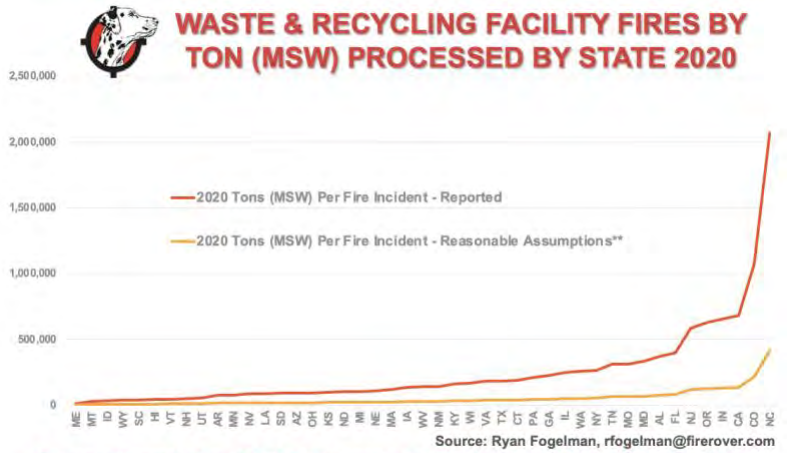


States w/Highest % Affected By Fire Incident: Michigan, Vermont, Texas, Virginia & Maine

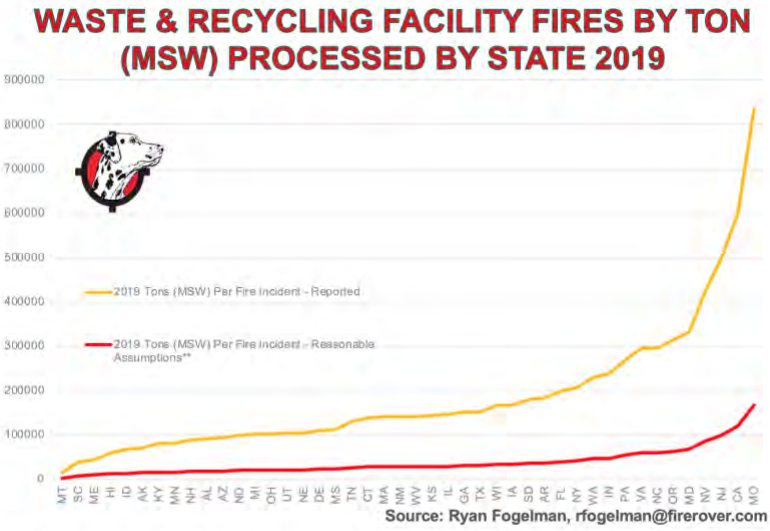


States w/Highest % Affected By Fire Incident: Maine, Virginia, Arizona, Michigan & New Jersey

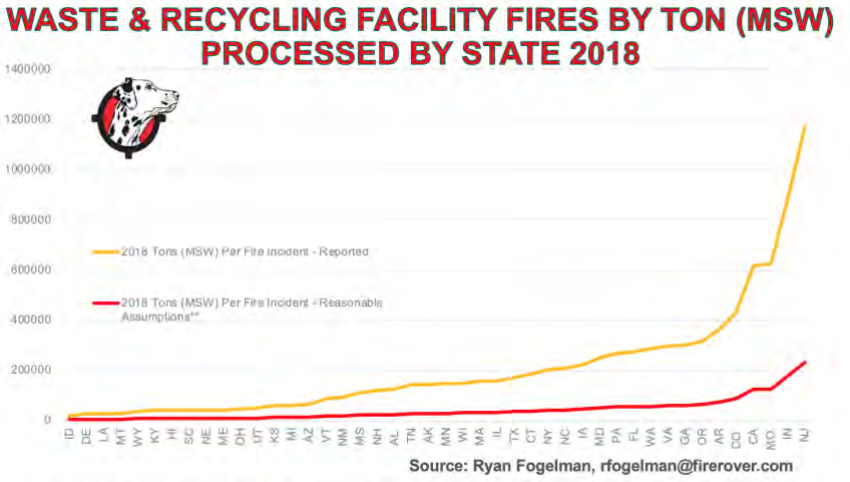
In the graphs below, I outline the estimated number of fire incidents using an estimated number of tons processed, the reported number of fire incidents and reasonable assumptions outlined earlier:



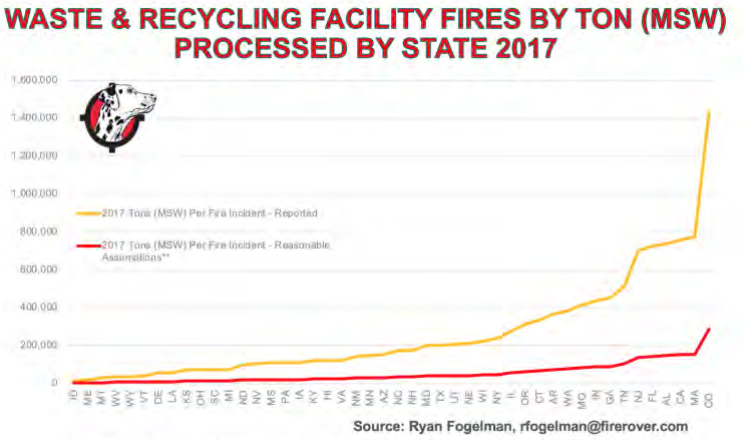
States w/Lowest Tons (MSW) Processed Per Fire Incident: Maine, Montana, Idaho, Wyoming & South Carolina



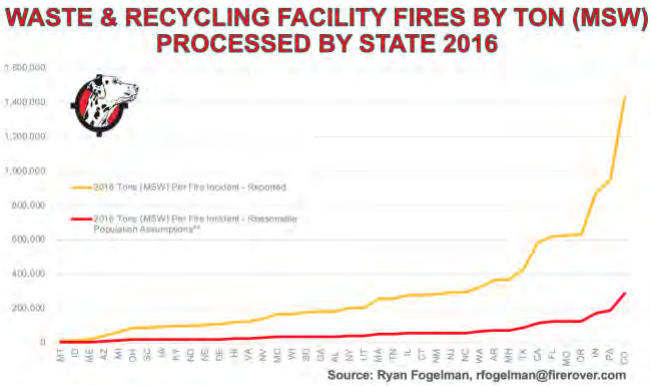
States w/Lowest Tons (MSW) Processed Per Fire Incident: Montana, South Carolina, Maine, Hawaii & Idaho



States w/Lowest Tons (MSW) Processed Per Fire Incident: Idaho, Delaware, Louisiana, Montana & Wyoming



States w/Lowest Tons (MSW) Processed Per Fire Incident: Idaho, Maine, Montana, West Virginia & Wyoming



States w/Lowest Tons (MSW) Processed Per Fire Incident: Montana, Idaho, Maine, Arizona & Michigan

The Consequences—Injuries, Illnesses and Deaths

The waste and recycling industry is No. 6 on the list of most dangerous occupations, and unfortunately, it's an industry where injuries, illnesses and even deaths can happen at a moment's notice.

However, with that in mind, members of the industry are constantly looking for ways to operate in a safer manner and to ensure that workers return home safely at the end of each workday. Some of these efforts include supporting and implementing Slow Down to Get Around legislation, ramping up safety training for employees and utilizing more safety technology.

In 2020, the industry experienced three deaths and 23 direct and indirect injuries. This is down from two deaths and 49 injuries in 2019 and slightly up from two deaths and 19 injuries in 2018.

REPORTED WASTE & RECYCLING FACILITY FIRES INJURIES & DEATHS IN US/CAN

	2018	2019	2020
Injuries Reported	19	49	23
Deaths Reported	2	2	3
# of Incidents Where Injuries Were Reported	12	25	14
Total Reported Fire Incidents	365	343	317
% of Fire Incidents w/Injuries or Deaths	3.3%	7.3%	4.4%

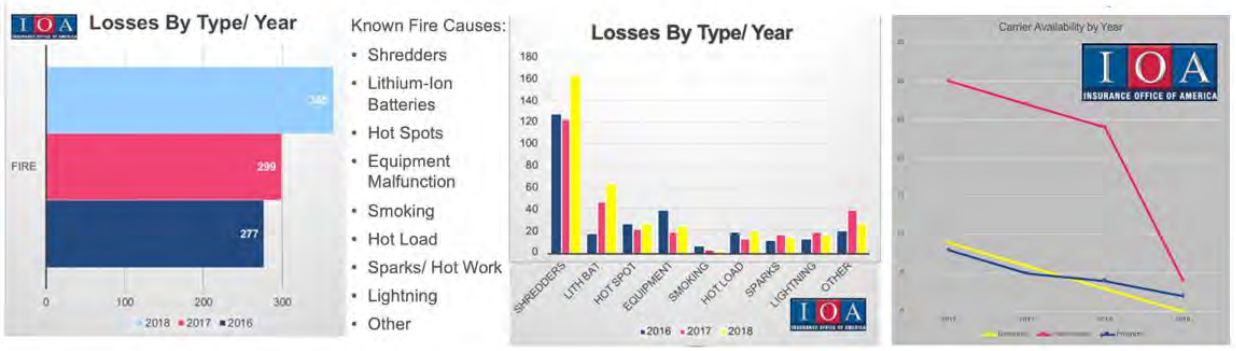
Source: Ryan Fogelman, rfogelman@firerover.com

While this is viewed as welcome news for the industry, we must keep in mind that most of the injuries occur to the fire professionals that come on scene to fight. The fewer major fires that occur means the few fire fighters required to fight these fires, exposing them to danger!

