COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Pneumatic Transfer Systems (not be be confused with dust collection, etc.).
- Centralized Vacuum Cleaning Systems.
- Mechanical Bulk Material Transfer Systems.
- Material Size Reduction Equipment.
- Mixing and Blending Equipment.
- This short session will only touch on the main issues and not in depth – more on these issues in the “break-out” session.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- **GOALS** of this portion of the session:
  - Discussion of the combustible dust considerations that are **common** to the significant majority of the equipment items and/or systems.
  - Discussion of the combustible dust considerations specific to the type of equipment and/or systems.

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- This is a ***HUGE*** subject to cover, and what makes me think I can provide the information you need?
- The simple answer is – heavy duty, direct, experience covering 35+ years.
- During that time period have designed, literally hundreds, if not thousands, of these systems – D.C., pneumatic transfer, bulk transfer, milling, mixing, weighing, feeding, storage, central vac cleaning, etc..

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- If it is a bulk material I have been very likely been involved with the design, specification, installation, start-up, training, and operations/maintenance manuals for the systems used to "bulk-handle" that material for processes and/or general bulk handling.

- No brag, just fact. This makes me an "expert" (little drip under high pressure and I traveled a lot more than 50 miles).

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Also member of four(4) NFPA committees – 654 (with 91 and 655), 664 (wood), 61 (agri and food), and the new “60” – fundamentals. On committees only for a short time (since about 2008).

- Honestly NOT trying to make myself out as someone “special”, just trying to assure the listeners that the information provided is based upon **real world practical experience.**

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- For those of you using "combustible dusts" the "you-know-what" hit the proverbial fan in 2008. That is when the NFPA (and other) documents became the standards by which OSHA determines a facility's compliance concerning combustible dust issues.
- That is also when I decided to get more involved in this issue – not knowing how utterly frustrating it can be.
- Read the NFPA documents (or tried to) and felt some real-world input was needed.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Went into the meeting (first was 654) thinking I could save industry from the “tyrant” of government intervention and instead discovered that NFPA was not affiliated with anyone – let alone the government – and their sole purpose was to develop information to assist industry in providing as safe an environment as reasonable and feasible for both production and the employees.

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Not to say the NFPA was or is "perfect". There is definite room for improvement.
- This symposium is a perfect example of their efforts to listen to and assist industry in compliance with the OSHA National Emphasis Program on combustible dusts.

- Apologize if that was boring – it needed to be said to clear-up misconceptions.

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- First, some additional, very necessary, clarification.
- Dust Collection is NOT the same as Pneumatic Conveying and Centralized Vacuum Cleaning is NOT the same as either of the previous systems. There are key differences in design, operation, and in combustible dust protection requirements.
- The NFPA recognizes that fact, is adjusting to this in the documents, and this symposium is further proof.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Basically the differences are:
  - Dust collection uses high air mass (comparative) and low differential pressures (comparative) to contain, capture, and control **airborne** dusts.
  - Pneumatic conveying/transfer uses relatively low air mass at high differential pressure to move a **controlled flow** of material from one point to another (or multiples).
  - Centralized vacuum cleaning systems use low air mass and high vacuum to remove material at rest on surfaces and convey that material to a central location – material flow is not controlled.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Common combustible dust compliance issues that apply to all the types of bulk handling systems:
  - Definitions – read and become familiar with them as there may be slight differences and they are constantly being refined and corrected. Each NFPA document has a section of definitions – some in common – some unique to that document (e.g. 61, 484, 664, etc.).
  - Virtually all the "special industry' documents – 61, 664, etc. – refer back to 654 which can be considered the "source" for much of the basic information.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- General Requirements for compliance:
  - Process Hazard Analysis, Risk Analysis, HAZOP, etc. Don't let all the listing get you frustrated. The key is to provide the **very necessary first step** of determining what **risks** your process, system, equipment, operations, etc., create when in use. That is why I prefer to use the terms "Risk Analysis" for this important task (see 7.1.1 – 654).
  - It is impossible to provide compliance with combustible dust issues without **FIRST** determining what those risks are – each system is unique.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- General Requirements for compliance:
  - Part of the purpose of this talk is to assist you in determining those risks.
  - Whoever best knows the system(s) is or are the individual(s) who should do the analysis.
- Section 4.4 (654) states:
  - Pneumatic System Design (all types): Systems that handle combustible particulate solids **shall be** designed by and installed under the supervision of qualified engineers who are knowledgeable about these systems and their associated hazards.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Don’t forget the “Performance Based Design” option:
  - This is specifically provided for those situations when, through honestly effective design, or other means, the risk can be made acceptable to the AHJ without complying with the more typical compliance methods.
  - Example – filter receivers with small lines.

- Document, document, document – cannot be overemphasized – you must prove what you did – forever.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Other "common" items:
  - 7.1.4.1 (654) – paraphrased – if an explosion hazard exists you shall provide isolation between the various equipment items, etc. Purpose is to prevent propagation of an explosion/fire.
  - Filter receivers, storage hoppers, or other containers less than 8 cu. ft. do NOT need isolation/venting/suppression – unless there is an obvious risk (always seems to be exceptions).
  - Don't interconnect various equipment without that isolation, etc. The picture following this slide illustrates why.

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Manifolded dust collection system - propagation

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Dilute Phase Pneumatic Transfer:
  - "Dense Phase" types will be discussed later.
  - The most common type of pneumatic transfer system – both vacuum and positive pressure.
  - They can be simple, complex, have more than one material source and/or more than one material discharge point.
  - The vast majority of these systems use positive displacement blowers for the motive force, operating usually below 15 psig or 12" hg vacuum.

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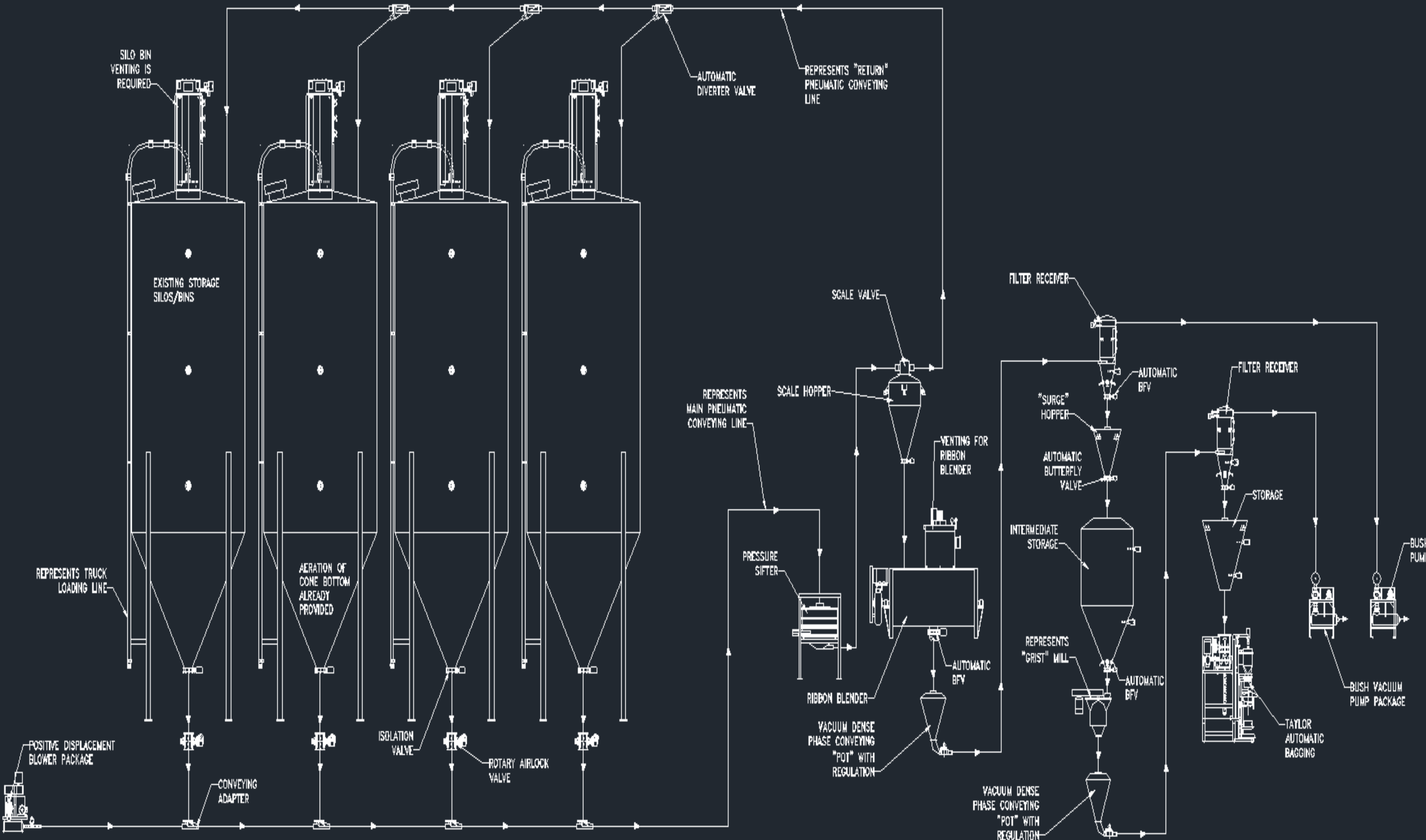

Positive Pressure Dilute and Vacuum Dense Phase Conveying

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Dilute Phase Pneumatic Transfer:
  - Unlike dust collection, pneumatic conveying has a positive, low (comparative) risk-history for fire and explosion.
  - Not that the risk is not evident, nor that it never occurs (because it does), but with proper design, proper deflagration protection and preventative maintenance, these systems can be relied upon to perform without incident for years.

