



A Division of The Society of The Plastics Industry, Inc.

October 25, 1988

TO: The VI Safety Subcommittee

RE: BFG Accident: Case History Presentation

Roy received the attached report on the May 9th accident at BFGoodrich's Avon Lake facility from Herm Waltemate.

Perhaps this would make a worthwhile presentation at a VI safety workshop, as Herm's note indicates it would be of interest to those in the compounding business and to manufacturers of impact modifiers. Let's discuss at the subcommittee meeting.

Meredith N. Scheck
Assistant Director

MNS/pmb

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TO: V1 Safety Subcommittee

Re: BFG Accident; Case History Presentation

Ray received the attached report on the May 9 accident at BF Goodrich's Avon Lake facility from Norm Waltemate.

Perhaps this would make a worthwhile presentation at a ^{V1} safety ~~workshop~~ workshop, as Norm's note indicates it would be of interest to those in the compounding business ^{and to} manufacturers of impact modifiers. Let's discuss at the Subcommittee meeting.

rnhs.

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BFGoodrich

The BFGoodrich Company
Geon Vinyl Division
6100 Oak Tree Boulevard
Cleveland, Ohio 44131
216-447-6000

October 18, 1988

RECEIVED

OCT 24 1988

DR. R. T. GOTTESMAN

Mr. Roy Gottesman
The Vinyl Institute
Wayne Interchange Plaza II
155 Route 46 West
Wayne, NJ 07470

Dear Mr. Gottesman:

Attached is a copy of the narrative report of the explosion BFGoodrich experienced at Avon Lake in the PVC compounding operation. I would be willing to present this explosion as a case history to members of the Vinyl Institute. Vinyl Institute members who are in the compounding business would gain the most from this presentation. Manufacturers of impact modifiers would also learn from this case history.

I was informed by the consultant we used that his partner recently investigated a dust explosion with one of our competitors which had a very similar ignition source.

Sincerely,

THE BFGOODRICH COMPANY
Geon Vinyl Division



Herm Waltemate
Manager, Safety

HW/kp
2535j

Attachment

cc: R. Grahek

CTL016289

GEON VINYL DIVISION
AVON LAKE GENERAL CHEMICAL PLANT
Avon Lake, Ohio
Compound Incident
Repetitive Accident Type 8
Chemical Fire

Summary

On Monday, May 9, 1988 at 8:30 p.m. an explosion was experienced on the fourth floor of Compounding Building 441. The explosion emanated from bin #2 on "Z" line. The manway opened under pressure releasing a dusty material, an acrylic impact modifier, to the fourth floor. The initial explosion damaged #2 raw material receiving bin. It was rapidly followed by a secondary explosion and fire resulting from quantities of accumulated dust from horizontal surfaces which had become airborne after the initial explosion. Following the explosion, raw materials continued to burn on the fourth floor for approximately two hours.

The explosion blew off portions of the fourth floor roof and siding from four sides of the building. It also caused extensive damage to masonry block walls in the building. The explosion, fire and water did additional damage to electrical and instrument wiring, heating and ventilation equipment and some processing equipment, primarily on the third and fourth floors. There was considerable smoke damage throughout the building.

With the exception of some minor smoke inhalation, there were no injuries to BFG or emergency response personnel.

Narrative

Several boards of review, employee interviews and group discussions were conducted to gather and evaluate the facts relating to this incident and to determine corrective measures necessary to prevent a recurrence. Key BFG employees involved include:

Bob Accarino	Sr. Safety/Environmental Engineer
Don Barnicki	Plant Engineer
Harry Calsing	Cleveland Engineering
Mike Cocco	Compound Operator
Gene Evans	Compound Foreman
Leroy Gall	Compound Operator
John Gressler	Manager, Human Resources & Safety
Bob Hentges	Compound Operator
Robert Holmes	Senior Safety Engineer
Bill Horton	Plant Manager
Dale Hruska	Senior Electrical Engineer

CTL016290

Gene Krupp	Senior Safety Engineer
Bob Obrin	Senior Instrument Engineer
Bob Reitz	Cleveland Engineering
Dick Rofe	Compound Operator
Mark Saunders	Section Supervisor, Engineering
John Shellenberger	Compound Manager
Leon Shinsky, Jr.	Compound Operator
Dick Swartz	Compound Operator
Rick Vanek	Environmental Health Tech.
Jim Vick	Compound General Foreman
Herm Waltemate	Cleveland Safety
Jim Weese	Compound Operator
Wilhelm Winnen	Compound Operator

Itemized below is the sequence of events leading up to and following the incident.

