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Technical Publication

Better Gas Tight Access Doors for Power Plants

by

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Presented at
POWER-GEN International
'96 Conference & Exhibition
December 4-6, 1996
Orlando, Florida

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Abstract.

This paper presents useful information concerning access doors for equipment at power plants and similar industries. Such doors are used for:

Boilers and Boiler Penthouses
Economizers and Air Heaters
Gas Ducts and Precipitators
Baghouses, Absorbers and Stacks.

Easy access into such equipment by personnel enhances the speed and thoroughness with which inspections and maintenance tasks are performed. This paper shows how to select and correctly install new doors or replace older models which may cumbersome to operate or unable to seal properly.

Good, gas tight access doors should not be overlooked as a contributor to top performance at power plants. Loss of efficiency or interior deterioration due to leakage are obvious targets and should be of prime concern. However, the case of access may be equally important.

Lasting reliability of any type of industrial equipment is usually a function of two things: First, the quality and care in design manufacture and installation. Second, the ability and dedication to maintain the equipment. If the ability or dedication to maintain the equipment is diminished it will impact on the lasting reliability of even the best-designed equipment.

Extensive engineering efforts, many pages of specifications and large sums of money are used on new power plants to assure practical, adequate and safe access to all parts of the equipment. Many times this is in stark contrast to the money and efforts used on the access doors, through which personnel has to enter for inspection and maintenance.

This paper highlights the basic functions which should be expected from all types of access doors. The special functions required by individual door types are also explained. This includes all the door types serving the different applications all the way along the gas passage from the high temperature boiler doors to the corrosion resistant doors for absorbers and stacks.

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The importance of good access doors should not be overlooked at power plants. Loss of efficiency, exterior spills of acids, and interior deterioration due to leakage are obvious problems and should be of prime concern. However, the ease of access may be equally important. Easy access for the personnel into all the major plant equipment enhances the speed and thoroughness with which inspections and maintenance tasks are performed.

Lasting reliability of any type of industrial equipment is usually a function of two things: First, the quality and care in design, manufacture and installation. Second, the ability and dedication to maintain the equipment. If the ability or dedication to inspect and maintain the equipment is diminished it will impact the lasting reliability of even the best designed equipment.

Extensive engineering efforts, many pages of specifications and substantial expenditures are used to assure practical, adequate and safe access to all parts of the equipment in new power plants. However, many times this is in stark contrast to the money and efforts used to procure the access doors.

Ten years ago, Indianapolis Power & Light planned for major upgrading of their existing air pollution control equipment. Precipitators and FGD system had access doors that did not always seal properly. In addition, the doors required excessive man-hours to open and close. During the FGD project, that involved access doors, a variety of doors on the market was studied. This study resulted in a better understanding of the basic requirements and details associated with successful access doors.

Basic requirements:

The minimum requirements for good access doors are few and obvious:

1. They must be gas/liquid tight.
2. The seals must be reliable through many operations.
3. They must be safe and easy to open and close.
4. The insulation, where required, must be durable and efficient.
5. They must be easy to get through.

As plant personnel will testify, there are many existing doors in the power plants which do not meet these basic requirements. To better understand what makes a difference in door quality it is helpful to carefully look at each basic requirement in greater detail.

Doors must be gas/liquid tight

- Any leakage will theoretically result in some loss of equipment efficiency. Therefore, regardless of where in the gas stream the door is located from the boiler to the stack, there are fundamental reasons to require tightness.
- In-leakage into ducts and equipment downstream from the air heater can cause serious corrosion damage in installations, especially in a cold climate and with high sulfur content in the flue gases. In-leaking ambient air can cool the casing walls, and even the flue gas, to below the acid dew point causing acid condensation and corrosion to casing and even the vital equipment internals.

- Most FGD systems operate with a slight positive pressure and out-leakage of flue gas and corrosive liquids can create an unsightly mess and damage the surrounding components.

Exterior leakage from doors on an FGD system is very obvious, and therefore is typically given proper attention. Conversely, in-leakage where the deterioration is hidden is usually not discovered until later, when the doors are opened.

The seal must be reliable

Seals must be reliable each and every time the door is used, without plant personnel having to adjust, repair or replace seals

The main sealing methods for access doors are generally one of the following:

- Rigid door construction, i. e. usually a cast door with machined contact surfaces and often with a rather thin gasket.
- A less rigid door using a rather small gasket and several "dogs" around the perimeter.
- A flexible door with a heavy, flexible gasket.

Operational data suggest, that in applications covered in this paper, the flexible door with the heavy gasket is the best method.

The design of the door determines if the sealing gasket is placed on the door frame or the door plate. Placement on the frame should be avoided unless the gasket is hidden in a groove or otherwise shielded from abuse. This is because traffic through the open door will invariably cause damage to an exposed gasket especially in the area below the opening.

Gasket material will contribute to seal reliability. Sealing gaskets are available in numerous materials and shapes. Excluding the types of popular caulks frequently used to solve acute leakage problems, we can divide the materials into two main categories; fibers and elastomers. In each category there are several brand names and choices of specialties for different applications. Some brands are made as a combination of both. The development of some of these materials substituted the asbestos seals, which predominated until asbestos was declared a health hazard.