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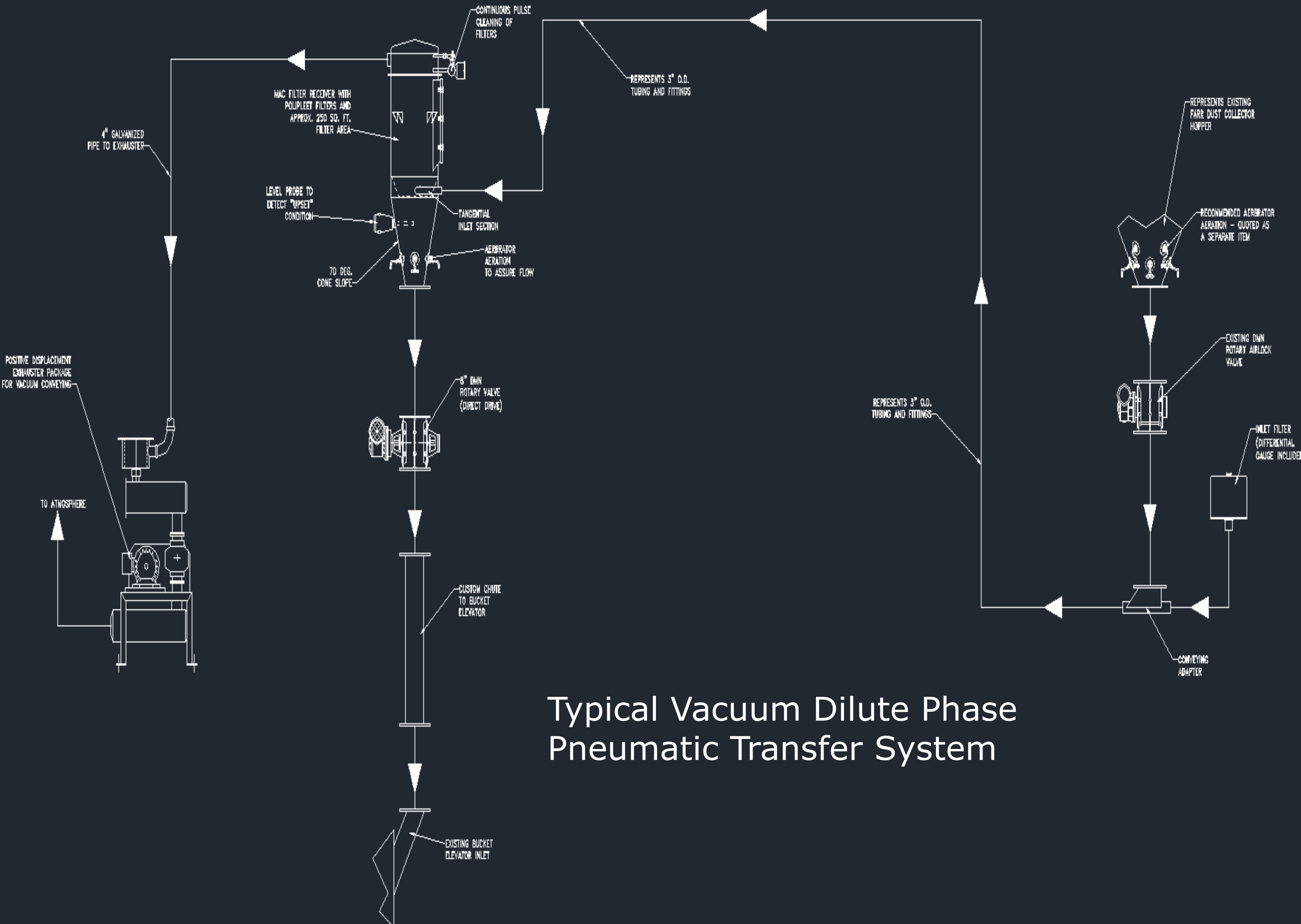
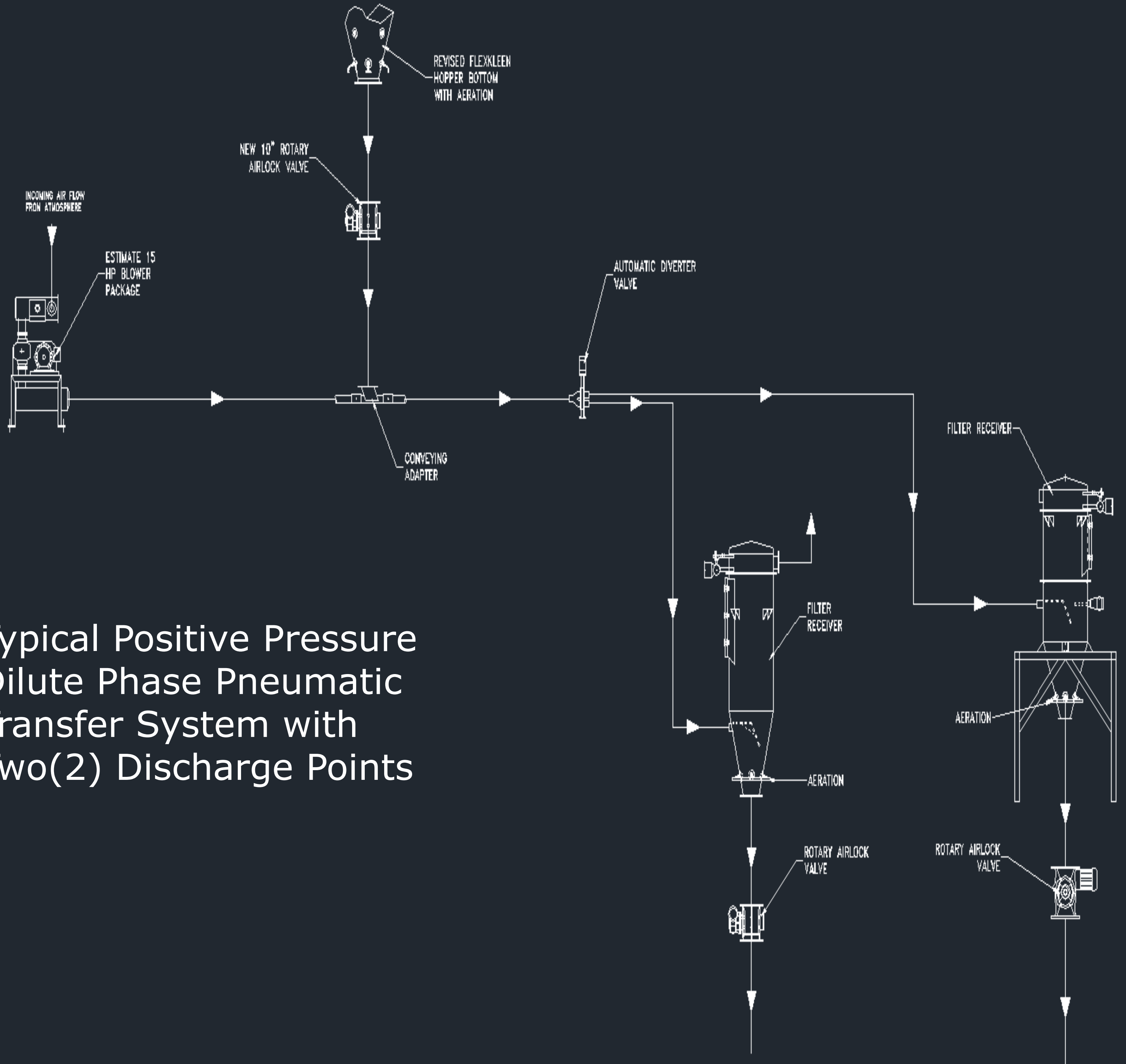


Typical Vacuum Dilute Phase Pneumatic Transfer System



Typical Positive Pressure
Dilute Phase Pneumatic
Transfer System with
Two(2) Discharge Points

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Main Equipment Items:
  - Blower Package:
    - Except for “pull/push” fan package systems, this device, assuming proper maintenance, presents a low risk. Only when used with positive pressure could failure result in supply of an ignition source. When this unit fails, the system ceases to perform.
  - Material Feeding Device:
    - Usually a rotary airlock valve, but can be many type of metering devices for a vacuum conveying system.
    - Again a low risk device. Only fixed-tip, steel units should be used. Provides for both isolation and metering of the material. Bearings a possible ignition source.

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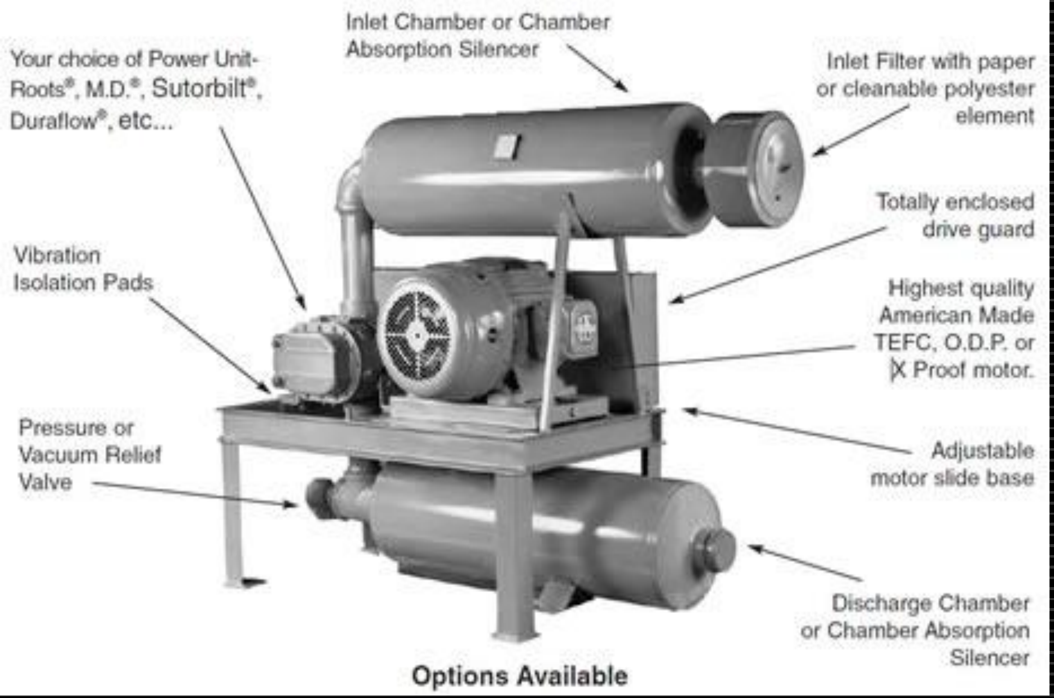

Typical Rotary Airlock Valve with Fixed Tips

Typical Positive Displacement Rotary Lobe Pressure Blower Package

Inlet Filter also acts as a "final filter" to limit dust entry, etc..

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Main Equipment Items:
  - Piping or Tubing:
    - Very low risk portion of the system. Proper grounding (continuity) is main concern along with abrasion and other wear-related items.
    - A vacuum system leaks "in", while a positive pressure system leaks "out". If a hole develops due to wear a positive pressure system could create a cloud of dust through a very small hole – a significant risk source.
    - Hoses are viable, must be static dissipative and must be checked for continuity. Can also be used as an "isolation" device (designed to fail – but would require Performance Based Design documentation).

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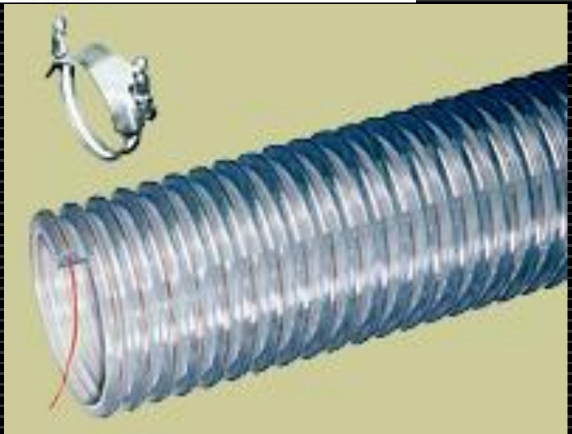
Compression clamp – can have ground strap

Elbows

Tubing

Copper Ground Straps

Hose with Ground



COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Main Equipment Items:
  - Filter Receiver (Air-Material-Separator):
    - Basically the same function as a dust collector, but designed for high differential pressure and high material loading.
    - Highest risk factor in the system and mainly due to the possible presence of an ignition source such as tramp metal.
    - Requires both isolation and suppression/venting.
    - Not normally used for material storage, but can be designed (hybrid) to do so. That would require additional venting/suppression due to higher volume (example – bin vent with silo or custom designed receiver).