The Consequences—Insurance Companies Leaving the Industry

It's no secret that the insurance and reinsurance industry see the waste and recycling industry as high risk and has been running from our industry for years. But the reasoning behind that assumption lies within insurance companies' actual claims data.

According to data provided by Nathan Brainard of Insurance Offices of America, 2018 was the banner year for claims, and consequently, insurance companies began to leave the market at a hurried pace. The increases were mainly caused by an uptick in lithium-ion batteries in our waste stream as well as in shredders, which many would attribute to the additional spark risks caused by the same culprit. As you can see from the charts below, 2019 was the year that many of the insurance companies decided to leave the waste and recycling industry.



Source: Nathan Brainard, nathan.brainard@ioausa.com

Brainard's number of incidents is eerily similar to the publicly reported number. The only difference that I see is that his numbers also include landfill fires. Although the numbers are similar, the real story in Brainard's data is the consequences the industry is experiencing due to these fire incidents.

In addition to the possible injuries, illnesses and even deaths caused by fire incidents, the industry is seeing insurance companies flee from the sector. In 2016, the industry had almost 50 insurance options. Now, it has less than 10.

When asked what this contraction means to the private waste and recycling facility operator, Brainard said, “Those with no losses could expect a 25 to 35 percent premium increase, those with moderate losses would have a 75 percent-plus increase, those with catastrophic losses could see their premiums double and those with multiple issues could be uninsurable.”

His predictions have become a reality for some, as higher premiums are starting to pop up across the industry. The South Bayside Waste Management Authority in Northern California, for example, saw its MRF’s insurance premium increase from $100,000-plus to more than a million after its first major fire, and the MRF was told it would be uninsurable if it had another incident.

In Alexandria, Minn., the Pope/Douglas Solid Waste Management-owned waste-to-energy facility is facing a possible increase of $300,000-plus for insurance fees due to claims in other parts of the country.

These are just a couple examples of what our industry is facing, and I think we can all agree that we need to make safety changes to mitigate insurance companies’ risk. These changes need to be implemented at the site level, and the insurability of each site needs to be evaluated by each insurance company based on a variety of factors such as historical claims, incident data, response, training, the rest of the sites in a portfolio and so on.

To get the ball rolling on bringing insurance companies back to our occupancy, I have helped a number of insurance companies understand the risk we face in our industry. I

have explained that **good operators definitely have less fires than bad operators. But, when good operators are still having fires, new solutions outside of the basic fire prevention are needed.**

That being said, we need to continue to implement real fire prevention and disaster response plans at all our facilities. This alone can work in industries where the fire hazard can be removed. In the waste and recycling industry, where good operators still have fires, we need to take more steps to help solve the problem.

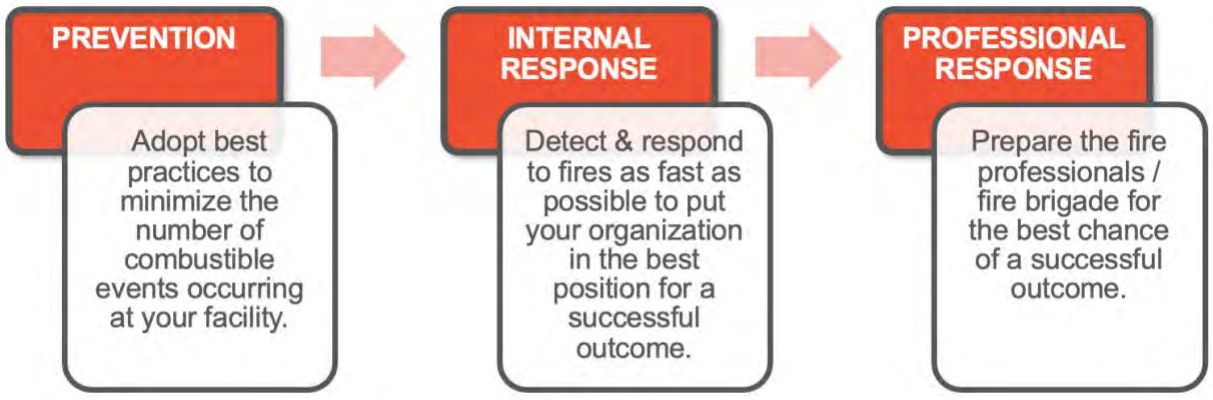
Insurance companies want to protect our industry occupancy. According to Ryan Butler, vice president of risk mitigation for Cottingham & Butler, which provides insurance for a number of different high-hazard industries, “Carriers become hesitant to enter or write complex classes of business when they see systemic losses. However, underwriters gain another level of confidence when they see operators investing time, capital and resources into auditing and analyzing their exposures, as this shows there is a wiliness to improve and avoid mistakes.

“To many people, auditing certain exposures on an annual basis can be a double-edged sword, as there is concern the insurance carrier will penalize and increase rates on any deficiency or issue unveiled during the audit. However, generally it is the exact opposite; when a carrier sees that an operator is investing and openly illustrating issues, and the remediation and capital expenditures that will be undertaken to fix the issues, they will have a different viewpoint and interest in the account.

“If an operator invests in an audit, they will be on the path to better risk management practices, which can actually help them reduce a catastrophic loss. It is imperative, irrespective of insurability and coverage options, that operators take the necessary precaution to avoid losses wherever possible, as experiencing a large loss will tarnish the reputation of the business for three to five years.”

The insurance companies want to see real effort defining the real scope of the problem, solutions and paths forward for strategies that will mitigate the specific risks of the occupancy. If they do not see this, the only thing they have to go on is historical claims data. **Fire prevention plans and disaster preparedness plans are the basic blocking and tackling strategies insurance underwriters already expect good operators to have in place. If they do not have those in place, they are not considered good operators.** The insurance companies want to see operators that will face problems head-on and not try to avoid them and wish they would just go away.

One way that operators can prove to insurance companies that they are taking fire prevention seriously is by planning for a live event.

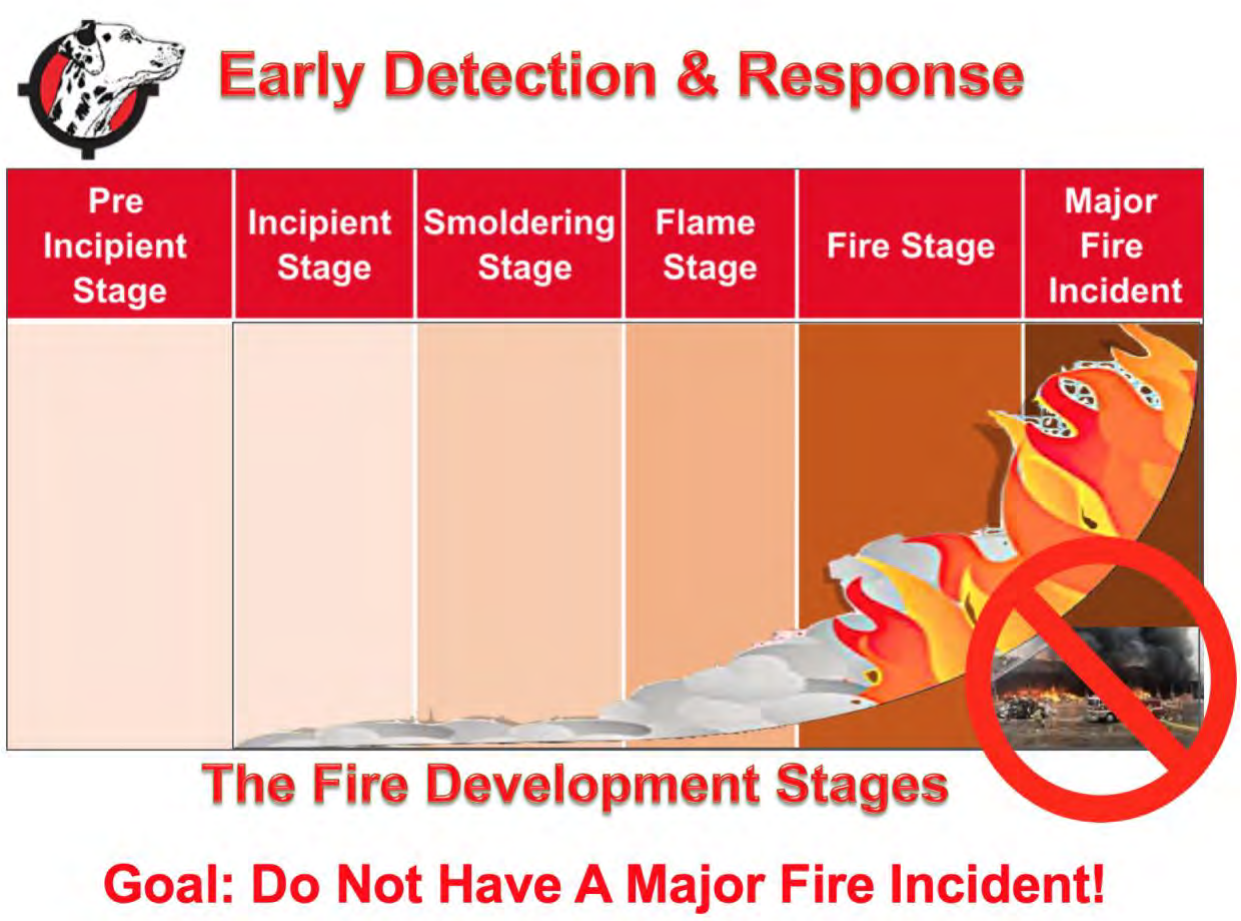


After prevention, the real opportunity is improvement in internal response time!