The fibers can be anything from heat resistant metal alloy wool to glass fiber. The fibers are usually braided or woven and shaped into the desired profiles. Woven or braided ceramic fiber gaskets are most common for temperatures above 400^0F. These are normally slightly porous and may breathe a little, especially when new. This slight leakage is too faint to cause any concerns with negative pressure, but it will cause exterior corrosion with positive pressure and corrosive gases.

Most elastomer gaskets will only serve at temperatures too low for power plant applications. An exception is the very expensive fluoroelastomer gaskets for continuous gas temperatures up to about 400^0F with excursions below 700^0F. These molded, or extruded gaskets can be made either as a closed cell sponge or as a solid profile with or without a hollow core. Fluoroelastomer sealing gaskets can give a completely tight seal even for liquids under positive pressure if they are correctly designed, manufactured and installed and receive reasonable maintenance. Examples of gasket shapes can be seen in Fig. 1.

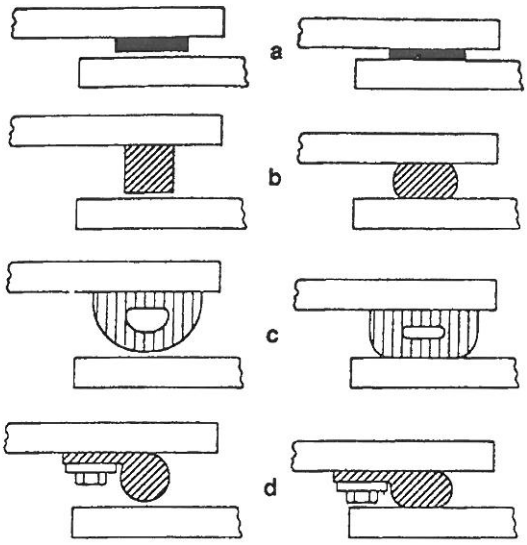


Fig. 1

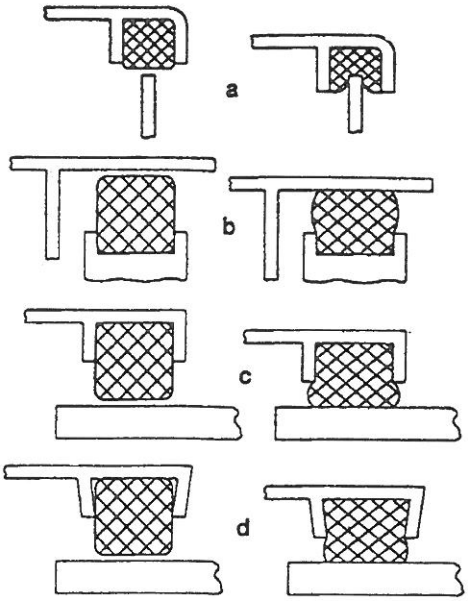


Fig. 2

For ease and speed of door operation and reduction in man-hour requirements, the sealing gaskets must be seated so they stay in place when the door is opened. There are different ways to seat gaskets and to use them for sealing. For braided ceramic fiber gaskets, the most common method downstream from the air heater is the "knife edge design" shown in Fig. 2a. Fig. 2b shows a poor design sometimes seen for elastomer or braided ceramic fiber gaskets. Even if adhesive is used, the groove in this common example is made far too shallow to retain the gasket after even the first cycle of operation. The method in Fig. 2c may be acceptable for braided ceramic fiber gaskets, but Fig. 2d shows an even better method where a square gasket in compression will adopt the dovetail shape of the grove. The tadpole gasket shown in Fig. 1d will make a good seal if the placement and strength is adequate to prevent damage and the size is ample enough to prevent the fastening screws from touching the seal surface. Retainer strips and screws must be made of good quality stainless steel to prevent corrosion.

For elastomer gaskets, the methods of seating also include bonding. This gives the freedom to use gasket profiles with an ideal shape for sealing and resistance to abuse. The gaskets themselves must also be reusable many times. This requires a low compression set for the gaskets, not only in the laboratory, but also when inhibited by the way they are retained on the door and deformed when the door is closed. This deformation is what makes the very common "knife edge design" less appealing after the first few cycles.

Doors must be safe and easy to open and close.

Doors that are easy to open and close will enhance interior equipment inspections and maintenance. Power plant personnel can truly appreciate the importance of being able to open and close access doors quickly and with a minimum of effort. This is beneficial whether the unit outage is scheduled for several days or weeks or for an unplanned, forced outage lasting only few hours. Some typical door types are shown in Fig. 3.