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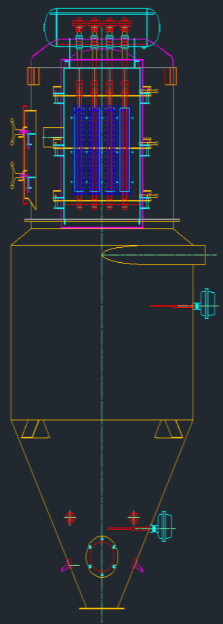

Hybrid Unit – Both Filter Receiver and Storage

Typical Filter Receiver with Pulse-Jet Automatic Filter Cleaning

Bin Vent acting as a "Filter Receiver" by providing the venting of the silo/bin "receiving" the material – requires considering all the assembly for deflagration hazards

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Main Equipment Items:
  - Filter Receiver (Air-Material-Separator):
    - Commonly a rotary valve is used for the receiver (AMS) discharge, but it can be part of a silo – making the whole assembly a “filter receiver” as well as a storage silo.
- Overall System Risk:
  - The main risk involves “foreign” material such as tramp metal.
  - This is especially true with truck and railcar unloading and conveying with a vacuum pick-up wand.
  - Unless it can be guaranteed that no foreign material is present then that risk remains.

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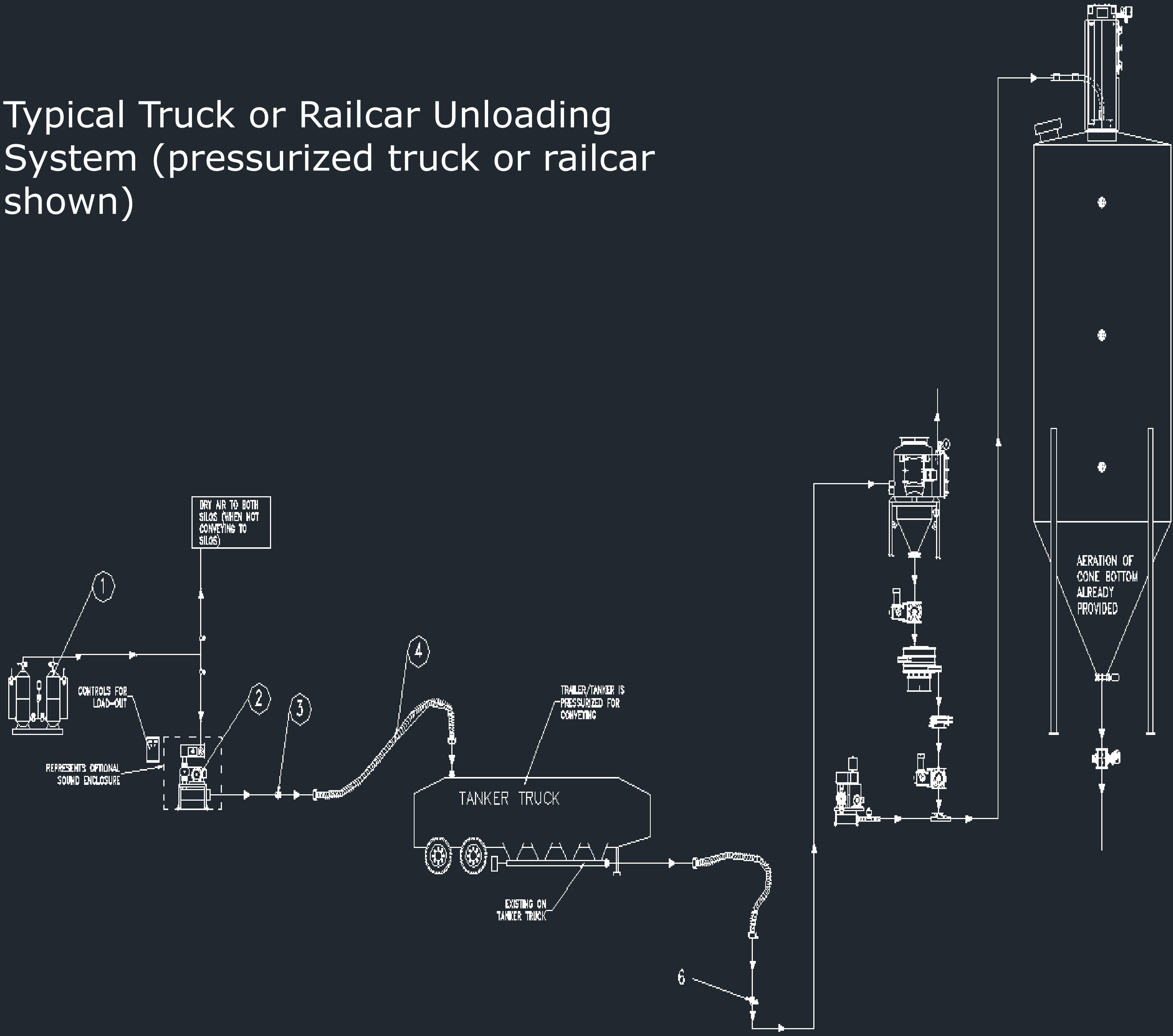
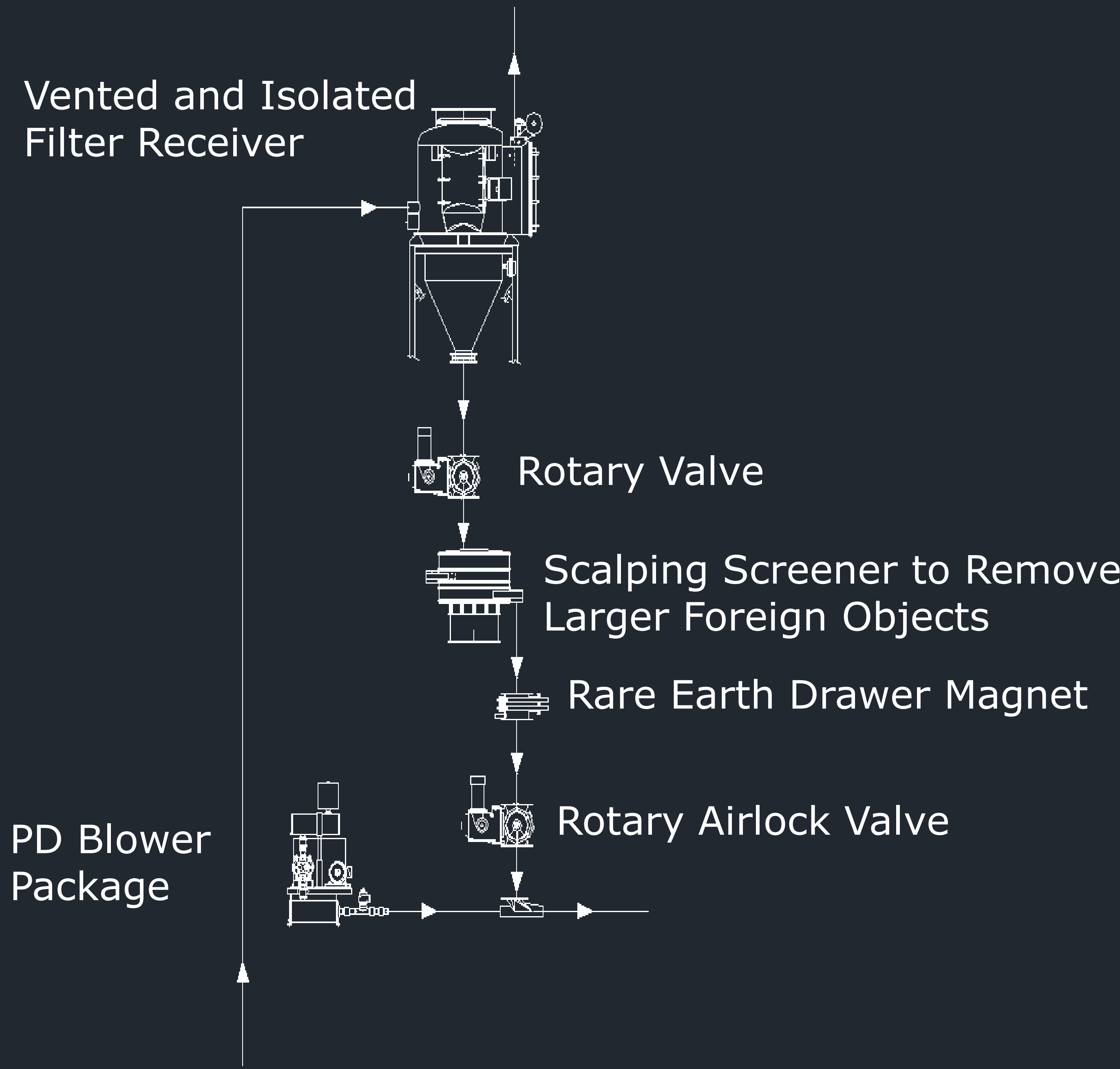
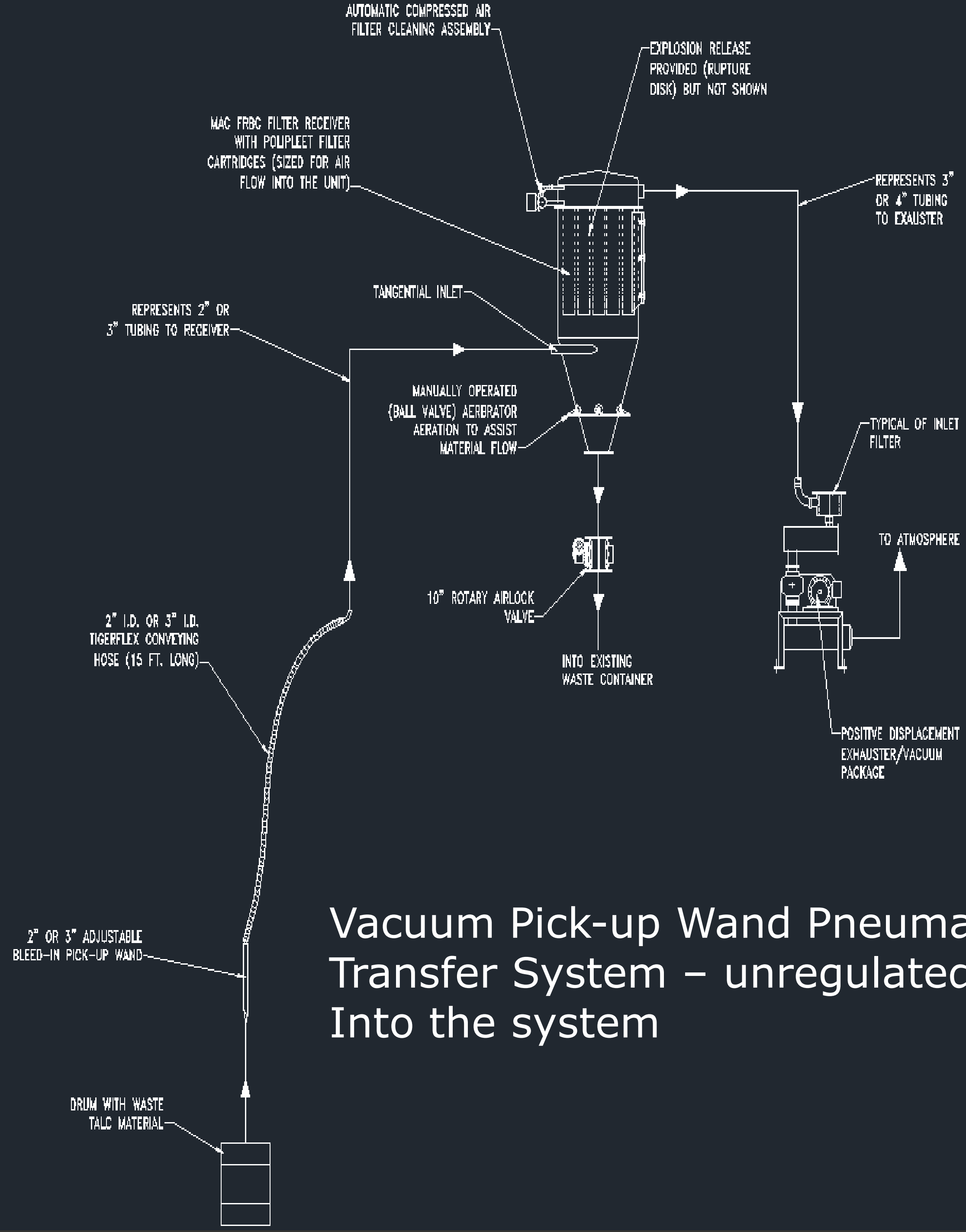
Typical Truck or Railcar Unloading System (pressurized truck or railcar shown)