Prevention. The most important part of fire prevention is to develop a plan of attack. Prevention is the basic blocking and tackling and should include all components of minimizing the potential number of events that can occur at your facility. Examples of this include having limits on the size and height of your in-feed and feedstock piles;

regularly cleaning the facility so it is free of dust that can combust; developing a disciplined hot works program; clearing your working floor; keeping proper pile separation so fire professionals have room to maneuver; having the proper fire protection in place commensurate to the amount of material being processed at your facility; identifying aerosols or propane tanks during presort; having frequent safety training of employees; and, last but not least, educating the public on proper disposal of non-hazardous material in the waste and recycling stream. For more specifics around the Combinational Approach to fighting waste and recycling facility fires, take a look at my article on how to reduce the fire risk profile of your waste and recycling facility.

Internal Response. I typically tell folks that early detection is the key to catching and mitigating a fire early. The goal is not just to catch a fire when there are flames but to understand that there are situations where hot spots can be cooled before they flame. Overlaying smoke analytics into detection is imperative, as it helps when we are dealing with deep-seated fires where smoke is the first sign. The faster we can detect a fire and apply an environmentally friendly cooling agent to the affected area, the better the chance the firefighters will arrive on scene with the fire fully suppressed or under control.



The goal is to set the trip wire as early in the process as possible. This can be done through top-grade thermal detection in combination with smoke and other analytics and, most importantly, a highly trained agent who is able to weed through false positives in an effort to fight only the incidents that need fighting. It's important to note that anyone can purchase a top-grade thermal camera, but just like most hardware and software are not off-the-shelf solutions, neither are these highly sophisticated pieces of equipment. To work properly in our highly active environments takes investment, skill, training and experience. Just as I would not know the first thing about running a recycling or hazardous materials facility, I would suggest leaving the highly specialized skill to the experts.

Professional Response. Another extremely important part of the internal response is to prepare the professional response. Investing in the proper equipment for the fire department to use onsite can be a huge timesaver. Even going as far as having attached and rollout hoses so the firefighters can immediately start applying suppressant to the affected area can make a huge difference. Investing in a compressed air foam system can save valuable time for the fire professionals as well, as they can fight a fire within less than a minute of arrival.

Most importantly, having an active relationship with your local fire department is imperative. They are the folks who will decide whether they actively fight the fire or take a defensive position where they do their best to contain the fire to the immediate area. The truth is that the goal of the fire department is to ensure that all of its department members, and anyone else on scene, make it home to their families. Fighting waste and recycling fires is hard enough when the fire department has a relationship and is familiar with the facility, exits, equipment, piles and storage, among other factors. Fighting these fires without this knowledge, however, would bring trepidation to any rational fire chief.

Ultimately, as an industry, we need to make a choice. We need to focus on dealing with the inherent risk of fires we encounter by developing processes and solutions that catch and suppress fires as quickly as possible. We spend so much of our time and resources on educating the public about the hazards of improper recycling in an effort to get these hazards out of the recycling stream. However, the issue that we face is that education only focuses on one piece of the problem. We see these hazards in construction and demolition, metal recycling, municipal solid waste processing and more. Don't get me wrong, educating the public on their unintended effects is important, but in my opinion, we can get more bang for our buck by investing in safety processes, plans and technologies that truly mitigate the fire risks before they have a chance to become major incidents.

The Solutions—The Fire Rover

I spent my first five years in the market trying to understand the problem and being cautious about saying that our patented product is the solution to the problem. Sometimes you need to call a spade a spade, and in my sixth year, I am 100 percent confident that our solution can and is the only solution on the market today that can lower the risk profile of a good operator to levels seen before the lithium-ion hazards hit our industry.

To prevent and eliminate fire incidents, you need to invest in solutions that actually work for your facility type. This means that traditional fire-suppression methods such as water sprinkler systems and smoke alarms may not be the best option to stop a fire at a facility where there's a lot of activity such as a materials recovery facility (MRF), transfer station or waste-to-energy facility.

It is great to provide fire protection equipment for employees to use on site, but no employer can force any employee to fight a fire incident at their facility. According to OSHA, "If a fire breaks out in the workplace, employees have two options: Fight or Flight. What employees don't have, however, is an obligation to do one action or the other. The decision on whether to Fight or Flight is entirely up to the employee. Proper employee training helps people take the right action faster."

This is why we developed Fire Rover, a comprehensive firefighting solution that combats incipient fires and explosions within seconds from ignition. This system is specifically designed for the waste and recycling industry and has eliminated more than 1,000 fires in waste and recycling facilities across the US and Canada.

There are many advantages to using the patented Fire Rover system, including:

1. Equipped with FLIR thermal cameras that can be paired with listed optical flame detectors to satisfy code compliance, the Fire Rover provides early heat abnormality detection before visible smoke or flames are present.

2. Once a heat abnormality is detected, alarms received from the detectors are transmitted to a UL central station, where a Fire Rover agent verifies if it's a false positive or if it's a threat and action needs to be taken.

3. If action needs to be taken, the Fire Rover agent alerts the facility, the fire department and authorities and then shoots an environmentally friendly cooling agent from the Fire Rover's nozzles onto the hot spot to eliminate a fire before or after it starts. This allows ample time for fire professionals to arrive on scene and for the facility operator and fire professionals to provide an appropriate response to the level of hazard.

4. Lastly, the Fire Rover is capable of superior suppression, which is partially due to the elevated water density a monitor delivers when compared to the design densities of a typical sprinkler system and partially due to the targeted suppression from controlling the monitor from the central station.

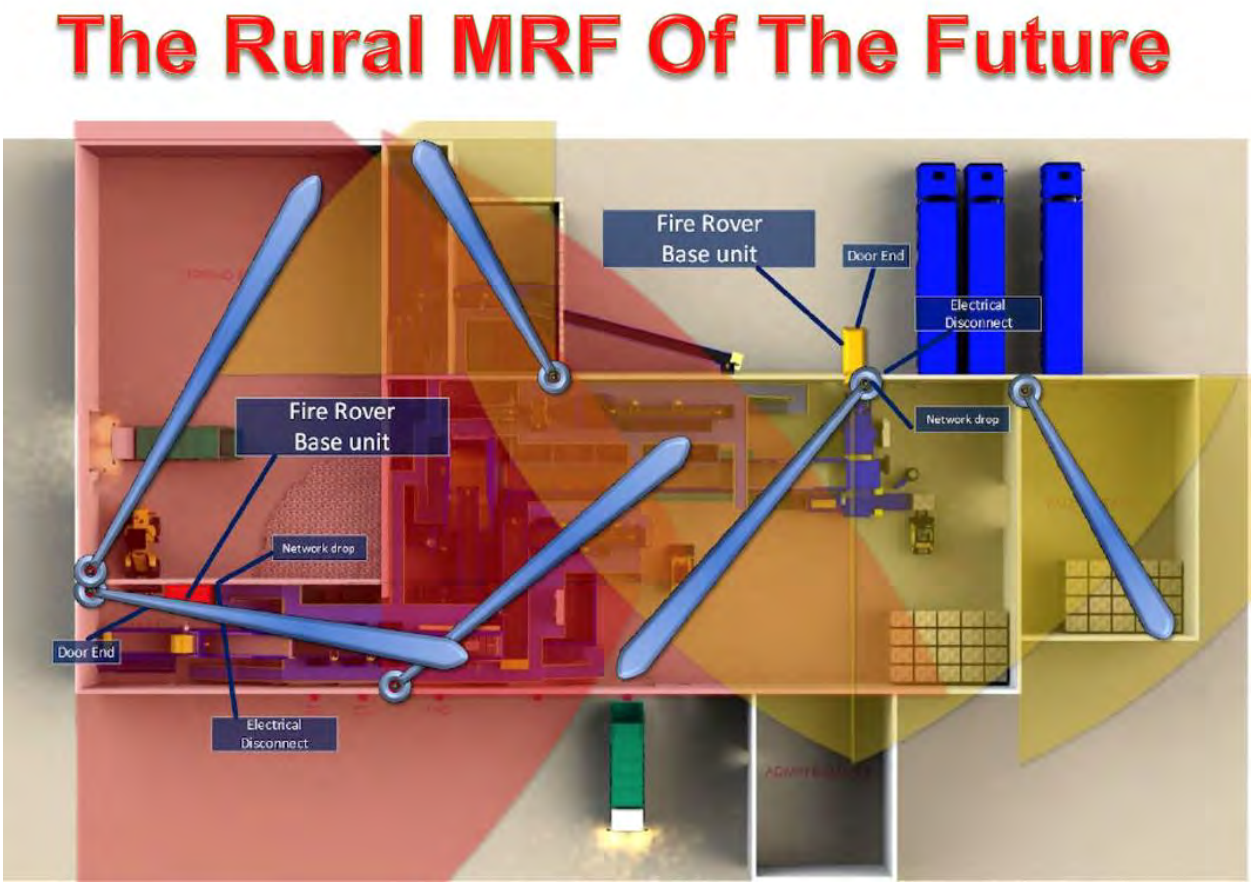
By detecting early when the fire is small, targeting the fire and putting large amounts of water in this initial growth stage, the total water usage is significantly reduced. This was the finding of a 2020 FM Research Technical Report entitled 'Reducing Water Demands with Innovative Fire Protection Solutions'. In this report, smart monitors demonstrated the ability to reduce the amount of water necessary for un-cartoned unexpanded plastic and cartoned unexpanded plastic fire sources by up to 88%. According to James Andy Lynch, founder and CEO of Fire Solutions Group, Fire Rover will be classified as a smart monitor by Factory Mutual (FM) and is defined in the FM standard 1421 Approval Standard for Fire Protection Monitor Assemblies.