At approximately 4:45 p.m., "A" CML Compounding in building 441 was shut down due to an electrical storm passing through the area. The other line in building 441, "Z" line, was not shut down. Line "A" was restarted at 5:50 p.m. From this point on, all operations appeared to be running normal.

At about 8:30 p.m., operators on the first and second floors heard what they described as a "rumbling" or "wooshing" sound. Two operators in the first floor lunch room observed the suspended ceiling lift, but did not see smoke or flames; they then exited the building. An operator at the first floor dumping station saw smoke (not fire) and went to activate the north fire alarm box; he left the building. Line "Z" buss operator was on the first floor where he heard an explosion and then a second explosion. He saw fire at the buss panel and immediately left the building. A fifth operator was inside of "A" line-mill cubicle where he observed black smoke in the vicinity of the lunch room. He did not see flames. He shut down the Farrel and mill before leaving the building. The "Z" line bagger observed fire and black smoke coming from the elevator south door and immediately left the building. The "A" line bagger heard a "boom" and felt the building shake where upon he immediately exited the building.

At the time of the explosion "A" and "Z" line Henschel operators were on the second floor at their work stations. Bob Hentges, "A" line operator, heard a "wooshing" sound and became engulfed in what he described as a flame thrower. He saw a fireball coming toward him from the elevator room. He fell to his knees and crawled through the breaker room to the west roof exit door.

Jim Weese "Z" line Henschel operator observed a fireball from the west and felt as though he was being gently pushed. The fire disappeared as quickly as it appeared. Jim could not see due to the heavy smoke but was able to exit through the north fire escape door.

CTL016291

Rick Vanek was at the guard station in building 430, approximately 500 feet northwest of building 441. There he observed part of the third floor north wall of building 441 blow out. The flame came straight out perpendicular to the north wall. Immediately following the NW corner and west wall blew out. The fire was described as a very deep dark orange color. He responded by notifying the on-duty nurse to contact emergency services and key personnel before reporting to building 441 to aid in the emergency. Using an air pak, he performed a floor by floor search for people.

Members of the plantwide fire brigade responded to the alarm at B/441. It was quickly determined that all building personnel had exited the building and were not injured. Brigade members along with additional volunteers from both ALGC and ALTC then quickly attacked the fire.

The Avon Lake Fire Department with assistance from Bay Village and Sheffield Lake Fire Departments supported the plant fire brigade in containing and extinguishing the fire. Other plant operations which were curtailed during the incident were able to assume operations by 11:00 p.m.

Investigations

Investigations as to the cause started on May 10, 1988 and have continued since that time. It was decided to contract Hazards Research Co., and George Petino, their dust explosion consultant. Mr. Petino has conducted a detailed investigation of this incident and continues as a consultant to help identify appropriate handling methods for all dusting situations. His written report of the incident has not been completed at the time of this report. Included, however, as appendices to this report, are the findings of the independent investigations conducted by Industrial Risk Insurers and the Avon Lake Fire Department.

Facts Surrounding the Incident

1. Operator accounts indicate that operations were normal throughout the building at the time of the incident.
2. Three raw material bins were in use for this run. Bin #7 contained approximately 1,100 pounds of impact modifier. Bin #3 contained about 800 pounds of impact modifier. Bin #2 contained approximately 8,000 pounds of impact modifier.
3. Impact modifier was being hand dumped at the first floor dump station and being pneumatically transferred to Bin #2 on the fourth floor. Approximately 4,000 pounds had been transferred to Bin #2 just prior to the explosion.
4. The explosion slightly bowed Bin #2 with the lid being severely bowed. The "J" bolt lid clamping devices were elongated and semi-straightened.
5. An indentation on the fill pipe indicates that the lid blew open with a substantial amount of force denting the fill pipe.

