CHEMETRON Fire Systems™

CARDOX

CO_2

Application Bulletin

Carbon Dioxide Fire Suppression —

Mini-Mills

Part 1: *Electric Furnaces & Continuous Casting Facilities*

In recent years, the development of the mini-mill concept has created a whole new segment of the steel industry.

Instead of following the traditional, integrated concept of steel production – starting with the production of iron, then steel, followed by the production of a variety of finished steel products – the mini-mill produces a single product or a very limited product range. They make steel by melting scrap, doing the metallurgy needed, casting the product, and then finishing it with very limited rolling mill facilities. Costs are substantially less. The plants are commonly located well away from the traditional steel making centers, where the need for bringing iron ore and coal together economically dictated plant locations. Often the mini-mill is located where there is low cost power and close to the markets served.

The history of the successful use of CO_2 for fire protection of key facilities in the steel plant is a long and successful one. Low Pressure CO_2 systems installed over 50 years ago are still providing important protection. Mini-mill operations present vital hazards for which CO_2 is a proven and ideal extinguishant. Since they often produce a single product, the loss of production due to a serious fire can be catastrophic.

The purpose of this bulletin, and another to come, is to familiarize the reader with these CO_2 fire protection applications, starting with the melting and casting end of the mill (Part 1), followed by the rolling mill (Part 2).

The drawing accompanying this bulletin illustrates protection for the Electric Furnace Transformer/Switchgear Areas, Control Pulpits, Electrical Control Room and Caster Turret.

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A World of Protection

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Electric Furnace Transformer and Switchgear Vaults

The protection of the arc furnace transformer/switchgear vaults with CO_2 is designed to offer protection against an oil fire caused by transformer failure, or an electrical fire involving equipment and /or cables.

Arc furnace transformer failures have been caused by an accumulation of moisture, loss of dielectric strength of the oil, presence of foreign material, defective connections, breakdown of insulation, overheating, transient over-voltages caused by switching, and malfunction in the tap changer. It should be noted that in some installations, the tap changer is a second transformer.

Quick extinguishment of an oil fire can limit the damage and protect the balance of the equipment and installation. Protection of the switchgear and other electrical equipment from fire, usually caused by an electrical breakdown, requires traditional CO_2 flooding to a higher concentration and holding it for an appropriate soaking period.

The CO_2 design involves flooding the vault to 34% CO_2 within one minute to take care of an oil fire, and continuing the discharge until 50% CO_2 by volume is reached. CO_2 is an ideal extinguishant – it's three dimensional, dry, a non-conductor, and easily handled. If the transformer bushings are not designed to accommodate a water discharge, or if the transformer is not sealed, the use of CO_2 is especially important. A very important feature of CO_2 is that no drainage is required; there is no need to capture fire protection water runoff (contaminated with oil).

It must be noted that CO_2 fire extinguishing concentrations are suffocating to personnel. Thus, supervised lock-outs, to prevent a CO_2 discharge when maintenance is required in the vault, are common. A predischarge alarm is part of the system controls to guard against a discharge taking place without adequate personnel warning. Vaults should be kept locked with access only by authorized and trained personnel.

Since we are often dealing with some potentially deep-seated burning material in these vaults, it is necessary to hold the CO_2 discharge in the vault until the fire is totally extinguished. This holding time normally does not necessitate the use of an extended CO_2 discharge, however. Points of CO_2 leakage are few and easily controlled. The opening where the bus bars carry power from the vault to the furnace cables is usually above the top level of the transformer and has minimal effect on CO_2 loss rates where the protection is needed.

Caution should be exercised in vaults with concrete block walls, which are usually porous if not coated (painted). CO_2 vapor will leak through the walls and be quickly lost.

The drawing accompanying this bulletin shows an AC powered arc furnace. A recent trend has been to DC arc furnaces. The DC furnace vault has both rectifiers and a rectifier furnace transformer, as well as other electrical equipment. Advantages to the DC system include reduced electric consumption, fewer flicker problems, less noise, and more uniform melting. The bottom of the furnace is made electrically conductive and only one electrode is used, resulting in less electrode use. A major disadvantage is higher initial capital costs.

On one installation, the rectifier furnace transformer comprised two independent primary and secondary systems, arranged one on top of the other, in a common transformer tank. The rectifiers were a floor above the transformer, with openings for connections between floors. This specialized equipment would be particularly susceptible to problems of loss or damage in case of fire.

Where the transformer/switchgear/rectifier vault is multi-floored, fire detection is required at all levels for automatic actuation, while a hazard analysis is needed to determine if CO_2 should be discharged at all levels or just at the higher elevations.

One school of thought is that in every case, a portion of the CO_2 needed to flood the vault should be locally applied directly to the transformer to take advantage of the extinguishing characteristics of a locally applied discharge.

NOTE

IN THE 1940S, CARDOX, PREDECESSOR TO CHEMETRON FIRE SYSTEMS, ESTABLISHED DESIGN PARAMETERS FOR PROTECTING OPEN TRANSFORMERS BY RUNNING AN EXTENSIVE SERIES OF FIRE TESTS USING LOCALLY APPLIED LOW PRESSURE CO_2. WHILE WATER SPRAY IS A BETTER FIRE EXTINGUISHANT FOR OPEN TRANSFORMERS, A NUMBER OF INSTALLATIONS HAVE BEEN MADE USING LOW PRESSURE CO_2 WHERE ADEQUATE FIRE PROTECTION WATER IS NOT AVAILABLE.

On some installations, the arc furnace is for melting only, and a secondary ladle furnace is used for metallurgy. Each has its own transformer vault requiring protection as shown on the drawing.