'Having been in the fire industry for more than 20 years, and working with a number of new and emerging technologies, I feel comfortable saying that Fire Rover has positioned itself as a must-have tool in the box of fire-protection equipment we as engineers must consider when designing fire protection for a facility,' says Lynch, who has worked with Fire Rover in multiple capacities including designing systems for proper coverage, preparing variances utilizing technical data to support its use, assisting with the FM approval process and submitting text changes to various fire codes.

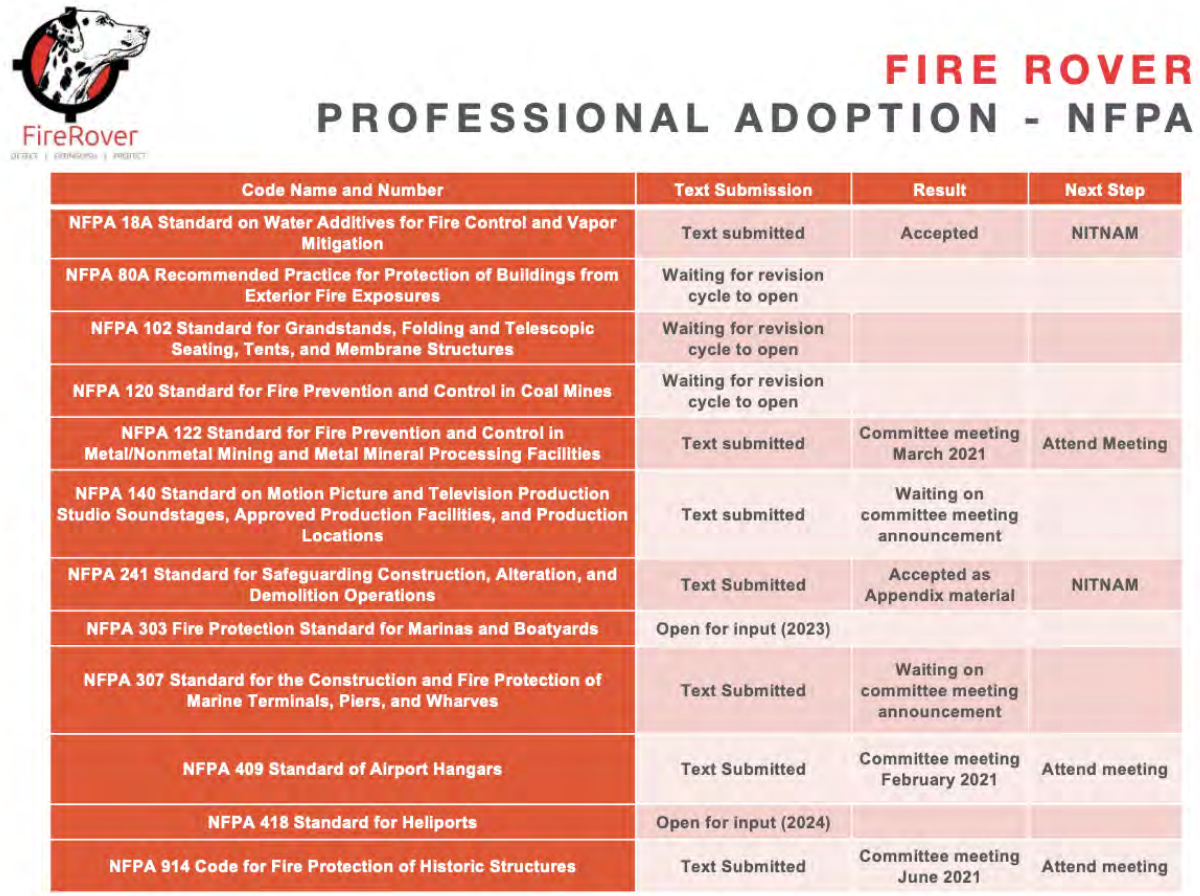
Keeping pace with the changes and needs of the industry, in 2020, we took our solution a step further by adding an additional ‘quick connection’ for fire professionals. The quick connect allows fire professionals to take a defensive approach to fighting a lithium-ion battery fire effectively while remaining safely outside the facility.

This solution, which is currently installed in 200 facilities across the US and Canada, received the National Waste & Recycling Association’s 2020 Innovator of the Year – Recycling Equipment award, which celebrates innovation in design and manufacturing that increases the effectiveness or efficiency of recycling equipment and operations.

This year our Fire Rover solution had the honor of being part of FCC and WM’s MRF of the future as well as a complete fire sprinkler replacement at The Rural MRF of the Future installed by Brad “The Landfill Warrior” Austin in Marquette Michigan. When I asked Brad, why he choose our solution versus going the traditional path he said, “When we started this process, I had heard from others regarding different solutions they had, and it became extremely apparent to my team that sprinklers offered very little protection in our type of facility. I felt the Fire Rover system was designed specifically for the waste and recycling industry, as it has eyes onsite and the ability to target fire quickly. Preventing the loss of equipment is critical, and we felt this was the best option to protect the investment we made into our facility. We were fortunate that our local authorities were so supportive and formerly provided a variance for the Fire Rover system to operate in place of the fire sprinkler requirement.”



Our solution has been blessed to be accepted as it has in the waste and recycling industry, but there is also a strong case for occupancies outside of waste and recycling such as refineries, construction sites, demolitions sites, historical structures, airplane hangars and garages specifically housing lithium powered electronic vehicles. As you can see from our submissions for inclusion of some sort in the NFPA codes, our solution is making progress due to its results proven in the waste and recycling occupancy.



Code Name and Number	Text Submission	Result	Next Step
NFPA 18A Standard on Water Additives for Fire Control and Vapor Mitigation	Text submitted	Accepted	NITNAM
NFPA 80A Recommended Practice for Protection of Buildings from Exterior Fire Exposures	Waiting for revision cycle to open		
NFPA 102 Standard for Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures	Waiting for revision cycle to open		
NFPA 120 Standard for Fire Prevention and Control in Coal Mines	Waiting for revision cycle to open		
NFPA 122 Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities	Text submitted	Committee meeting March 2021	Attend Meeting
NFPA 140 Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations	Text submitted	Waiting on committee meeting announcement	
NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations	Text Submitted	Accepted as Appendix material	NITNAM
NFPA 303 Fire Protection Standard for Marinas and Boatyards	Open for input (2023)		
NFPA 307 Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves	Text Submitted	Waiting on committee meeting announcement	
NFPA 409 Standard of Airport Hangars	Text Submitted	Committee meeting February 2021	Attend meeting
NFPA 418 Standard for Heliports	Open for input (2024)		
NFPA 914 Code for Fire Protection of Historic Structures	Text Submitted	Committee meeting June 2021	Attend meeting

Additionally, Fire Rover has designed and installed a box-less solution for waste-to-energy and industrial facilities that utilizes the operators' existing water infrastructure. The targeted deluge solution can replace a traditional deluge system with the ability to target any fire with water, providing more control of the event, alleviating the issue of accidental discharge and allowing dual control of the system by both the Fire Rover agents as well as the operators which is being installed in large industrial operations across the county.

As we continue to innovate and evolve our solution our customers can be assured of one thing that is not typically true of most equipment or any fire protection equipment that I know of, our solution gets better with age. We partner with our clients to understand their business and work with them on their solutions. Be it remote control,

cameras for preemptive maintenance on parts of their equipment, or helping them build a new operation from the ground up, we are there with them every step of way. Are we perfect, absolutely not, but fighting fires is not a science. Human beings have been trying to control fire since the beginning of time. Anyone that says they can "guarantee" your operation does not have a fire is off his rocker. We are an outsourced fire department, like the Pinkertons of fire, that is there to help you fight fires early. No fire professional would argue that the earlier you identify and start fighting a fire, the better the result in the end. 100% success is impossible, but insurers are not looking for 100% success, but risk mitigation to a level that allows them to sleep at night along with our customers is our goal.

Thank You

I give all the credit of Fire Rover to the waste and recycling industry for being so open to allowing our solution in your operations and allowing us to partner with you to get this global problem of fires in our waste and recycling streams under control. As the Austrian article said it best, "No other substance [Li-ion Batteries] or material has ever comparably endangered the whole waste [and recycling] industry."

At Fire Rover, we have worked very hard to develop a solution to address a number of causes of fire at waste and recycling facilities (i.e., tip floors, preemptive maintenance of industrial equipment, storage, rubber feedstock, shredders, auto shredder residue, hazmat, material in-feeds and more).

As you're making your operational plans for 2021, it's important to implement fire prevention and reduction best practices and to invest in technologies and solutions that are going to keep your employees safe and your operations running more efficiently.

Without these preparations, an unfortunate incident could present unexpected costs, operational downtime and danger to your biggest asset – your employees. I encourage you to take action now and to be prepared. After all, good operators have fewer fires

than bad operators, but new and innovative solutions are needed when good operators are still having fires!