CTL016292

6. The aluminum piping and bag house manifold above the lid were melted in such a manner that indicates that flame had impinged upon them.
7. The interior of #2 bin was charred and blackened while the interior of the other bins were relatively clean with some being slightly charred at the powder level.
8. Each of the raw material receiving bins are equipped with level probes. The level probes on #2 bin were found lying in the bin on top of the unburned material. The level relays mounted on the exterior of the bins and connected to the probes were severely damaged in the fire.
9. The bag house exhaust blower was operating during the transfer. The bags were changed at regular intervals. No malfunction was found.
10. Electrical continuity was checked throughout the system including the transfer line, bag house to receiving bin, bag cages to bag house, bag house exhaust line and level probe couplings. All continuity checks met standard. The bags were equipped with grounding straps.
11. The rotary valve on the first floor dump station was dismantled and inspected for proper bearing lubrication and/or seizing. It was also examined for damage which may have resulted from a foreign material passing through the valve. Other than normal wear and tear the valve was found to be in proper working condition.
12. All electrical equipment on the fourth floor was of general purpose classification for a non-hazardous area with the exception of the bin level indicators, which carried an explosion proof rating. Florescent lights provided lighting. The electrical was checked for shorts or arcing; there was nothing to indicate an electrical malfunction.
13. The fourth floor heating and ventilating system was removed and examined. Nothing abnormal was found.
14. As a result of an electrical storm passing through the area earlier in the evening, the building was inspected for a lightning strike. There was no evidence of lightning striking the building.
15. The raw material, impact modifier, was examined for contamination or decomposition. There was no evidence to indicate that the material was contaminated or that it had decomposed.

CTL016293

16. Samples of impact modifier were sent to an independent testing lab for the purpose of determining its explosion characteristics. An initial analysis of material as received and material through 200 mesh sieve indicated the material to be a "moderate" explosion hazard as classified by the Bureau of Mines rating categories. A second analysis was conducted in mid-July and was prepared for testing by passing it through a 400 mesh sieve. All samples can be ignited as a dispersed dust cloud using an electrical ignition source. The finer 400 mesh sample material is classified as a "severe" dust explosion hazard. Additionally, under these conditions, this material is very sensitive to electrostatic discharge ignition. (See Appendix)
17. During pneumatic transfer from the first floor dumping station to the fourth floor bins, dusting conditions on the fourth floor varied based on the material being transferred. At times, dusting on the fourth floor appeared to be above what was normally considered acceptable.
18. Some interior panels of the elevator shaft were damaged which indicates that the fire did travel downward through the elevator shaft.
19. The smoke patterns also indicate that the fire traveled downward through pipe raceways and floor openings.
20. Major equipment building structure damage was minimal, however, there was extensive damage to portions of the wall and roof panels. The majority of the damage to wall panels being on the third and fourth floors.
21. The sprinkler system activated as designed helping to minimize damage.
22. There were no hazardous work operations (hot work) being performed at the time of the incident.
23. Local newspapers, television and radio covered the incident as it occurred. (See Appendix).
24. The U.S. Department of Labor, Occupational Safety and Health Administration conducted an on site investigation. Following their investigation, three citations were issued. (See appendix)
25. Several meetings were held following the incident with local safety force personnel to review the incident. All parties agreed that prior planning contributed to the efficient and effective handling of the incident.

CTL016294

Management Systems Investigations

1. In March, 1985, "Z" line was completed as a turn key project by Rage Engineering. Since that time a number of improvements were made to enhance safe operations. Some of the improvements included: a) improved exhaust systems at the weigh booths; b) improved resin handling system; c) removal of dusty inclined screw feeder; d) impact modifier feeder changes; e) provided remote building ventilation pick-up points.
2. Operating procedures were prepared and available. All building operators had been trained in the operating procedures.
3. Safety equipment was provided and all operating personnel trained in its use. Material safety data sheets were available in the building and operating personnel trained on their use.
4. All electrical equipment was installed according to the National Electric Code for non-hazardous (unclassified) locations. The only explosion proof/dust ignition-proof electrical equipment on the fourth floor were the bin level indicators.
5. A fire protection sprinkler system was provided throughout the building with the exception of the fourth floor raw material storage area.
6. Most compound raw materials were recognized to be a dust nuisance but not considered to be an explosion hazard.
7. Maintenance systems are in place to handle normal maintenance repair and preventive maintenance. However, it was learned that the lids on the raw material bins were not dust tight and did allow leakage during transfer.
8. Housekeeping practices and responsibilities are outlined but did not include removal of accumulated dust from overhead, horizontal surfaces.
9. Each raw material receiving bin is interlocked with the dust collection exhaust system whereby when transferring or hand dumping (with the bin lid open) the exhaust system is automatically activated.
10. Fire brigade training and emergency response planning with local safety forces has been recognized as a primary factor in minimizing the emergency and preventing injury to personnel.
11. Independent studies of the material involved, demonstrate that under certain conditions, _____ can ignite from an electrostatic discharge.
12. After a thorough and comprehensive investigation, which included mechanical, electrical or natural causes, it has been determined that an ignition source cannot be conclusively identified.