Vented and Isolated
Filter Receiver
Rotary Valve
Scalping Screener to Remove
Larger Foreign Objects
Rare Earth Drawer Magnet
Rotary Airlock Valve
PD Blower
Package



Vacuum Pick-up Wand Pneumatic Transfer System – unregulated flow Into the system

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Dense-Phase Pneumatic Transfer:
  - As the name implies the system conveys a much higher mass of material in the same size pipe as a "dilute" phase system.
  - This is done through various means but mainly more pressure, etc.
  - Can be vacuum or positive pressure.
  - Some materials cannot be conveyed in this manner.
  - Overall these systems are very similar to the previous.
  - Inherently safer due to lower velocity, construction, high material loadings, etc..

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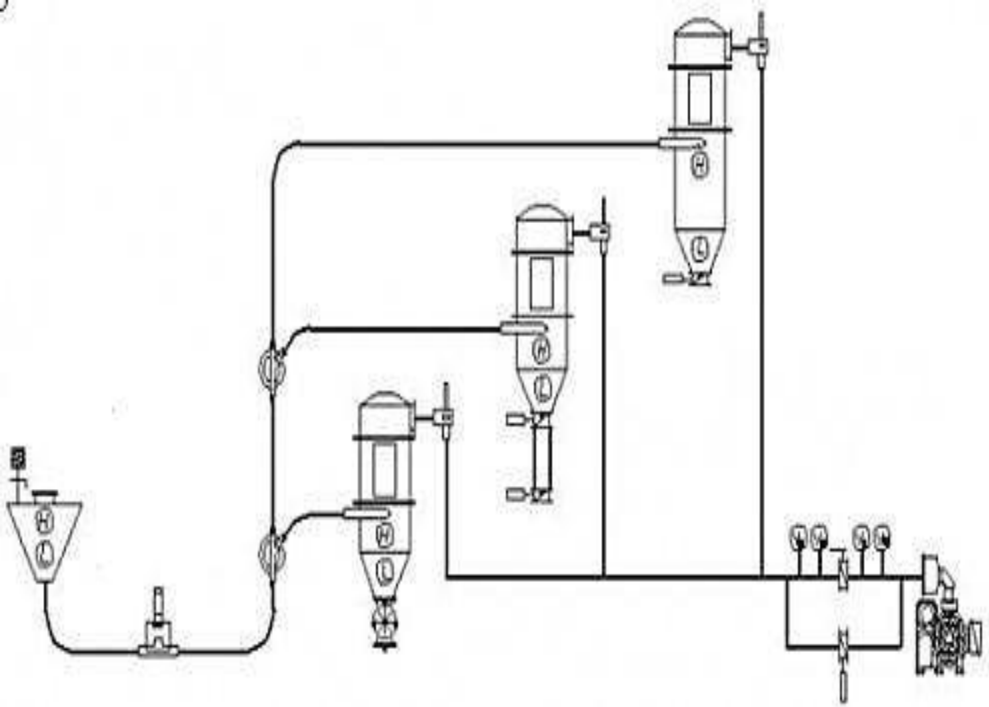
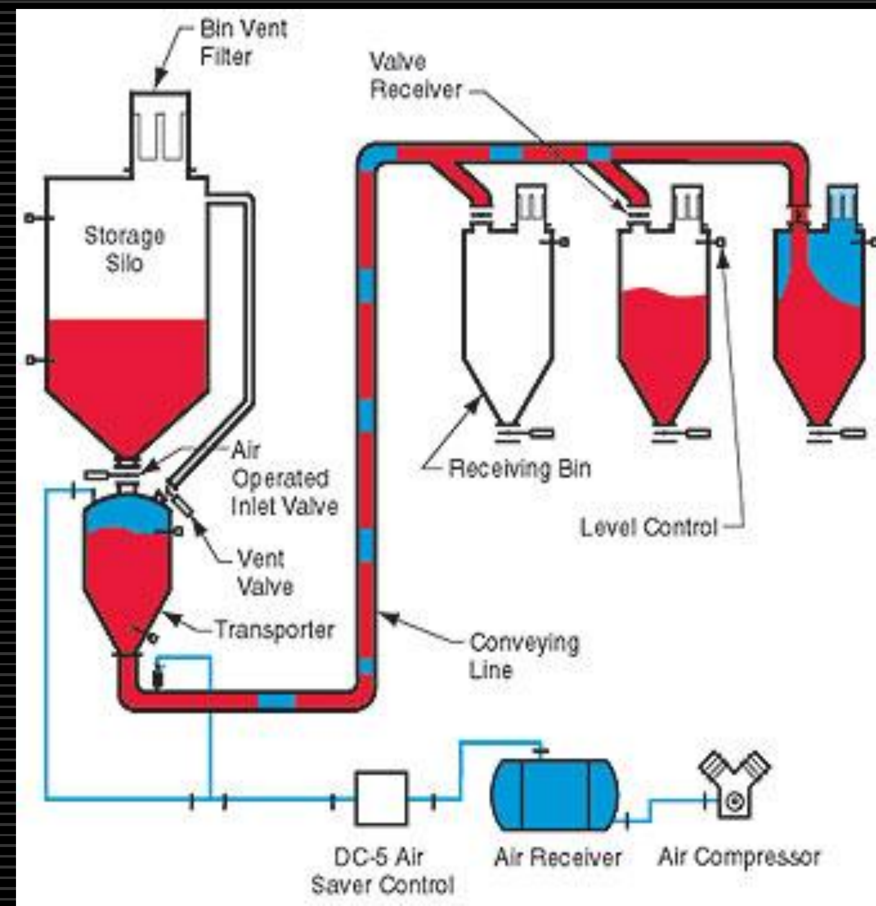


Vacuum Dense Phase Conveying System with Multiple Discharges

Typical “Pressure-Pot” Dense Phase Pneumatic Transfer System



COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Dense-Phase Pneumatic Transfer:
  - Also, usually the equipment is much smaller, for the same conveying rate, than a dilute phase system.
  - Especially with low MIE materials and those with higher risks (e.g. pulverized coal, sulfur, phenolics, stearates, etc.) this would be a strong alternative.
- Special note – smaller systems with filter receivers of less than 8 cu. ft. total volume require no suppression/venting unless special circumstances exist.

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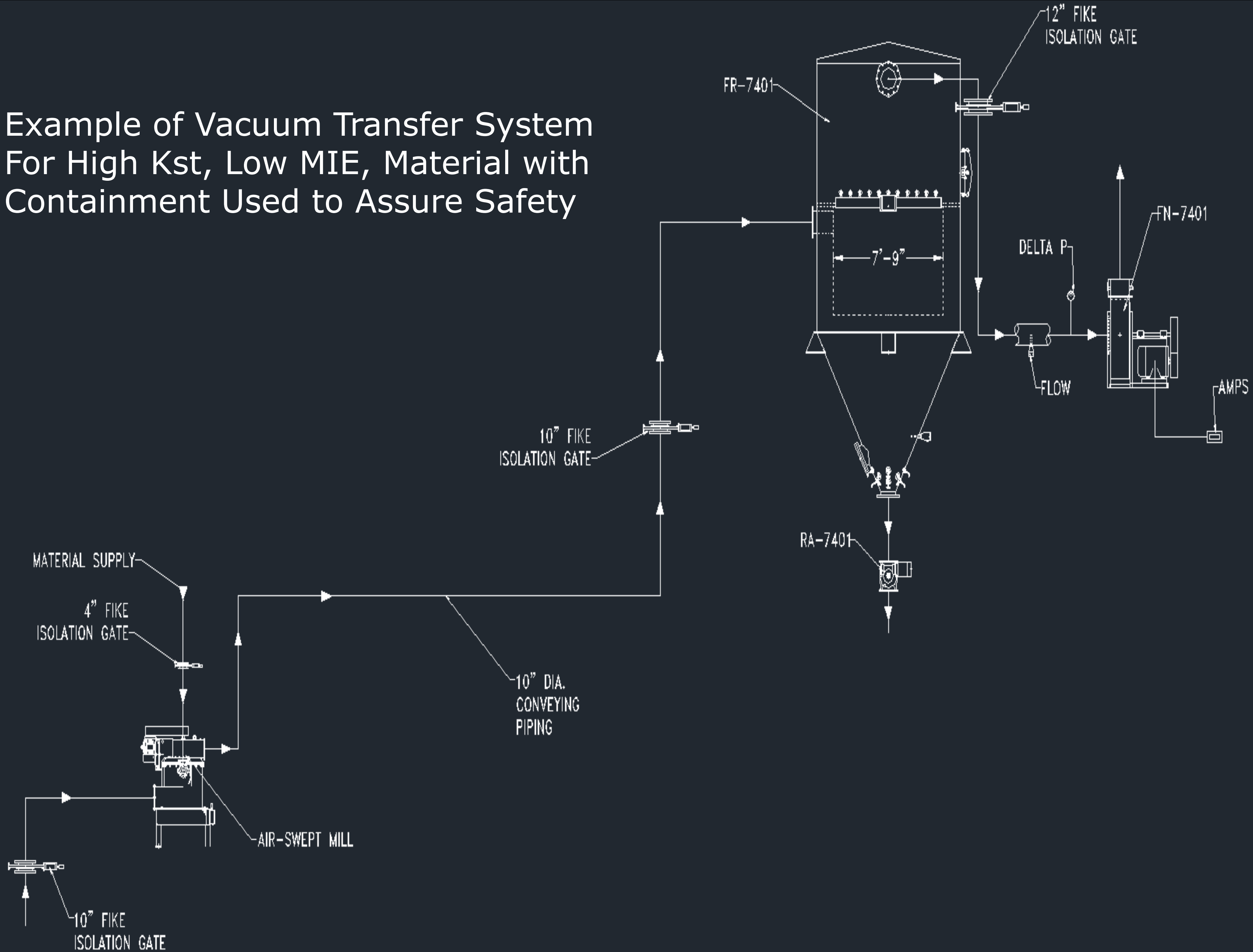
COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Another alternative is to consider "containment".
  - This involves designing the system to CONTAIN any deflagration event within the system and its equipment.
  - For some high risk materials this is the best and most feasible alternative.
- Another possibility is use of low oxygen and/or nitrogen gas (substitute for air) conveying. Examples would be coal, metal dusts, etc..