Contact Information

Ryan Fogelman

Partner, Fire Rover, LLC

LinkedIn - linkedin.com/in/ryanjayfogelman

Email - rfogelman@firerover.com

Phone – (614) 327-3744

Marketing Email - https://signup.e2ma.net/signup/1795170/1758003/

Fire Rover YouTube Channel - https://www.youtube.com/channel/UCtlwkn6QZkm0zi0Mg2Pz8jQ

Appendix A. 2020 ANNUAL REPORTED WASTE & RECYCLING FACILITY FIRES US/CAN - Published by Ryan Fogelman, Fire Rover, rfogelman@firerover.com

State	Country	Reported Fire Incidents 2020	Reported Fire Incidents 2019	Reported Fire Incidents 2018	Reported Fire Incidents 2017	Reported Fire Incidents 2016	Average Annual Fire Per Year ('16-'19)	2020 Increase (Decrease) Compared To Average ('16-'19)	2020 Increase (Decrease) % Compared To Average ('16-'19)	Number Of Recycling Facilities*	Tonnage Processed By State*	2020 % Facilities Affected By Fire Incident - Reported	2020 Reasonable Population Assumption**	2020 % Facilities Affected By Fire Incident - Reasonable Population Assumptions**	2020 Tons (MSW) Per Fire Incident - Reported	2020 Tons (MSW) Per Fire Incident - Reasonable Assumptions**
CA	USA	29	33	32	26	34	31	(2)	-7%	256	19,774,000	11%	145	57%	681,862	136,372
TX	USA	14	17	15	13	6	13	1	10%	51	2,591,000	27%	70	137%	185,071	37,014
MA	USA	13	11	10	2	6	7	6	79%	44	1,551,000	30%	65	148%	119,308	23,862
ME	USA	13	4	4	8	9	6	7	108%	15	173,000	87%	65	433%	13,308	2,662
SC	USA	12	12	11	6	5	9	4	41%	83	452,000	14%	60	72%	37,667	7,533
OH	USA	12	11	25	15	13	16	(4)	-25%	130	1,119,000	9%	60	46%	93,250	18,650
FL	USA	11	22	16	6	7	13	(2)	-14%	119	4,354,000	9%	55	46%	395,818	79,164
NY	USA	11	14	14	12	14	14	(3)	-19%	134	2,880,000	8%	55	41%	261,818	52,364
MN	USA	10	9	5	5	2	5	5	90%	41	733,000	24%	50	122%	73,300	14,660
IL	USA	9	15	14	8	8	11	(2)	-20%	92	2,211,000	10%	45	49%	245,667	49,133
CT	USA	9	12	9	5	6	8	1	13%	85	1,674,000	11%	45	53%	186,000	37,200
WA	USA	9	10	8	6	7	8	1	16%	182	2,297,000	5%	45	25%	255,222	51,044
MI	USA	9	9	15	12	15	13	(4)	-29%	65	911,000	14%	45	69%	101,222	20,244
PA	USA	9	7	7	17	2	8	1	9%	98	1,893,000	9%	45	46%	210,333	42,067
WI	USA	8	8	9	6	8	8	0	3%	109	1,346,000	7%	40	37%	168,250	33,650
VA	USA	8	5	5	12	12	9	(1)	-6%	37	1,473,000	22%	40	108%	184,125	36,825
MO	USA	8	3	4	6	4	4	4	88%	206	2,506,000	4%	40	19%	313,250	62,650
NH	USA	7	4	3	2	0	2	5	211%	70	355,000	10%	35	50%	50,714	10,143
NJ	USA	6	7	3	5	12	7	(1)	-11%	54	3,500,000	11%	30	56%	583,333	116,667
TN	USA	5	12	11	3	6	8	(3)	-38%	66	1,553,000	8%	25	38%	310,600	62,120
AZ	USA	5	5	7	3	12	7	(2)	-26%	50	465,000	10%	25	50%	93,000	18,600
IA	USA	5	4	3	6	7	5	-	0%	108	673,000	5%	25	23%	134,600	26,920
AR	USA	5	2	1	1	1	1	4	300%	139	366,000	4%	25	18%	73,200	14,640
NV	USA	5	1	0	4	3	2	3	150%	45	425,000	11%	25	56%	85,000	17,000
OK	USA	5	0	3	0	0	1	4	567%	59	NA	8%	25	42%	NA	NA
IN	USA	4	11	3	6	3	6	(2)	-30%	109	2,626,000	4%	20	18%	656,500	131,300
OR	USA	4	8	8	8	4	7	(3)	-43%	134	2,516,000	3%	20	15%	629,000	125,800
GA	USA	4	6	3	2	5	4	-	0%	62	906,000	6%	20	32%	226,500	45,300
CO	USA	4	3	10	3	3	5	(1)	-16%	154	4,292,000	3%	20	13%	1,073,000	214,600
UT	USA	4	2	4	1	1	2	2	100%	37	206,000	11%	20	54%	51,500	10,300
KY	USA	3	6	12	4	5	7	(4)	-56%	126	482,000	2%	15	12%	160,667	32,133
MD	USA	3	3	4	5	6	5	(2)	-33%	69	996,000	4%	15	22%	332,000	66,400
HI	USA	3	2	3	1	1	2	1	71%	37	121,364	8%	15	41%	40,455	8,091
KS	USA	3	2	5	4	0	3	0	9%	109	289,000	3%	15	14%	96,333	19,267
AL	USA	2	8	6	1	4	5	(3)	-58%	148	739,000	1%	10	7%	369,500	73,900

NM	USA	2	2	3	2	1	2	-	0%	78	282,000	3%	10	13%	141,000	28,200
NE	USA	2	2	5	1	2	3	(1)	-20%	38	211,000	5%	10	26%	105,500	21,100
SD	USA	2	1	0	0	1	1	2	300%	58	180,000	3%	10	17%	90,000	18,000
ID	USA	2	1	4	4	4	3	(1)	-38%	22	67,000	9%	10	45%	33,500	6,700
VT	USA	2	0	1	2	0	1	1	167%	10	88,056	20%	10	100%	44,028	8,806
LA	USA	2	0	6	3	0	2	(0)	-11%	24	171,000	8%	10	42%	85,500	17,100
NC	USA	1	7	10	12	7	9	(8)	-89%	108	2,071,000	1%	5	5%	2,071,000	414,200
MT	USA	1	2	1	1	2	2	(1)	-33%	19	29,000	5%	5	26%	29,000	5,800
ND	USA	1	1	0	1	1	1	0	33%	36	100,230	3%	5	14%	100,230	20,046
WV	USA	1	1	0	4	0	1	(0)	-20%	56	141,000	2%	5	9%	141,000	28,200
WY	USA	1	0	1	1	0	1	1	100%	39	36,136	3%	5	13%	36,136	7,227
AK	USA	0	2	1	0	0	1	(1)	-100%	40	142,366	0%	0	0%	NA	NA
MS	USA	0	1	1	1	0	1	(1)	-100%	38	111,000	0%	0	0%	NA	NA
DE	USA	0	1	4	2	1	2	(2)	-100%	13	110,000	0%	0	0%	NA	NA

*** EREF Data Published 2016 (Source: *https://erefdn.org/product/municipal-solid-waste-management-u-s-2010-2013/*)**

**** Chief Fire Officers Association (CFOA) reported from the EA an average of 332 documented fires at waste facilities between 2001 and 2014. The CFOA also reported* 250 fires in 2015 at waste and recycling companies.**

Appendix B. 2019 ANNUAL REPORTED WASTE & RECYCLING FACILITY FIRES US/CAN - Published by Ryan Fogelman, Fire Rover, rfogelman@firerover.com

State	Country	Reported Fire Incidents 2019	Reported Fire Incidents 2018	Reported Fire Incidents 2017	Reported Fire Incidents 2016	Average Annual Fire Per Year ('16-'18)	2019 Increase (Decrease) Compared To Average ('16-'18)	2019 Increase (Decrease) % Compared To Average ('16-'18)	Number Of Recycling Facilities*	Tonnage Processed By State*	2019 % Facilities Affected By Fire Incident - Reported	2019 Reasonable Population Assumption**	2019 % Facilities Affected By Fire Incident - Reasonable Population Assumptions**	2019 Tons (MSW) Per Fire Incident - Reported	2019 Tons (MSW) Per Fire Incident - Reasonable Assumptions**
CA	USA	33	32	26	34	31	2	8%	256	19,774,000	13%	165	64%	599,212	119,842
FL	USA	22	16	6	7	10	12	128%	119	4,354,000	18%	110	92%	197,909	39,582
TX	USA	17	15	13	6	11	6	50%	51	2,591,000	33%	85	167%	152,412	30,482
IL	USA	15	14	8	8	10	5	50%	92	2,211,000	16%	75	82%	147,400	29,480
NY	USA	14	14	12	14	13	1	5%	134	2,880,000	10%	70	52%	205,714	41,143
TN	USA	12	11	3	6	7	5	80%	66	1,553,000	18%	60	91%	129,417	25,883
CT	USA	12	9	5	6	7	5	80%	85	1,674,000	14%	60	71%	139,500	27,900
SC	USA	12	11	6	5	7	5	64%	83	452,000	14%	60	72%	37,667	7,533
IN	USA	11	3	6	3	4	7	175%	109	2,626,000	10%	55	50%	238,727	47,745
MA	USA	11	10	2	6	6	5	83%	44	1,551,000	25%	55	125%	141,000	28,200
OH	USA	11	25	15	13	18	(7)	-38%	130	1,119,000	8%	55	42%	101,727	20,345
WA	USA	10	8	6	7	7	3	43%	182	2,297,000	5%	50	27%	229,700	45,940
MN	USA	9	5	5	2	4	5	125%	41	733,000	22%	45	110%	81,444	16,289
MI	USA	9	15	12	15	14	(5)	-36%	65	911,000	14%	45	69%	101,222	20,244
AL	USA	8	6	1	4	4	4	118%	148	739,000	5%	40	27%	92,375	18,475
OR	USA	8	8	8	4	7	1	20%	134	2,516,000	6%	40	30%	314,500	62,900
WI	USA	8	9	6	8	8	0	4%	109	1,346,000	7%	40	37%	168,250	33,650
NJ	USA	7	3	5	12	7	0	5%	54	3,500,000	13%	35	65%	500,000	100,000
PA	USA	7	7	17	2	9	(2)	-19%	98	1,893,000	7%	35	36%	270,429	54,086
NC	USA	7	10	12	7	10	(3)	-28%	108	2,071,000	6%	35	32%	295,857	59,171
GA	USA	6	3	2	5	3	3	80%	62	906,000	10%	30	48%	151,000	30,200
KY	USA	6	12	4	5	7	(1)	-14%	126	482,000	5%	30	24%	80,333	16,067
AZ	USA	5	7	3	12	7	(2)	-32%	50	465,000	10%	25	50%	93,000	18,600
VA	USA	5	5	12	12	10	(5)	-48%	37	1,473,000	14%	25	68%	294,600	58,920
NH	USA	4	3	2	0	2	2	140%	70	355,000	6%	20	29%	88,750	17,750
IA	USA	4	3	6	7	5	(1)	-25%	108	673,000	4%	20	19%	168,250	33,650
ME	USA	4	4	8	9	7	(3)	-43%	15	173,000	27%	20	133%	43,250	8,650
MO	USA	3	4	6	4	5	(2)	-36%	206	2,506,000	1%	15	7%	835,333	167,067
MD	USA	3	4	5	6	5	(2)	-40%	69	996,000	4%	15	22%	332,000	66,400
CO	USA	3	10	3	3	5	(2)	-44%	154	4,292,000	2%	15	10%	1,430,667	286,133
AK	USA	2	1	0	0	0	2	500%	40	142,366	5%	10	25%	71,183	14,237
AR	USA	2	1	1	1	1	1	100%	139	366,000	1%	10	7%	183,000	36,600
MT	USA	2	1	1	2	1	1	50%	19	29,000	11%	10	53%	14,500	2,900

