Safe Design of Portland Cement Plants

L. Harvey Kirk III, MSHA
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Safe by Design
(Inherently Safe)

A process, plant, equipment or product that has purposely incorporated in it certain physical and/or chemical characteristics that noticeably reduce hazardous conditions and the risk of injury and illness resulting from its use or operation.
Safe by Design -
A Personal Experience

- $400 M plant expansion & modernization
- Double plant production capacity
- Equipment & technology: quantum leap up
Safety Pre-Planned for Construction Phase

- Early decision by Corporate Risk Mgmt & Insurance broker
- OCIP – Owner Controlled Insurance Policy
Safe by Design
Promoted at Plant Level

- No corporate safety dept.
- Began as part of plant input & review process
- Champions: Plant Mgr. & Manufacturing VP
• Plant-level team assembled
  – All engineers & technical managers
    • Production, Maintenance, Environmental, Project, Quality, Safety
  – Key process & maintenance personnel
Safety woven throughout project

- Began at concept level
- Specifications
- Design review
- Contractor pre-bid / qualification
- Construction phase
- Commissioning & Start-up
Key Safety Concepts & Concerns

- Fire / explosion
- Preheater vessels
- Noise attenuation
- Equipment guarding
- Manual material handling
- Fall protection / Safe access
- Maintenance safety / Lockout systems
- Signage / Color coding
- Illumination
Design Specifications

• A lesson learned...
• Safety specifications written, just as for:
  – Site preparation and grading
  – Mechanical and electrical systems
  – Structural steel, concrete, etc.
• Resources
  – MSHA and corporate standards
  – Best Practices
    • Construction, Chemical, Europe, ASSE, Local, Personal
• All other specs reviewed for and modified to address safety issues
• Incorporated into Purchase Orders
First of all... No explosions, please
Coal Fire & Explosion Prevention

- Modern coal mill & peripheral equipment
- Pulverization in inert atmosphere
- CO sensors for incipient combustion

Coal Mill DC bags grounded to eliminate static charges
Coal Fire & Explosion Protection

Redundant systems
  • Explosion venting
  • CO2 inundation
  • Suppression
  • Isolation
Explosion Protection

Venting

Suppression

Isolation
CO₂ Inerting System

CO₂ can be directed to individual problem areas

**CO₂ Inerting System**

**SA = Simple Asphyxiant, Odorizer added**

*WARNING*

LEAVE AREA IMMEDIATELY WHEN ALARM SOUNDS.
EXPOSURE TO CARBON DIOXIDE GAS MAY BE FATAL.
SHUT OFF SYSTEM WHEN SERVICING.
THIS AREA PROTECTED BY A CARBON DIOXIDE FIRE SUPPRESSION SYSTEM.
CO2 Injection

Vapor or Liquid
Noise Attenuation

- Individual equipment: spec ≤ 85 dBA
- Fans, mills, compressors & blowers
- Silencers
- Noise barrier materials
- Noise absorbing materials
- Power transmission equipment
- Vibration dampening
- Laboratory equipment included
Decoupling material on ductwork

Silencer & Anti-vibration mount

Sound absorbing material
Duct wrapping

Silencer; Fan duct insulation not yet installed

Verification: noise levels attenuated to specification
Signs & Labels

- CAUTION
  - Grinding Aid
  - Health: 3
  - Flammability: 0
  - Reactivity: 1
- NOTICE
  - Noise Level: 75 dBA
- CAUTION
  - Confined Space
  - Use Lock-Out & Entry Procedures Prior to Entry
- CAUTION
  - Wear Hearing Protection When Equipment Operates
  - 93 - 104 dBA
- DANGER
  - No Smoking
  - No Open Flames
Travelways & Work Platforms
Work Platforms & Travelways

Folding & other non-conventional work platforms installed
350-lb. skylights, perimeter fall protection cables and other anchor points installed (for construction & maintenance later)
Missed crossover walkways between buildings
Vessel Cleaning

Air cannons

Cleaning platforms
Lockout Systems

No Local Disconnect Switches (Some Installed Later)
Equipment Guarding

- Specification: Meet MSHA requirements
- Purchase Order: Meet MSHA & OSHA requirements
  - Suppliers were back-charged & payment delayed
  - Deficiencies corrected before start-up
- Engineer worked one month designing guards
  - Used MSHA Guide to Equipment Guarding
As-received:
Stop cord only

As-built:
Guards all around
As-received: No motion sensor guard

As-Built: Guard fabricated and installed on-site
As-received:
Inadequate guard

As-built:
Improved guard

Lifting eye & hoist provided
Manual Material Handling

In addition to automatic packer & palletizer...

Vacuum-Assist Bag Lifter

Auto-Leveling / Rotating Pallet Supports
Radioactive Source
Devices for Measurement

Radioactive source

Gamma ray receiver and sensor “tail”

Extra shielding & sign installed in some locations
Illumination

Specified Conformance to ANSI / ISO Standards
Thank You -- Any Questions ???

L. Harvey Kirk III, CSP
Senior Mine Safety & Health Specialist
Division of Safety & Health
Metal & Nonmetal Mine Safety & Health
Mine Safety & Health Administration
1100 Wilson Blvd.
Arlington, VA  22209-3939
Ph.  (202) 693-9617
E-mail:  kirk.lewis@dol.gov