Example of Vacuum Transfer System For High Kst, Low MIE, Material with Containment Used to Assure Safety



COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- General Operational Considerations:
  - Provide for adequate monitoring systems such as pressure transmitters/gauges (best), zero speed switches, bearing temperature, etc.
  - Starting-up – initiate the blower assuring air flow and proper “no-material” pressure and that all items confirmed running normal.
  - Shut down – stop feed and let system clean out. Dense phase blow-out if feasible.
  - Constantly monitor pressure – best indication.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Pneumatic Transfer System Deflagration Protection:
  - Risk analysis – determine actual risk.
  - If a risk is there then isolation and suppression/venting will be required.
  - Performance Based Design may be an option that minimizes both risks and costs.
  - Consider passive over "active" when feasible/viable.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Centralized Vacuum Cleaning Systems:
  - What is it? – A system of equipment designed to allow individuals to utilize vacuum pneumatic conveying to remove accumulations of dusts and larger particles from one location to another, centralized, location.
  - Consists of:
    - Vacuum producer.
    - Filter receiver.
    - Tubing/piping.
    - Inlet valves – hose connection stations.
    - Vacuum cleaning hose and tools.

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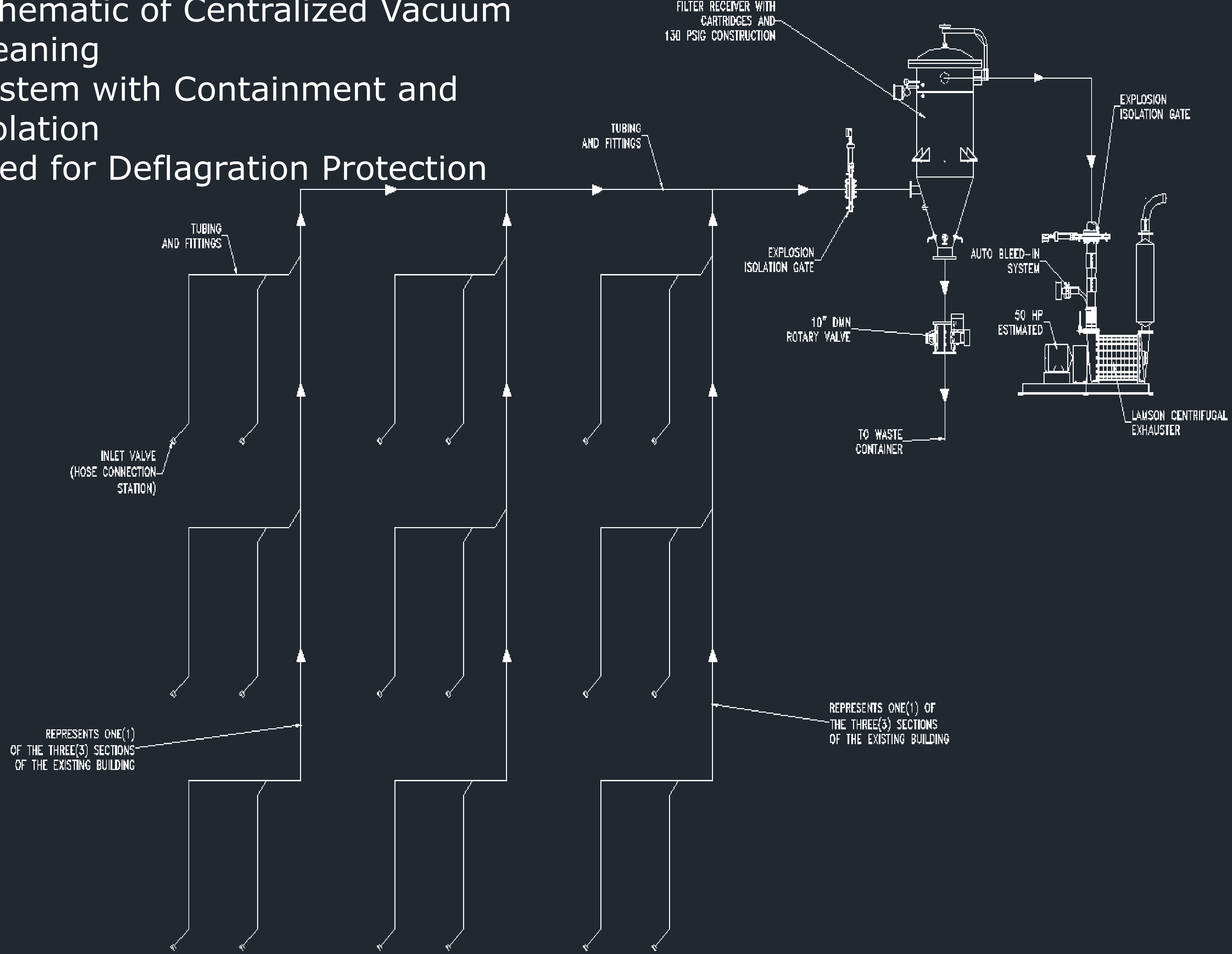
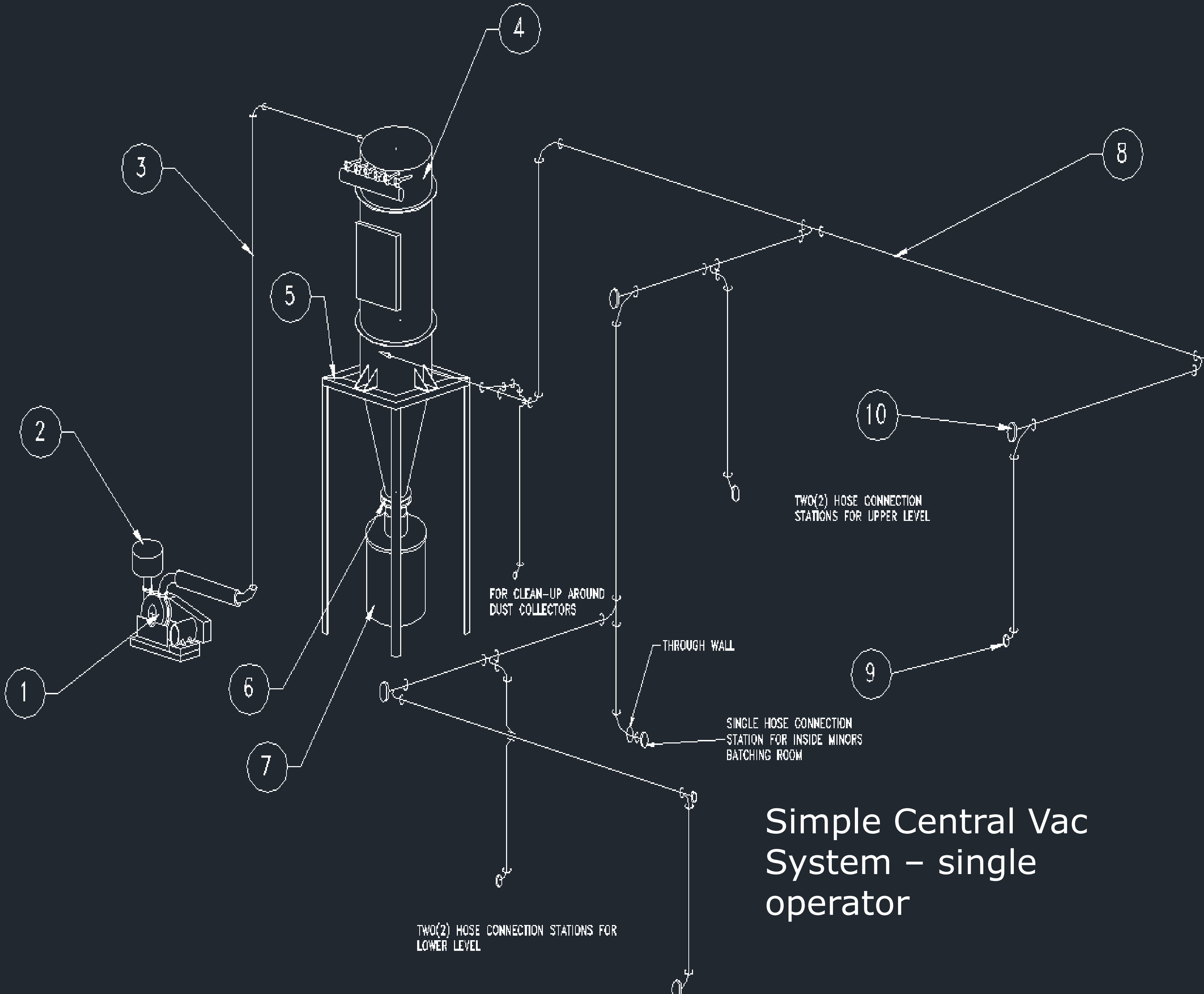
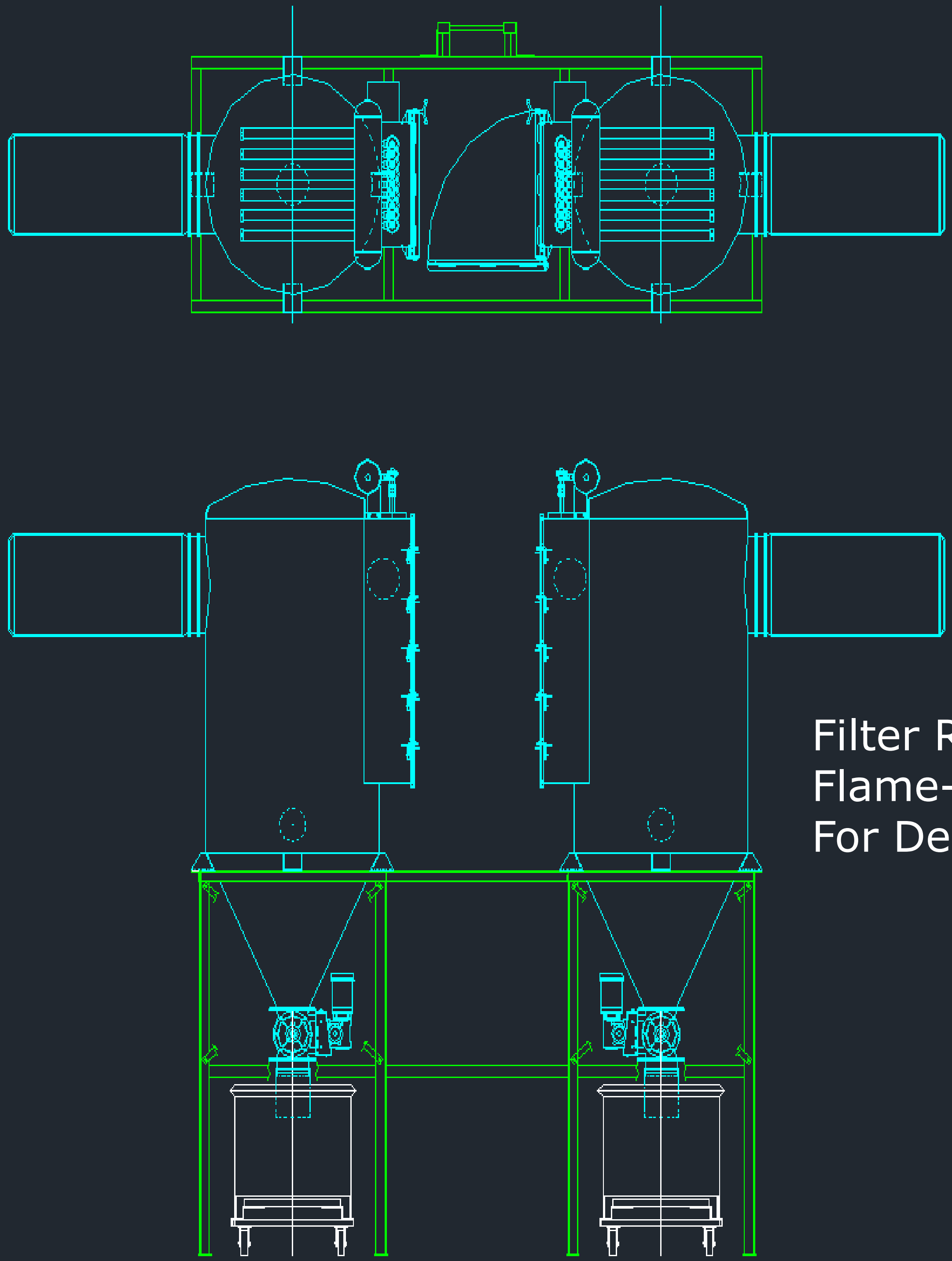
Schematic of Centralized Vacuum Cleaning
System with Containment and Isolation
Used for Deflagration Protection