HI	USA	2	3	1	1	2	0	20%	37	121,364	5%	10	27%	60,682	12,136
UT	USA	2	4	1	1	2	-	0%	37	206,000	5%	10	27%	103,000	20,600
NM	USA	2	3	2	1	2	-	0%	78	282,000	3%	10	13%	141,000	28,200
NE	USA	2	5	1	2	3	(1)	-25%	38	211,000	5%	10	26%	105,500	21,100
KS	USA	2	5	4	0	3	(1)	-33%	109	289,000	2%	10	9%	144,500	28,900
SD	USA	1	0	0	1	0	1	200%	58	180,000	2%	5	9%	180,000	36,000
ND	USA	1	0	1	1	1	0	50%	36	100,230	3%	5	14%	100,230	20,046
MS	USA	1	1	1	0	1	0	50%	38	111,000	3%	5	13%	111,000	22,200
WV	USA	1	0	4	0	1	(0)	-25%	56	141,000	2%	5	9%	141,000	28,200
DE	USA	1	4	2	1	2	(1)	-57%	13	110,000	8%	5	38%	110,000	22,000
NV	USA	1	0	4	3	2	(1)	-57%	45	425,000	2%	5	11%	425,000	85,000
ID	USA	1	4	4	4	4	(3)	-75%	22	67,000	5%	5	23%	67,000	13,400
WY	USA	0	1	1	0	1	(1)	-100%	39	36,136	0%	0	0%	NA	NA
VT	USA	0	1	2	0	1	(1)	-100%	10	88,056	0%	0	0%	NA	NA
OK	USA	0	3	0	0	1	(1)	-100%	59	NA	0%	0	0%	NA	NA
LA	USA	0	6	3	0	3	(3)	-100%	24	171,000	0%	0	0%	NA	NA

*** EREF Data Published 2016 (Source: *https://erefdn.org/product/municipal-solid-waste-management-u-s-2010-2013/*)**

**** Chief Fire Officers Association (CFOA) reported from the EA an average of 332 documented fires at waste facilities between 2001 and 2014. The CFOA also reported* 250 fires in 2015 at waste and recycling companies.**

Appendix C. 2018 ANNUAL REPORTED WASTE & RECYCLING FACILITY FIRES US/CAN - Published by Ryan Fogelman, Fire Rover, rfogelman@firerover.com

State	Country	Reported Fire Incidents 2018	Reported Fire Incidents 2017	Reported Fire Incidents 2016	Average Annual Fire Per Year ('16-'17)	2018 Increase (Decrease) Compared To Average ('16-'17)	2018 Increase (Decrease) % Compared To Average ('16-'17)	Number Of Recycling Facilities*	Tonnage Processed By State*	2018 % Facilities Affected By Fire Incident - Reported	2018 Reasonable Population Assumption**	2018 % Facilities Affected By Fire Incident - Reasonable Population Assumptions**	2018 Tons (MSW) Per Fire Incident - Reported	2018 Tons (MSW) Per Fire Incident - Reasonable Assumptions**
CA	USA	32	26	34	30	2	7%	256	19,774,000	13%	160	63%	617,938	123,588
OH	USA	25	15	13	14	11	79%	130	1,119,000	19%	125	96%	44,760	8,952
MI	USA	15	12	15	14	2	11%	65	911,000	23%	75	115%	60,733	12,147
NY	USA	14	12	14	13	1	8%	134	2,880,000	10%	70	52%	205,714	41,143
VA	USA	5	12	12	12	(7)	-58%	37	1,473,000	14%	25	68%	294,600	58,920
NC	USA	10	12	7	10	1	5%	108	2,071,000	9%	50	46%	207,100	41,420
TX	USA	15	13	6	10	6	58%	51	2,591,000	29%	75	147%	172,733	34,547
PA	USA	7	17	2	10	(3)	-26%	98	1,893,000	7%	35	36%	270,429	54,086
NJ	USA	3	5	12	9	(6)	-65%	54	3,500,000	6%	15	28%	1,166,667	233,333
ME	USA	4	8	9	9	(5)	-53%	15	173,000	27%	20	133%	43,250	8,650
IL	USA	14	8	8	8	6	75%	92	2,211,000	15%	70	76%	157,929	31,586
AZ	USA	7	3	12	8	(1)	-7%	50	465,000	14%	35	70%	66,429	13,286
WI	USA	9	6	8	7	2	29%	109	1,346,000	8%	45	41%	149,556	29,911
WA	USA	8	6	7	7	2	23%	182	2,297,000	4%	40	22%	287,125	57,425
FL	USA	16	6	7	7	10	146%	119	4,354,000	13%	80	67%	272,125	54,425
IA	USA	3	6	7	7	(4)	-54%	108	673,000	3%	15	14%	224,333	44,867
OR	USA	8	8	4	6	2	33%	134	2,516,000	6%	40	30%	314,500	62,900
CT	USA	9	5	6	6	4	64%	85	1,674,000	11%	45	53%	186,000	37,200
MD	USA	4	5	6	6	(2)	-27%	69	996,000	6%	20	29%	249,000	49,800
SC	USA	11	6	5	6	6	100%	83	452,000	13%	55	66%	41,091	8,218
MO	USA	4	6	4	5	(1)	-20%	206	2,506,000	2%	20	10%	626,500	125,300
TN	USA	11	3	6	5	7	144%	66	1,553,000	17%	55	83%	141,182	28,236
KY	USA	12	4	5	5	8	167%	126	482,000	10%	60	48%	40,167	8,033
IN	USA	3	6	3	5	(2)	-33%	109	2,626,000	3%	15	14%	875,333	175,067
MA	USA	10	2	6	4	6	150%	44	1,551,000	23%	50	114%	155,100	31,020
ID	USA	4	4	4	4	-	0%	22	67,000	18%	20	91%	16,750	3,350
GA	USA	3	2	5	4	(1)	-14%	62	906,000	5%	15	24%	302,000	60,400
NV	USA	0	4	3	4	(4)	-100%	45	425,000	0%	0	0%	NA	NA

MN	USA	5	5	2	4	2	43%	41	733,000	12%	25	61%	146,600	29,320
CO	USA	10	3	3	3	7	233%	154	4,292,000	6%	50	32%	429,200	85,840
AL	USA	6	1	4	3	4	140%	148	739,000	4%	30	20%	123,167	24,633
KS	USA	5	4	0	2	3	150%	109	289,000	5%	25	23%	57,800	11,560
WV	USA	0	4	0	2	(2)	-100%	56	141,000	0%	0	0%	NA	NA
NE	USA	5	1	2	2	4	233%	38	211,000	13%	25	66%	42,200	8,440
MT	USA	1	1	2	2	(1)	-33%	19	29,000	5%	5	26%	29,000	5,800
NM	USA	3	2	1	2	2	100%	78	282,000	4%	15	19%	94,000	18,800
DE	USA	4	2	1	2	3	167%	13	110,000	31%	20	154%	27,500	5,500
LA	USA	6	3	0	2	5	300%	24	171,000	25%	30	125%	28,500	5,700
AR	USA	1	1	1	1	-	0%	139	366,000	1%	5	4%	366,000	73,200
HI	USA	3	1	1	1	2	200%	37	121,364	8%	15	41%	40,455	8,091
UT	USA	4	1	1	1	3	300%	37	206,000	11%	20	54%	51,500	10,300
ND	USA	0	1	1	1	(1)	-100%	36	100,230	0%	0	0%	NA	NA
NH	USA	3	2	0	1	2	200%	70	355,000	4%	15	21%	118,333	23,667
VT	USA	1	2	0	1	-	0%	10	88,056	10%	5	50%	88,056	17,611
SD	USA	0	0	1	1	(1)	-100%	58	180,000	0%	0	0%	NA	NA
WY	USA	1	1	0	1	1	100%	39	36,136	3%	5	13%	36,136	7,227
MS	USA	1	1	0	1	1	100%	38	111,000	3%	5	13%	111,000	22,200
OK	USA	3	0	0	-	3	NA	59	NA	5%	15	25%	NA	NA
AK	USA	1	0	0	-	1	NA	40	142,366	3%	5	13%	142,366	28,473