During the hazard analysis of an electric furnace installation, caution should be followed to identify combustible oil filled hydraulic systems and speed reducers to ensure that they are adequately protected. (These systems are not shown on the drawing.)

Control Pulpits

Bulletins #0600, Protection of Spaces Beneath Raised Floors, and #0615, Critical Computer and Electrical Control Cabinets are your reference for the protection of these important areas.

Electrical Control Rooms

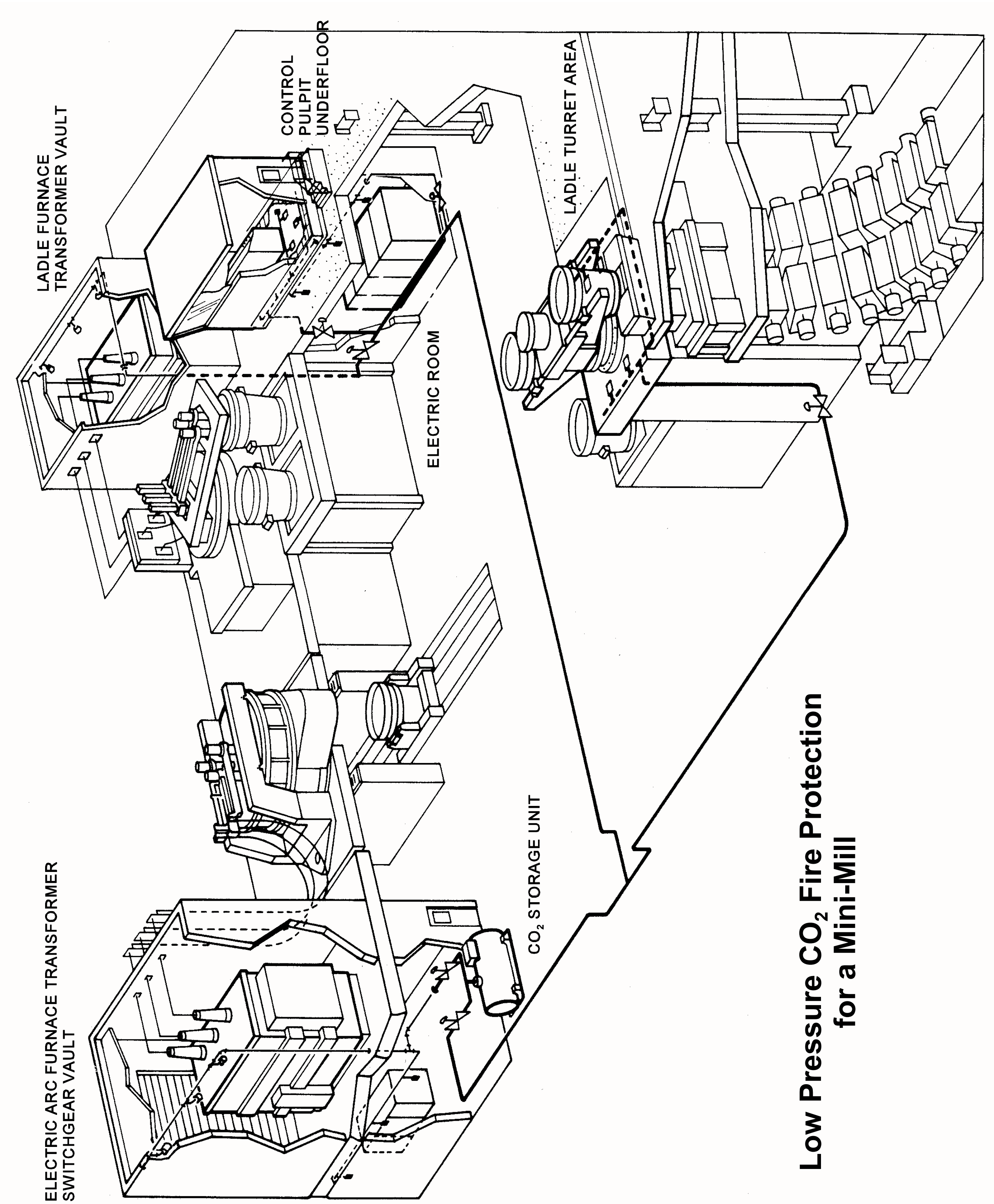
These areas are normally totally flooded with CO_2 to the requirements of NFPA Standard No. 12. When the gear is enclosed in a room, the room is flooded. If switchgear cabinets are in the open, internal protection can be provided by internal flooding. The internal protection of metal-clad electrical switchgear will be the subject of a future applications bulletin. In the meantime, Chemetron Fire Systems can help define protection requirements.

Ladle Turrets

The need for internal lubrication of the turret, allowing movement of steel-filled ladles over the caster and then out of the way again, creates a space inside wherein an inaccessible hazard area exists. This area is piped before installation with an adequate number of CO_2 nozzles and with piping sized to the protection requirements. This piping can then be tied in to the Furnace/Caster Area protection system to allow proper protection for this area. This is as shown on the drawings.

The CO_2 design level is that required for oils and greases – 34% CO_2 by volume – with provisions for losses out of uncloseable openings.

It should be noted that the production of sheet steel on a thin slab caster feeding into a single stand hot mill and then to a cold rolling facility is rapidly changing the sheet steel market. The hot rolling facilities of the mini-mill, along with such specialized mills as "Z" mills, will be covered in Bulletin #0320, Mini-Mills Part 2. In the meantime, Bulletin #0305, Metal Rolling Mills — Multi-Stand Mills/Mills with Water Based Coolant, is a good reference as to fire protection of cold rolling mills.



Low Pressure CO_2 Fire Protection for a Mini-Mill

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