Simple Central Vac System – single operator



Filter Receivers each with
Flame-Arrestor Units (Vented)
For Deflagration Control

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Centralized Vacuum Cleaning Systems:
  - Much higher risk than a pneumatic conveying system.
  - Why? Operators vacuuming-up anything that will fit into the hose – no such thing as "foreign" material as nuts, bolts, washers, welding rods, bits-and-pieces, etc. – even cigarettes will find their way into this system.
  - It ***must be assumed*** the risk of a deflagration is high.
  - Why use one? It **REMOVES** the combustible dusts in a controlled, safe manner to a safe, central location.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Centralized Vacuum Cleaning Systems:
  - Design criteria for a successful system:
    - No single line (from vacuum point to receiver) must designed for more than two(2) simultaneous operators. This allows assurance of adequate velocity.
    - Maximum of 25 ft. hose length.
    - 1.5" or 2.0" hose i.d.
    - Vacuum range from 10" to 12" hg to assure performance.
    - Use PD unit where feasible (not always) for the vacuum source – will not "unload" when trying to "unplug" (and these systems do plug – hair nets, plastic, paper, coke bottles and cans, etc.).
    - Size filter receiver and vacuum blower conservatively.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Centralized Vacuum Cleaning Systems:
  - Specific considerations:
    - Hoses and tools: Readily available. Metal tools and cuffs on hoses – no PVC or similar. Hoses must be static dissipative and properly grounded at the ends for continuity.
    - Use the custom fabricated "vacuum cleaning" tubing and fittings. Avoid shrink-sleeve coupling (have to ground) – use compression clamps with proper grounding.
    - Cyclone is not recommended nor necessary – just extra cost.
    - Filter receiver – as before with pneumatic transfer systems. NO storage capacity – constant discharge recommended (into safe container).

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Various Hoses and Tools

Metal tools with static
Dissipative hoses

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Centralized Vacuum Cleaning Systems:
  - Specific considerations:
    - Locate the filter receiver (AMS) in a safe place. Not around other risk areas or dust (e.g. not in maintenance area around welding activities). Outside is always preferred.
    - Filter receiver will "normally" require isolation and suppression (or venting).
    - It is feasible to use Performance Based Design criteria to establish that inlet isolation is not required. If vacuum blower is outside or discharges outside, isolation may not be required for that portion also.
    - Good rotary valve will provide isolation for the material discharge.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Centralized Vacuum Cleaning System Deflagration Protection:
  - Basically same as pneumatic transfer.
  - Risk analysis – determine actual risk.
  - If a risk is there then isolation and suppression/venting will be required.
  - Performance Based Design may be an option that minimizes both risks and costs.
  - Consider passive over “active” when feasible/viable.

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Explosion Proof Portable Vacuum Cleaners:
  - They DO exist – they are not cheap.
  - Various types from electric to pneumatic (usually a venturi type using compressed air).
  - Class II, Division 1 (and 2) certified, listed/labeled.
  - Examples follow on next slide – from internet – each claiming to be certified/listed.

Various Portable Vacuum Cleaners Meeting Class II, Division 1 and 2 Requirements

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Systems and Equipment:
  - Typical equipment systems consist of bucket elevators/conveyors, belt conveyors, drags, screws, pocket, vibrating conveyors and feeders, and a multitude of specialty items.
  - Any time there are moving parts, especially with bearings and metal involved, there are multiple sources of ignition.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Systems and Equipment:
  - Major risk items:
    - By far – by far – bearings are the major risk items in this (and other rotating) equipment. This includes the bearings in idlers, rollers, drives, etc., and cover the fully range of types. Bearing failure is quite common. Both Imperial Sugar and Georgia Biomass (wood dust) cause factors are associated with failed bearings. Airdusco knows of two(2) recent explosions in our area – property damage only – with two(2) grain terminals – bucket elevators involved with each.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Systems and Equipment:
  - Major risk items:
    - Metal-to-metal friction and sparks. This includes digger-buckets, rubbing of drag conveyors and screw conveyors, etc.
    - Plugged, blocked, or backed-up inlet chutes/feed points and/or discharge chutes/outlets. Most mechanical bulk conveying equipment items are “positive displacement” for the material and will “force-feed” at the discharge – causing significant risks to occur.
    - Lack of proper dust collection. In almost every incident, proper dust collection may have eliminated the resulting deflagration.

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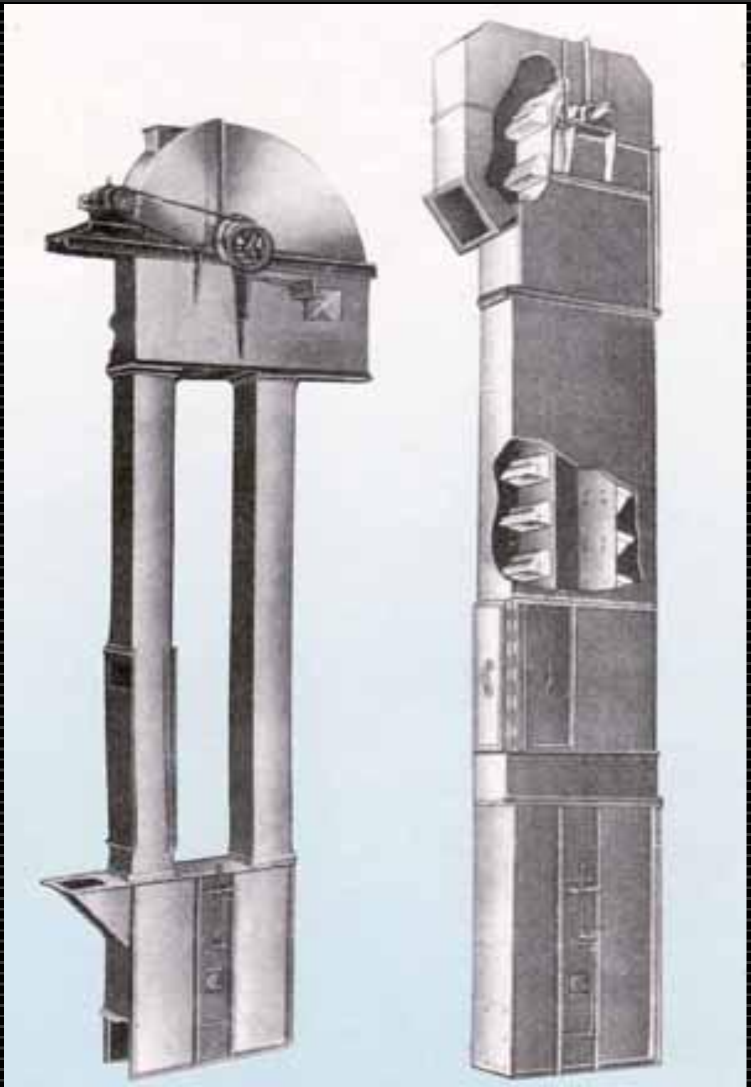
"Z" Type Bucket Elevator/Conveyor

Typical of Bucket Elevators



COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - Bucket Elevators and/or Conveyors (Z):
    - Enclosed bucket elevators represent a high risk for combustible dusts. The inherent operation of these devices create a perfect environment for deflagration – especially with a vertical lift and material falling down – very common.
    - NFPA 654 and 61 have a multitude of exclusions. These are not there to allow the circumventing of proper protection, only to make the reader aware of possible, real reasons, why some risks are less than others.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - Bucket Elevators and/or Conveyors (Z):
    - It is my **very strong belief** that ***all enclosed bucket elevators be considered a signficant deflagration risk.***
    - For example – consider the previous example of the two(2) grain terminals with bucket elevator explosions. Both units were operating below the limits listed in 61 – yet both resulted in explosions with significant property damage.
    - Consider, also, Imperial Sugar, with 14 deaths and 36 injuries: This shows the aftermath – of which the bucket elevators in question were a major, secondary explosion, contributor.

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THIS WAS IMPERIAL SUGAR IN GEORGIA

THIS IS THE AFTERMATH.

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - These are excerpts from the public document of the case between OSHA/Secretary of Labor and Imperial Sugar regarding the lack of deflagration protection equipment on two(2) of the bucket elevators directly involved in the deaths and injuries:
    - "Secretary alleges the bucket elevators in the South Packing House and Bosch Packing House, used to convey granular sugar, were not equipped with bearing temperature, belt alignment, and vibration detection monitors……these same bucket elevators were not equipped with explosion relief venting to prevent secondary dust explosions and/or rupture of the elevator housing."

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - Imperial's response:
    - "Imperial asserts that the bucket elevators used at the facility do nut run at speeds greater than 500 fpm and fit within the exceptions to certain sections of NFPA 61…"
    - This despite the fact Imperial vented other bucket elevators conveying the same material.
    - NFPA offers these exceptions only as a comparison of risk levels – NOT to imply that any bucket elevator carrying combustible dust below a certain performance level is automatically safe – that is not so. Offering an option does **not** mean NO risk.
  - Consider the REAL risks – is that bucket elevator really safe?

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - Bucket Elevators and/or Conveyors (Z):
    - Recommended compliance approach:
      - Perform a Risk Analysis.
      - Provide bearing monitors for vibration and temperature – especially temperature.
      - If feasible – belt alignment monitors.
      - Avoid digger buckets – sparks.
      - Use proper bucket size.
      - Provide venting of the vertical enclosure (and perhaps horizontal) if warranted or consider suppression.
      - Use adequate Dust Collection – a key element.
      - Monitor the inlet and outlet for proper flow.