*** EREF Data Published 2016 (Source: *https://erefdn.org/product/municipal-solid-waste-management-u-s-2010-2013/*)**

**** Chief Fire Officers Association (CFOA) reported from the EA an average of 332 documented fires at waste facilities between 2001 and 2014. The CFOA also reported* 250 fires in 2015 at waste and recycling companies.**

Appendix D. 2017 ANNUAL REPORTED WASTE & RECYCLING FACILITY FIRES US/CAN - Published by Ryan Fogelman, Fire Rover, rfogelman@firerover.com

State	Country	Reported Fire Incidents 2017	Reported Fire Incidents 2016	Yr/Yr. Increase (Decrease)	Yr./Yr. % Increase (Decrease)	Number of Recycling Facilities*	Tonnage Processed by State*	2017 % Facilities Affected by Fire Incident - Reported	2017 Reasonable Population Assumption**	2017 % Facilities Affected by Fire Incident - Reasonable Population Assumptions**	2017 Tons (MSW) Per Fire Incident - Reported	2017 Tons (MSW) Per Fire Incident - Reasonable Assumptions**
AL	USA	1	4	(3)	-75%	148	739,000	0.7%	5	3%	739,000	147,800
AB	CAN	4	4	0	0%	NA	NA	NA	20	NA	NA	NA
AZ	USA	3	12	(9)	-75%	50	465,000	6.0%	15	30%	155,000	31,000
AR	USA	1	1	0	0%	139	366,000	0.7%	5	4%	366,000	73,200
BC	CAN	10	5	5	100%	NA	NA	NA	50	NA	NA	NA
CA	USA	26	34	(8)	-24%	256	19,774,000	10.2%	130	51%	760,538	152,108
CO	USA	3	3	0	0%	154	4,292,000	1.9%	15	10%	1,430,667	286,133
CT	USA	5	6	(1)	-17%	85	1,674,000	5.9%	25	29%	334,800	66,960
DE	USA	2	1	1	100%	13	110,000	15.4%	10	77%	55,000	11,000
FL	USA	6	7	(1)	-14%	119	4,354,000	5.0%	30	25%	725,667	145,133
GA	USA	2	5	(3)	-60%	62	906,000	3.2%	10	16%	453,000	90,600
HI	USA	1	1	0	0%	37	121,364	2.7%	5	14%	121,364	24,273
ID	USA	4	4	0	0%	22	67,000	18.2%	20	91%	16,750	3,350
IL	USA	8	8	0	0%	92	2,211,000	8.7%	40	43%	276,375	55,275
IN	USA	6	3	3	100%	109	2,626,000	5.5%	30	28%	437,667	87,533
IA	USA	6	7	(1)	-14%	108	673,000	5.6%	30	28%	112,167	22,433
KS	USA	4	0	4	100%	109	289,000	3.7%	20	18%	72,250	14,450
KY	USA	4	5	(1)	-20%	126	482,000	3.2%	20	16%	120,500	24,100
LA	USA	3	0	3	100%	24	171,000	12.5%	15	63%	57,000	11,400
ME	USA	8	9	(1)	-11%	15	173,000	53.3%	40	267%	21,625	4,325
MB	CAN	1	0	1	100%	NA	NA	NA	5	NA	NA	NA
MD	USA	5	6	(1)	-17%	69	996,000	7.2%	25	36%	199,200	39,840
MA	USA	2	6	(4)	-67%	44	1,551,000	4.5%	10	23%	775,500	155,100
MI	USA	12	15	(3)	-20%	65	911,000	18.5%	60	92%	75,917	15,183
MN	USA	5	2	3	150%	41	733,000	12.2%	25	61%	146,600	29,320
MS	USA	1	0	1	100%	38	111,000	2.6%	5	13%	111,000	22,200
MO	USA	6	4	2	50%	206	2,506,000	2.9%	30	15%	417,667	83,533
MT	USA	1	2	(1)	-50%	19	29,000	5.3%	5	26%	29,000	5,800
NE	USA	1	2	(1)	-50%	38	211,000	2.6%	5	13%	211,000	42,200
NV	USA	4	3	1	33%	45	425,000	8.9%	20	44%	106,250	21,250
NH	USA	2	0	2	100%	70	355,000	2.9%	10	14%	177,500	35,500
NJ	USA	5	12	(7)	-58%	54	3,500,000	9.3%	25	46%	700,000	140,000
NM	USA	2	1	1	100%	78	282,000	2.6%	10	13%	141,000	28,200
NY	USA	12	14	(2)	-14%	134	2,880,000	9.0%	60	45%	240,000	48,000
NC	USA	12	7	5	71%	108	2,071,000	11.1%	60	56%	172,583	34,517

ND	USA	1	1	0	0%	36	100,230	2.8%	5	14%	100,230	20,046
NS	CAN	2	1	1	100%	NA	NA	NA	10	NA	NA	NA
OH	USA	15	13	2	15%	130	1,119,000	11.5%	75	58%	74,600	14,920
ON	CAN	11	12	(1)	-8%	NA	NA	NA	55	NA	NA	NA
OR	USA	8	4	4	100%	134	2,516,000	6.0%	40	30%	314,500	62,900
PA	USA	17	2	15	750%	98	1,893,000	17.3%	85	87%	111,353	22,271
SK	CAN	1	0	1	100%	NA	NA	NA	5	NA	NA	NA
SC	USA	6	5	1	20%	83	452,000	7.2%	30	36%	75,333	15,067
SD	USA	0	1	(1)	-100%	58	180,000	0.0%	0	0%	NA	NA
TN	USA	3	6	(3)	-50%	66	1,553,000	4.5%	15	23%	517,667	103,533
TX	USA	13	6	7	117%	51	2,591,000	25.5%	65	127%	199,308	39,862
UT	USA	1	1	0	0%	37	206,000	2.7%	5	14%	206,000	41,200
VT	USA	2	0	2	100%	10	88,056	20.0%	10	100%	44,028	8,806
VA	USA	12	12	0	0%	37	1,473,000	32.4%	60	162%	122,750	24,550
WA	USA	6	7	(1)	-14%	182	2,297,000	3.3%	30	16%	382,833	76,567
WV	USA	4	0	4	100%	56	141,000	7.1%	20	36%	35,250	7,050
WI	USA	6	8	(2)	-25%	109	1,346,000	5.5%	30	28%	224,333	44,867
WY	USA	1	0	1	100%	39	36,136	2.6%	5	13%	36,136	7,227

*** EREF Data Published 2016 (Source: *https://erefdn.org/product/municipal-solid-waste-management-u-s-2010-2013/*)**

**** Chief Fire Officers Association (CFOA) reported from the EA an average of 332 documented fires at waste facilities between 2001 and 2014. The CFOA also reported* 250 fires in 2015 at waste and recycling companies.**

Appendix E. 2016 ANNUAL REPORTED WASTE & RECYCLING FACILITY FIRES US/CAN - Published by Ryan Fogelman, Fire Rover, rfogelman@firerover.com