Conclusions:

While pneumatically transferring impact modifier from the first floor to the fourth floor, the material was ignited in the receiving bin by an unidentified source. The pressure in the bin reached a level sufficient enough to force the bin lid open. Burning impact modifier escaped through the open lid. The pressure wave disturbed accumulated dust suspending the dust in a combustible cloud. The suspended dust continued to ignite until it was burned off.

The material in the bin plus partial skids of impact modifier and Hycar rubber, which were staged for hand dumping into other raw material bins, continued to burn and smolder for approximately two hours following the initial explosion.

Corrective Action

To prevent a recurrence the following corrective actions have been taken:

1. Pneumatic transferring of combustible raw materials has been curtailed until safeguards can be designed and installed. We have resumed hand dumping on the fourth floor.
2. All general purpose fluorescent lighting on the fourth floor was replaced by lighting suitable to a Class II, Division II area.
3. All general purpose electrical equipment on the fourth floor including switches, outlets and a welding outlet were either removed or replaced with equipment suitable for a Class II, Division II area.
4. Plastic conduit on the third and fourth floors was replaced with metal conduit.
5. An electric industrial truck with an "E" rating is being replaced with one with an "EE" rating suitable for a class II, Division II area. Delivery is expected in 16 weeks.
6. A number of actions have been taken to facilitate improved housekeeping:
 - a. Housekeeping assignments and responsibilities have been redefined and reviewed with all operating personnel.
 - b. Housekeeping audits are conducted weekly by department management.

CTL016296

- c. Hard to clean surfaces and floor openings have been sealed to prevent dust accumulation and migration.
 - d. Raw material bins were improved, including redesigned lids and closure devices, so as to make them more dust tight.
 - e. Additional vacuum pick up ports have been installed along with improved vacuum cleaning attachments.
 - f. The bin exhaust systems were improved (doubled fan size) resulting in increased airflow through the bins and collectors.
 - g. More effective bags are being utilized in the bin dust collectors.
 - h. The dust collectors' blowers and motors were removed from the fourth floor and relocated to the roof.
 - i. Use of compressed air for cleaning purposes has been reduced significantly.
 - j. Vents have been added to the third floor scale system to reduce dusting.
 - k. A number of obsolete internal masonry block walls have been removed.
- 7. The changing of dust collector bags has been added to the preventive maintenance program. Ease of changing has been enhanced through design modifications.
 - 8. Ventilation on the fourth floor has been improved through increased air changes. A new heating, ventilating unit is currently on order.
 - 9. False ceilings have been eliminated for the purpose of minimizing dust accumulation.
 - 10. Bonding and grounding of equipment has been verified throughout the building. Additional bonding and grounding of equipment throughout the building has been completed.
 - 11. Plant personnel have met with local police and fire departments to identify emergency response plan improvements.
 - 12. We have identified and trained an individual who will design systems and methods for safe handling of powdered materials.
 - 13. Money has been requested to make similar electrical classification changes in other department compounding operations.