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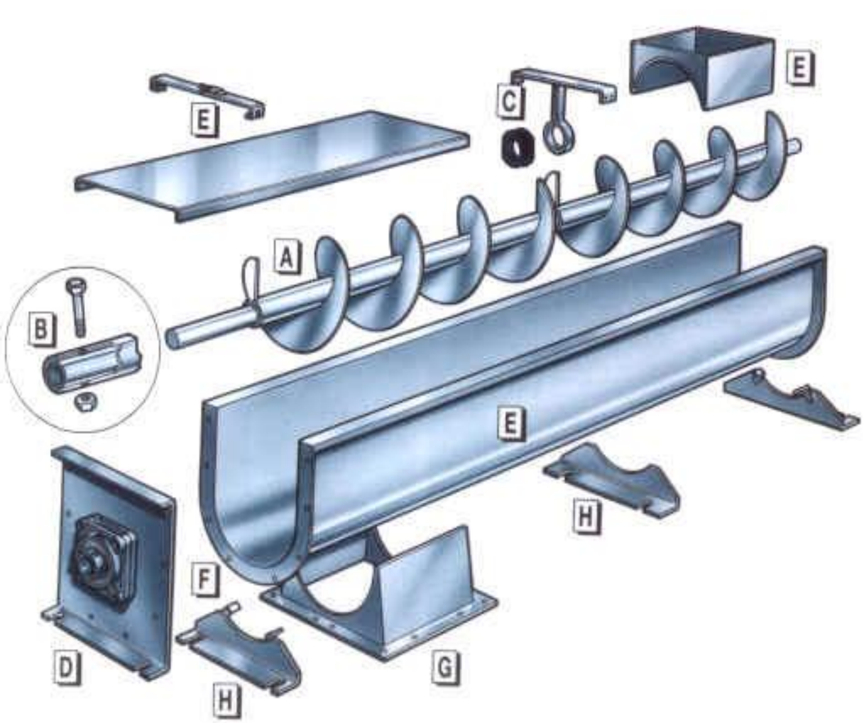

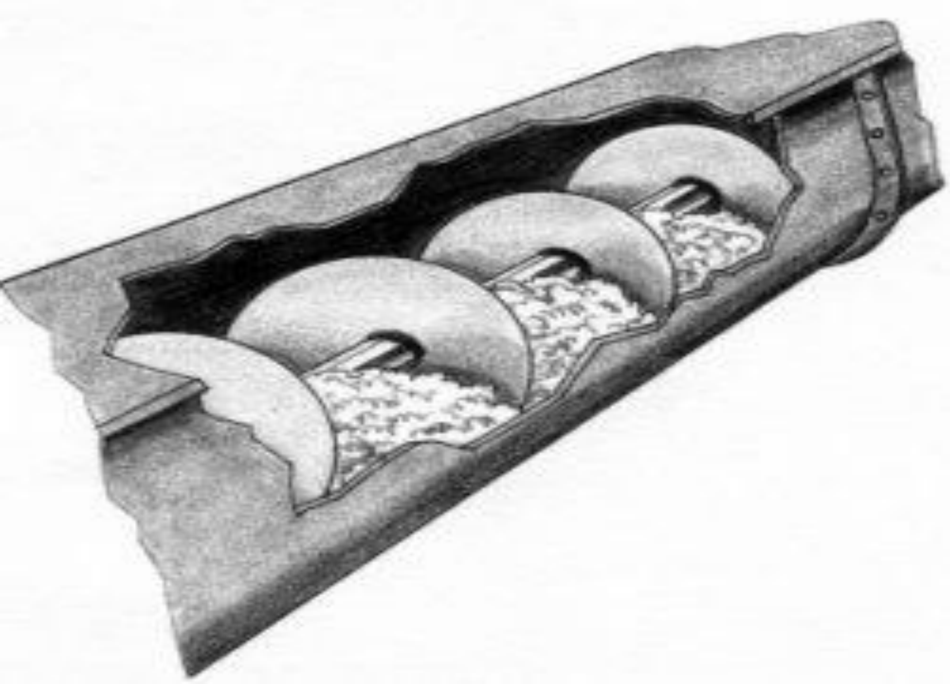

Images of Screw Conveyors and Screw Conveyor Components

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - Screw Conveyors:
    - Normally considered a comparatively low risk device, assuming proper maintenance, use, and operation.
    - Risk considerations:
      - Drive – often belt or gear drives. Have personally witnessed a drive "on fire" around piles of burnable materials (rice mill).
      - Internal hanger bearings – failure leads to all sorts of "ignition source" possibilities.
      - End bearings – can be another source.
      - Plugged flow into and out of the unit.
      - Lack of proper dust collection – allows accumulations of finer dust particles.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - Screw Conveyors:
    - Recommended for compliance and safety:
      - Zero speed switch/monitor.
      - Plugged flow monitor (discharge most important).
      - Proper dust collection.
      - Using bearings that limit possible heat transmission.
      - Avoiding hanger bearings where feasible.
      - Low rpm operation.
      - Use materials that would limit possibility of spark generation.
      - Proper grounding.

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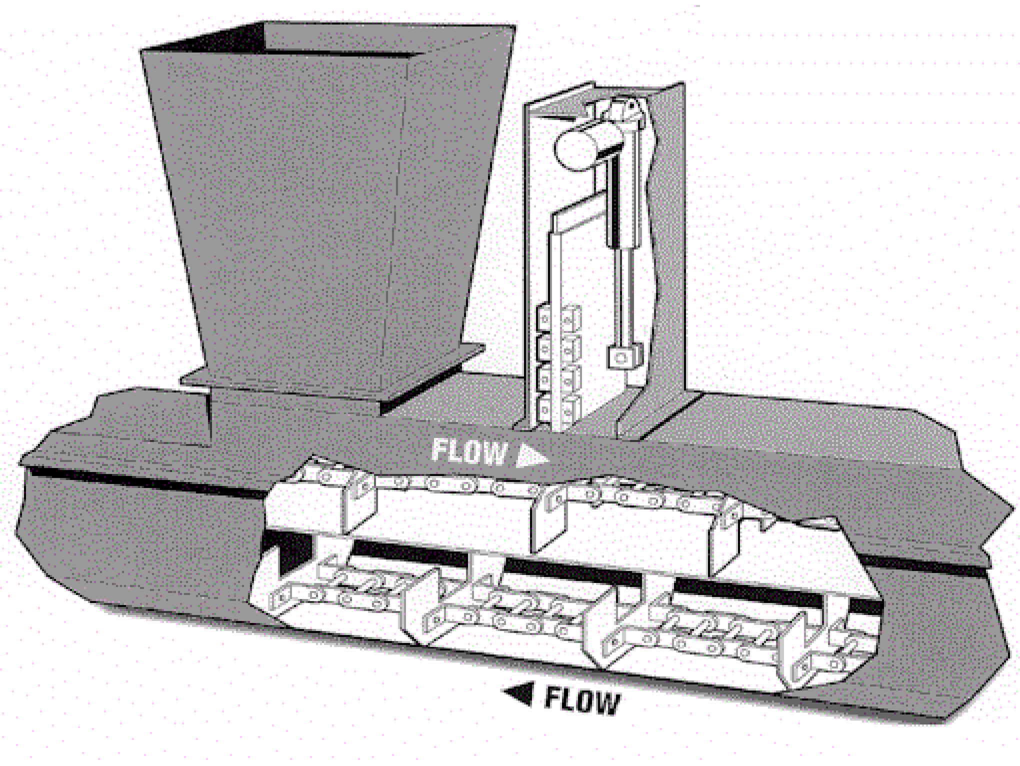

Images of Drag Conveyors
And Drag Conveyor Components

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - Drag Conveyors:
    - What I would consider a "medium" risk device – more than a screw conveyor, but less than a bucket elevator.
    - Main risks are very similar to the screw conveyor, but the operation of a drag conveyor inherently leads to more metal-on-metal contact and increased risk of creating a viable ignition source.
    - This device, like the screw conveyor, is more likely to convey an ember, etc., to a deflagration risk location (e.g. silo, bin, etc.).
    - Compliance and safety methods would be very similar to the screw conveyor.

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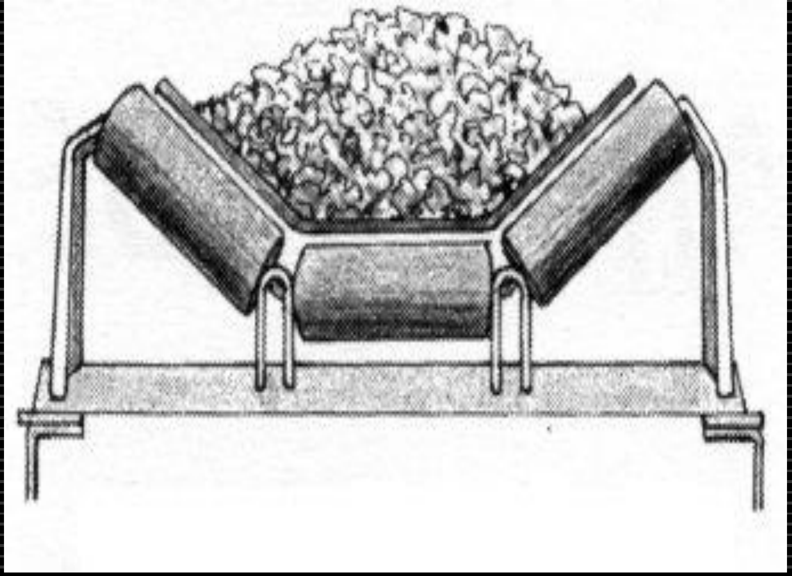
Roller Conveyor



Profile of Trough Belt Conveyor

Typical of Enclosed Belt Conveyors

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - Belt and Roller Conveyors:
    - Also what I would consider a “medium” risk.
    - However, these devices (the bearings in the idlers/rollers) led to the Imperial Sugar and Georgia Biomass explosions. The risk is real.
    - Main risks are involved with the drive and roller/idler bearings and the accumulation of materials on those items. Bearing failure, etc., leads to heat which is transmitted to and through the combustible dust accumulations.
    - Lack of proper dust collection and enclosures of the inlet and discharge lead to that unwanted accumulation of materials.
    - Or just plain lack of proper housekeeping.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mechanical Bulk Conveying Equipment:
  - Belt and Roller Conveyors:
    - Combustible dust compliance and safety would involve:
      - Proper dust collection and housekeeping.
      - Bearing monitors for the drives.
      - Plugged-chute detection.
      - Regular inspection of the idlers and belting.
      - Belt alignment monitoring.
  - Vibrating conveyors and feeders:
    - Basically one of the lowest risk, mechanical conveying and feeding devices available.
    - Will not force-feed, no internal moving parts (material contact).
    - Viable alternative where feasible.