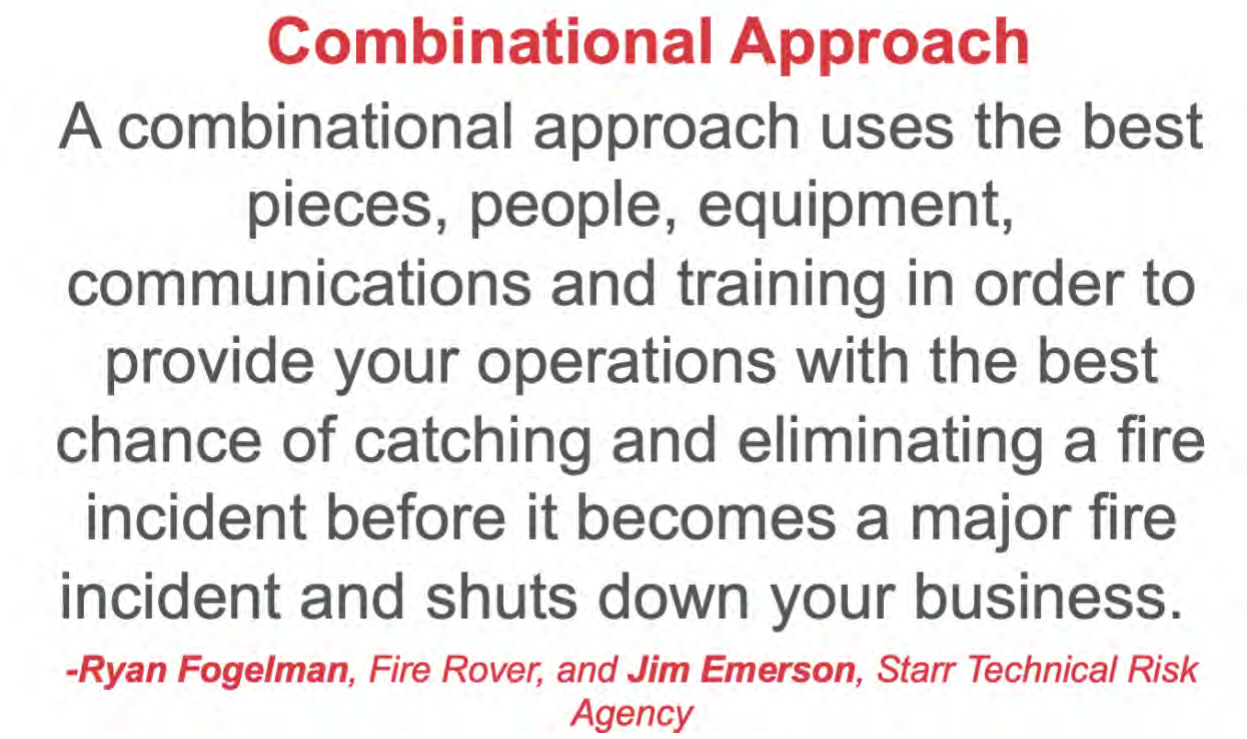
State	Country	Reported Fire Incidents 2017	Reported Fire Incidents 2016	Yr/Yr. Increase (Decrease)	Yr./Yr. % Increase (Decrease)	Number of Recycling Facilities*	Tonnage Processed by State*	2016 % Facilities Affected by Fire Incident - Reported	2016 Reasonable Population Assumption**	2016 % Facilities Affected by Fire Incident - Reasonable Population Assumptions**	2016 Tons (MSW) Per Fire Incident - Reported	2016 Tons (MSW) Per Fire Incident - Reasonable Population Assumptions**
AL	USA	1	4	(3)	-75%	148	739,000	2.7%	20	14%	184,750	36,950
AB	CAN	4	4	0	0%	NA	NA	NA	20	NA	NA	NA
AZ	USA	3	12	(9)	-75%	50	465,000	24.0%	60	120%	38,750	7,750
AR	USA	1	1	0	0%	139	366,000	0.7%	5	4%	366,000	73,200
BC	CAN	10	5	5	100%	NA	NA	NA	25	0%	NA	NA
CA	USA	26	34	(8)	-24%	256	19,774,000	13.3%	170	66%	581,588	116,318
CO	USA	3	3	0	0%	154	4,292,000	1.9%	15	10%	1,430,667	286,133
CT	USA	5	6	(1)	-17%	85	1,674,000	7.1%	30	35%	279,000	55,800
DE	USA	2	1	1	100%	13	110,000	7.7%	5	38%	110,000	22,000
FL	USA	6	7	(1)	-14%	119	4,354,000	5.9%	35	29%	622,000	124,400
GA	USA	2	5	(3)	-60%	62	906,000	8.1%	25	40%	181,200	36,240
HI	USA	1	1	0	0%	37	121,364	2.7%	5	14%	121,364	24,273
ID	USA	4	4	0	0%	22	67,000	18.2%	20	91%	16,750	3,350
IL	USA	8	8	0	0%	92	2,211,000	8.7%	40	43%	276,375	55,275
IN	USA	6	3	3	100%	109	2,626,000	2.8%	15	14%	875,333	175,067
IA	USA	6	7	(1)	-14%	108	673,000	6.5%	35	32%	96,143	19,229
KS	USA	4	0	4	100%	109	289,000	0.0%	0	0%	0	0
KY	USA	4	5	(1)	-20%	126	482,000	4.0%	25	20%	96,400	19,280
LA	USA	3	0	3	100%	24	171,000	0.0%	0	0%	0	0
ME	USA	8	9	(1)	-11%	15	173,000	60.0%	45	300%	19,222	3,844
MB	CAN	1	0	1	100%	NA	NA	NA	0	0%	NA	NA
MD	USA	5	6	(1)	-17%	69	996,000	8.7%	30	43%	166,000	33,200
MA	USA	2	6	(4)	-67%	44	1,551,000	13.6%	30	68%	258,500	51,700
MI	USA	12	15	(3)	-20%	65	911,000	23.1%	75	115%	60,733	12,147
MN	USA	5	2	3	150%	41	733,000	4.9%	10	24%	366,500	73,300
MS	USA	1	0	1	100%	38	111,000	0.0%	0	0%	0	0
MO	USA	6	4	2	50%	206	2,506,000	1.9%	20	10%	626,500	125,300
MT	USA	1	2	(1)	-50%	19	29,000	10.5%	10	53%	14,500	2,900
NE	USA	1	2	(1)	-50%	38	211,000	5.3%	10	26%	105,500	21,100
NV	USA	4	3	1	33%	45	425,000	6.7%	15	33%	141,667	28,333
NH	USA	2	0	2	100%	70	355,000	0.0%	0	0%	0	0

NJ	USA	5	12	(7)	-58%	54	3,500,000	22.2%	60	111%	291,667	58,333
NM	USA	2	1	1	100%	78	282,000	1.3%	5	6%	282,000	56,400
NY	USA	12	14	(2)	-14%	134	2,880,000	10.4%	70	52%	205,714	41,143
NC	USA	12	7	5	71%	108	2,071,000	6.5%	35	32%	295,857	59,171
ND	USA	1	1	0	0%	36	100,230	2.8%	5	14%	100,230	20,046
NS	CAN	2	1	1	100%	NA	NA	NA	5	NA	NA	NA
OH	USA	15	13	2	15%	130	1,119,000	10.0%	65	50%	86,077	17,215
ON	CAN	11	12	(1)	-8%	NA	NA	NA	60	NA	NA	NA
OR	USA	8	4	4	100%	134	2,516,000	3.0%	20	15%	629,000	125,800
PA	USA	17	2	15	750%	98	1,893,000	2.0%	10	10%	946,500	189,300
SK	CAN	1	0	1	100%	NA	NA	NA	0	NA	NA	NA
SC	USA	6	5	1	20%	83	452,000	6.0%	25	30%	90,400	18,080
SD	USA	0	1	(1)	-100%	58	180,000	1.7%	NA	5%	180,000	36,000
TN	USA	3	6	(3)	-50%	66	1,553,000	9.1%	30	45%	258,833	51,767
TX	USA	13	6	7	117%	51	2,591,000	11.8%	30	59%	431,833	86,367
UT	USA	1	1	0	0%	37	206,000	2.7%	5	14%	206,000	41,200
VT	USA	2	0	2	100%	10	88,056	0.0%	0	0%	0	0
VA	USA	12	12	0	0%	37	1,473,000	32.4%	60	162%	122,750	24,550
WA	USA	6	7	(1)	-14%	182	2,297,000	3.8%	35	19%	328,143	65,629
WV	USA	4	0	4	100%	56	141,000	0.0%	0	0%	0	0
WI	USA	6	8	(2)	-25%	109	1,346,000	7.3%	40	37%	168,250	33,650
WY	USA	1	0	1	100%	39	36,136	0.0%	0	0%	0	0

*** EREF Data Published 2016 (Source: *https://erefdn.org/product/municipal-solid-waste-management-u-s-2010-2013/*)**

**** Chief Fire Officers Association (CFOA) reported from the EA an average of 332 documented fires at waste faciltiies between 2001 and 2014. The CFOA also reported* 250 fires in 2015 at waste and recycling companies.**

APPENDIX F. The Combinational Approach™ to Fighting a Waste and Recycling Fire:



The Combinational Approach™ to Fighting a Waste and Recycling Fire

1. Thermal cameras (automatic thermal detection can often sense dangerous temperature differentials before a fire even starts).
2. Use of a pre-wetting foam agent, possibly in combination with twin 1-1/2-inch or 1-3/4-inch water nozzles.
3. Remote, human-verified, manual control of foam agent dispersal from a safe location.
4. Pre-wetting should be configured so that it reaches a 180-degree area with the best line-of-site coverage available, and the ability to operate for sweeping and pre-wetting around the fire perimeter and collateral assets.

5. Eliminate fire brigade as it puts valued employees at risk and is difficult to administer in compliance with OSHA requirements. (OSHA allows a limited fire brigade that can monitor evacuation and address incipient stage fires as long as they are not interior structural fires.)
6. Configure an emergency response such as providing a lancing nozzle, hookup and rollout of a fire service hose and a deck gun in order to be prepared for the fire professionals' arrival.
7. Ensure that a pathway is maintained for the fire professionals to safely enter and move around the facility.
8. Train employees to start the fire pump and shut off the proper electrical circuits to save time for the fire response professionals.
9. Have a trained bulldozer/loader operator with the proper equipment, or make sure the fire department is trained on your equipment.
10. Have a working automatic sprinkler system and adequate water supply. The water supply may be lacking at some locations, so having a tank system is highly recommended.
11. Have a solid worker training program. This means regular inspections and testing of fire equipment. Also have a simple but effective fire emergency response plan. Good housekeeping, contractor and hot work controls are essential.
12. Have manually operable roof vents to let heat escape. Heat is likely to get out through roll up doors and melt light panels on exterior walls, but having the ability to open roof vents is much safer since the fire service will not have to manually cut a vent in the top of the roof. However, let the firefighters decide about whether to open the vents.
13. Have secondary rally points in a safe place, potentially even offsite, for personnel who can stay and help the fire service with tasks such as crane operation and ensuring the plant is safely shut down. The fire service may wish to have personnel leave the site either immediately or shortly due to smoke and the need to assure personnel safety.

Having a place offsite where you can rally and stay in communication can be very instrumental.

14. Develop a rapport with the fire department, which includes training with the Texas A&M Engineering Extension Service/National Fire Protection Association on how to fight a fire in a recycling and trash tipping floor/pit operation.

Benefits of the Combinational Approach™ to Fighting a Waste and Recycling Facility Fire:

- Early detection with fire detection technology and application of pre-wetting foam can eliminate fires, prepare for the firefighter response and greatly reduce or eliminate major fire incidents.
- Adding additional compressed air foam systems allows for more manual applications of foam from a safe distance for employees.
- Installing a deck gun and setting it up for the fire department's arrival will save valuable time upon arrival. This process takes a lot longer than what we see in the movies and allows the fire department to get right to work.
- If you can only provide one form of sprinkler head, protect the structural steel columns in combination with an early detection and suppression system.
- Roof vents can be opened. Let the fire department do this as it will want to be able to control this important aspect. Being able to do this with a button versus mounting the roof manually and cutting with a saw protects emergency responders from a potentially dangerous situation.

This approach allows the threat to structural steel elements to be greatly reduced. This is the main inflection point in firefighting. At this point, the fire department can become the most effective on the interior attack toward the seat of the fire.