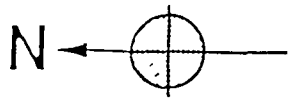
CTL016297

Appendix

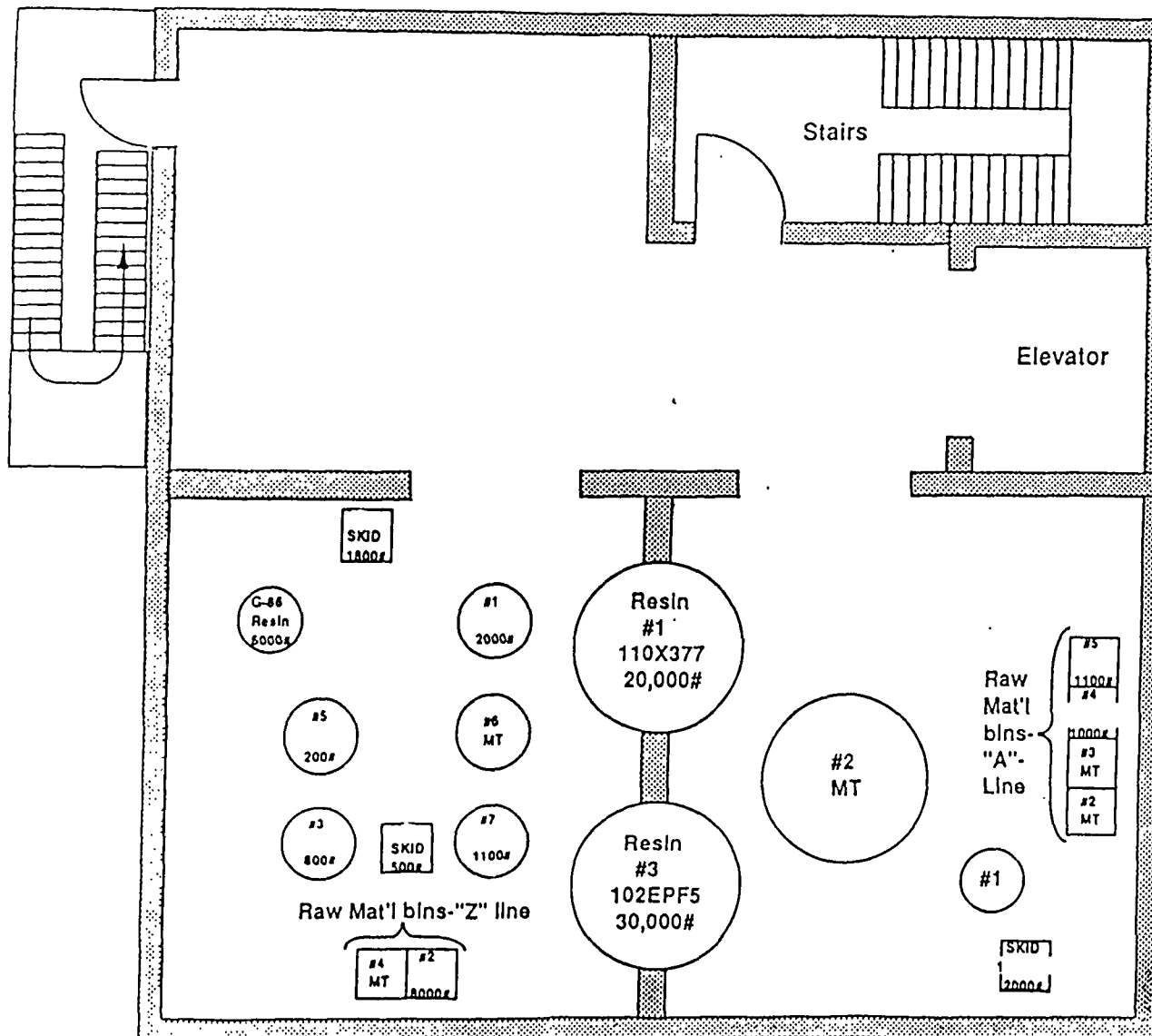
Attached to the report is additional information related to the May 9, incident; included are:

1. Compound Building 441 Fourth Floor Layout
2. Dust Explosion Characteristics of impact modifier , June 17, 1988
3. Dust Explosion Characteristics Through 400 Mesh of impact modifier , July 14, 1988
4. Avon Lake Fire Department Investigation Report
5. Industrial Risk Insurers Investigation Report
6. U.S. Department of Labor OSHA Citations
7. BFGoodrich Reply to OSHA Citations
8. Various Newspaper Accounts

CTL016298



COMPOUND BUILDING, B/441
RAW MATERIAL STORAGE BINS
FOURTH FLOOR



RAW MATERIALS

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