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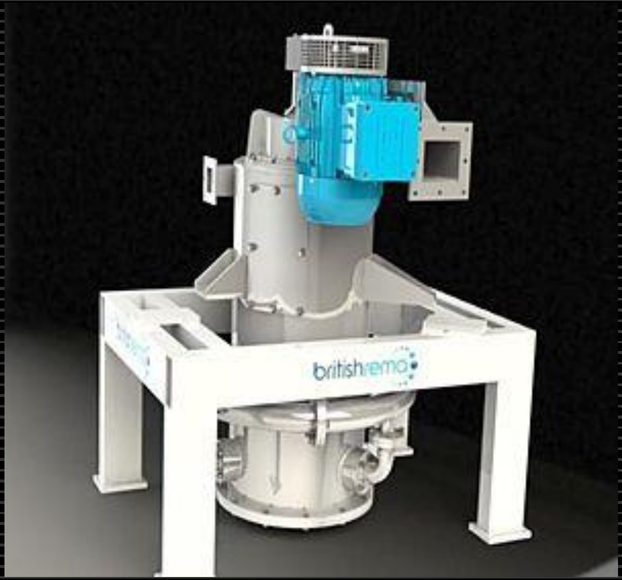
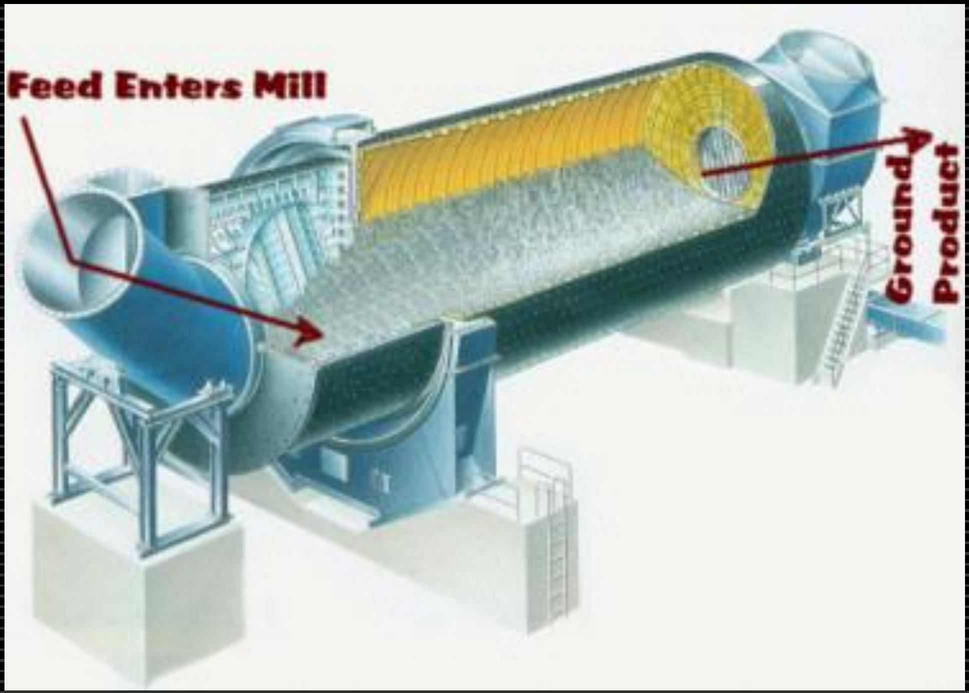
Typical of Vibrating Conveyors

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Size Reduction Equipment & Systems:
  - There is an almost unbelievable range of sizes, shapes, methods, etc., of various size reduction equipment.
  - Examples are:
    - Hammermills.
    - Air mills.
    - Hogs.
    - Pulverizers.
    - Ball mills.
    - Shredders.
    - Delumpers.
    - Cutters, Etc.



Air Classifying Mill



Ball Mill

Cone Crusher

Hammermill

Cutters (Cutting or Shredding Mill)

Inside a Hog Mill

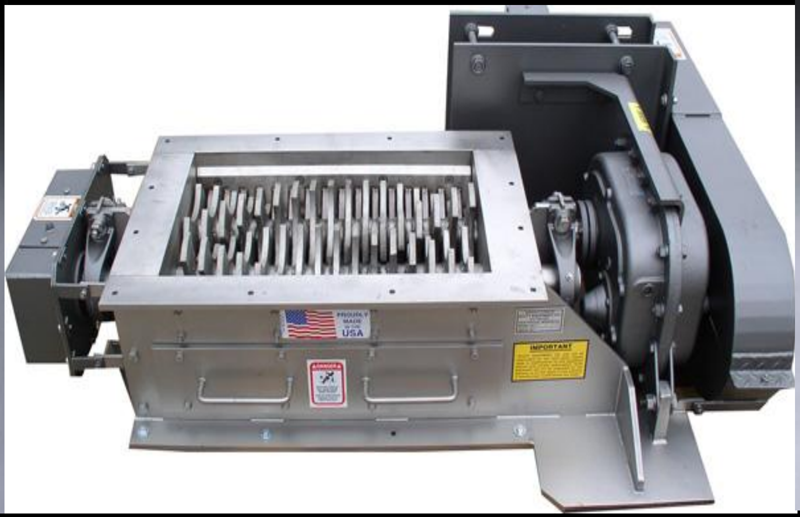
Food Grade Micropulverizer

Lump Breaker

Shredder

HOG

Cutter



Small Crusher

Attrition Mill

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Size Reduction Equipment and Systems:
  - Heat and Spark generation are the main concerns.
  - All mills will generate heat due to the "reduction" of the material – this depends upon the rpm, method, material, etc.
  - Also, these units are **highly sensitive** to foreign materials – especially metals.
  - The risks involve:
    - Failure due to foreign materials, fatigue, or other operating conditions.
    - Metal entering the milling process generating sparks and heat.
    - Bearing failure.
    - Heat build-up due to lack of proper dust collection and/or ventilation and Poor Housekeeping in the area.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Size Reduction Equipment & Systems:
  - Recommendations for Compliance Issues:
    - Starch (and blends such as powdered sugar) require special considerations and NFPA 61 should be consulted.
    - Where feasible, physically isolate the system as much as feasible.
    - Provide for screening prior to the mill.
    - Provide for rare earth or similar magnets for tramp metal removal immediately prior to the mill.
    - Provide monitoring of mill vibration and/or bearing temperatures.

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Size Reduction Equipment & Systems:
  - Recommendations for Compliance Issues:
    - Proper ventilation and/or dust collection – isolate the system from other vented equipment.
    - Isolation of the discharge conveying system from the mill.
    - Use non-sparking construction as much as feasible.
    - Amperage of the mill drive – often will indicate a problem before actual failure – also helps in optimizing the mill functions.

Larger Drawer Magenet

Typical of Rare Earth Drawer Magnet for Feed Chute Installation

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mixers and Blenders:
  - These devices also come in a very wide variety of shapes, sizes, uses, types, etc.
  - They can also vary, significantly, whether they are "continuous" or "batch". The most common is "batch", but continuous mixers (constant feed and mixing) are gaining popularity due to the overall lower costs.

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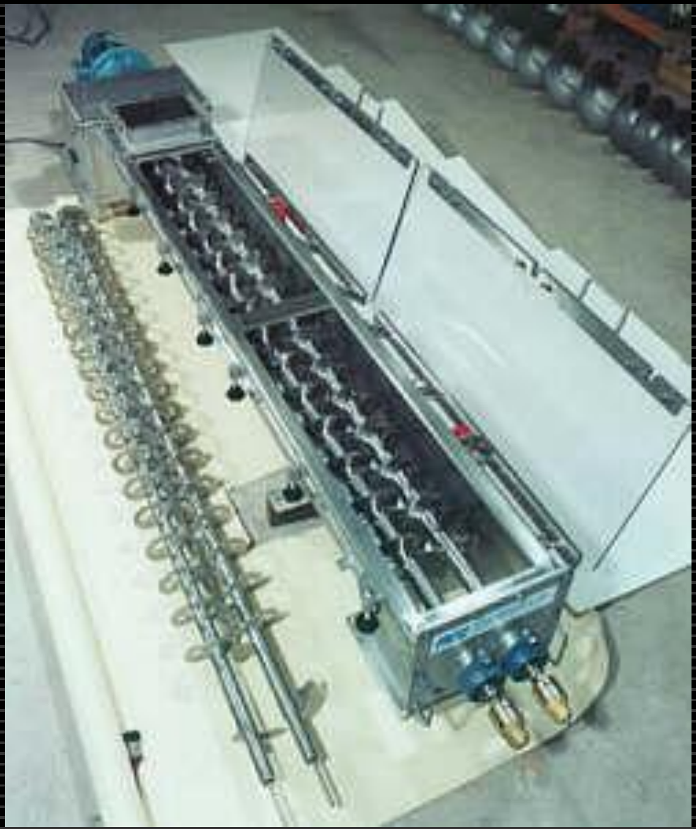
Continuous Mixer (Similar to Extruder)

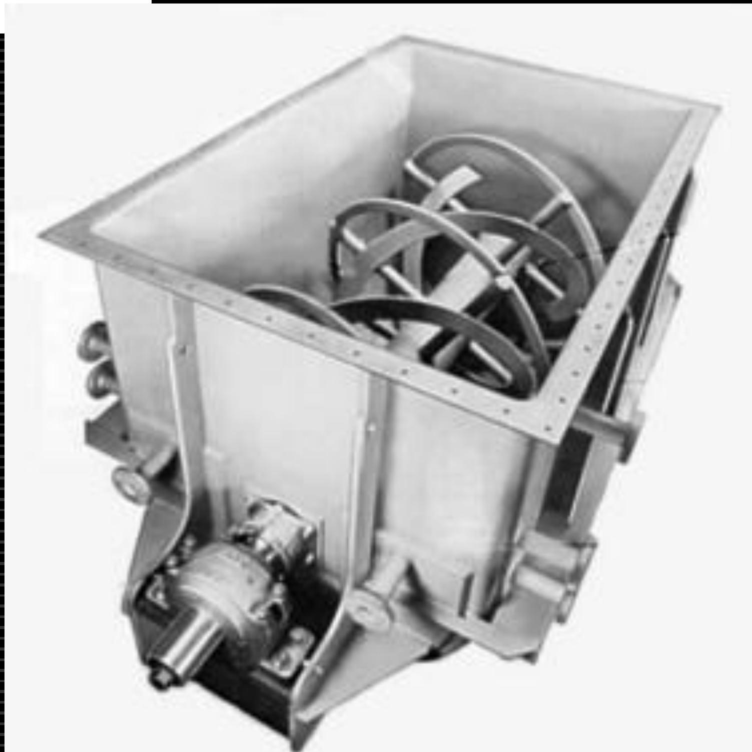
Double-Screw Type
Continuous Mixer/Blender



Batch Conical Screw Mixer/Blender

"V" or Pant-Leg Rotary Batch Mixer

Typical Drum Mixer



Typical of the "workhorse" The Ribbon Blender or Mixer

COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mixers and Blenders:
  - Main risks center around:
    - Foreign objects – especially metal.
    - Method of material feed – bag dumping, pneumatic transfer, FIBC's, barrels, etc.
    - Is the reaction taking place exothermic?
    - Metal-on-metal contact.
    - Bearing failure.
    - Poor dust collection allowing build-up of combustible dusts inside and around the unit (seen many a bearing and drive covered-up in dusts).

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COMBUSTIBLE DUST ISSUES FOR BULK MATERIAL HANDLING

- Mixers and Blenders:
  - Compliance Methods:
    - First and foremost is proper dust collection of all dust-producing operations.
    - Monitor bearings for temperature and vibration.
    - Material feeds should be designed to minimize dust generation – critical.
    - Minimize possibility of foreign materials.
    - Some mixers (conical screws) have other problems that can generate heat for ignition.
    - Proper grounding – Low MIE.

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