Insight: Steel Coal Silos – Inspection Practices

Coal Silo Failures Can be Catastrophic

Recognizing the Risk

A potential industry oversight may well be in the works as aging coal fired power plants designed for base loaded operations are operating in very competitive environments resultant from alternative energy capacity and inexpensive natural gas prices. There have been at least two of these failure events reported in the industry in the past 14 months, one in July 2016 and another in February 2017. Failures result in separation of the bottom hopper cone from coal silo shell, resulting in the release of entire silo contents. Quantifying property damage resultant from such failures takes considerable time as buried equipment requires excavation to proceed with definitive assessment.

These failures occurred at attachment weld between the vertical shell of the silo wall and bottom discharge cone. (See Figure 1) As a result, entire silo contents engulfed and damaged plant equipment located below the silo. The most recent failures did not result in human injuries, however if operating personal were in the area, they could have incurred serious injury or death.

A typical coal fired power plant has multiple coal storage silos where one shift or one day's worth of coal is inventoried and fed to the combustion process. During unit operation coal within the silo travels downward as coal is consumed, exiting silo bottom through the lower cone section where it is fed to coal scales for weighing and subsequent delivery through feeders to coal pulverizers. Consequently, these silos are either in constant or intermittent use and are never completely emptied except during outage periods. A coal silo can be very large and hold hundreds of tons of coal. To facilitate freedom of coal movement through the lower cone section, it is typically lined with stainless steel material which reduces wall friction. Vibrators are also mounted on outside of the bottom cone to assist in maintaining fluid coal movement. Some plants have also used air cannons and sonic horns to augment vibration in an effort to further facilitate fluid movement.

A coal silo is typically supported by a metal ring or skirt that is a continuation of the vertical wall, in the area where conical section begins. This supporting approach together with the stainless-steel internal liner makes inspection of the bottom hopper and key attachment weld difficult. Consequently, this weld can go many years without inspection.

Challenging Service

Coal is very abrasive. The continuous movement of coal downward wears away at silo walls and conical section. Coal contains Sulphur and carries with it contaminants such as moisture resulting in a corrosive environment that leads to deterioration of attachment weld and silo parent metal. Additionally, the use of bottom cone vibrators and other means to keep coal moving fluidly introduces vibratory mechanical forces to the coal silo which can reduce the fatigue life of silo and result in cracking and failure of the bottom conical section attachment weld.

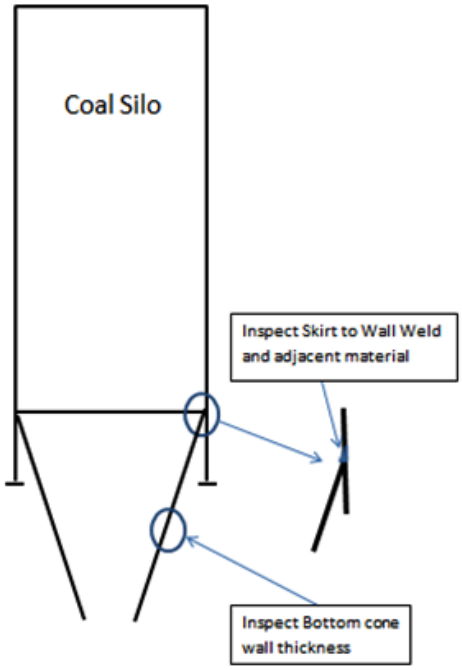

Figure 1 Coal Silo Construction

Recommendations

Coal silos must be completely emptied and inspected for wall thinning and weld deterioration / cracking periodically. Of particular concern is the conical attachment skirt weld that attaches the cone to the vertical wall and the bottom cone. The weld that connects the vertical wall (cone to skirt) weld is particularly susceptible to cracking and can lead to a failure resulting in conical section detachment. This weld must be inspected from inside the silo, via a Bosun chair or scaffolding.

Inspection Recommendations

Initial silo inspections should be conducted at the first opportunity after 10 years of service. The initial inspection should include:

- Visual inspection of the external bottom cone for cracks and deterioration in the area of the support skirt and vibrators.
- Visual inspection of the bottom cone internals, including the stainless steel liner for thinning and wear. Visual inspection of the bottom cone attachment weld, for wear and cracking. NDE of this weld is recommended. If this weld is covered by a liner, the stainless steel liners should be removed to expose this weld for inspection. If stainless steel liners are added they should not cover up this weld.
- Ultrasonic thickness reading should be conducted at various locations of the bottom cone.

After an initial inspection the silos should be inspected as follows:

- Annually or at boiler minor inspection interval.
  - Visual inspection of exterior condition of the bottom cone including the vibrator attachments. Visual inspection of the internals of the bottom cone liner sheets and conical section attachment weld. When installing liner sheets this weld should be left uncovered
  - Every 5 years or at boiler major maintenance interval

- Visual inspection and NDE of the internal bottom cone attachment weld

For more information, contact your local AIG Risk Engineer.