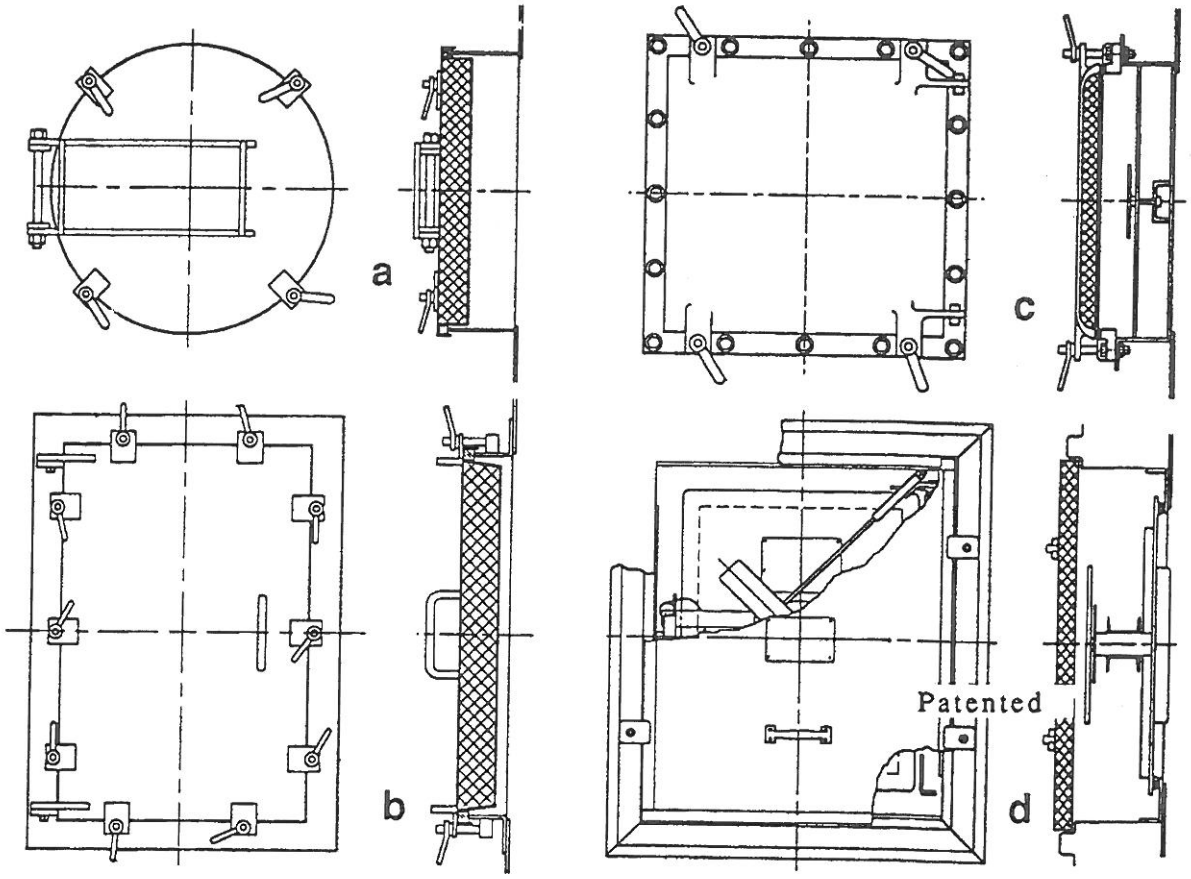


Fig 3

Even after years of service a well designed door should be able to be opened and closed by hand in just seconds without the use of any tools and without any service of a maintenance crew. This requires a small number of closing devices on each door, non-corrosive hardware and a design heavy enough to stand up to abuse. Some designs like the patented IMTEC FLEXISEAL doors Fig: 3d have only one or two stainless steel closing mechanisms and do not require any tools to open and close.

When opening this door type a feature in the mechanism retracts the door plate from the frame, thereby pulling any sticking sealing gasket away from its contact surface. This door type also has a safety mechanism which prevents the door from being opened if there is a dangerous gas pressure inside.

Appropriate warning signs of durable quality must be placed on access doors. On electrostatic precipitators, all doors must have key interlock systems. Such systems can be field installed on any door design with little difficulty. In hoppers and other places where material can build up behind closed doors, it is mandatory that the doors be equipped with a safety chain with easy hook-on features. The chain should be just long enough to allow probing behind the door for a deadly avalanche of material.

Occasionally there are requirements for doors to be lockable in open position. This is most relevant for the doors designed with the type of "dogs" which could conceivably fall into their closed position if the door get slammed closed and thus trap personnel inside.

Door insulation must be durable and efficient.

If an insulated door is required it is important to define why it is or should be insulated. Doors are insulated for one or more of four reasons:

1. To protect personnel from being burned by high temperatures
2. To protect doors from being damaged by temperatures
3. To prevent cooling of process gases and loss of system efficiency
4. To protect against interior acid condensation and corrosion.

- Reason No. I, safety, should influence the choice of door in areas where the environment generally is safe for persons to touch the exposed surfaces. This is normally from the economizer and downstream.

- Reason No. 2, to protect doors, is the main factor in choices upstream from the economizer where overheating could cause serious equipment failure.

- Reason No. 3, loss of system efficiency, is rarely a motivating factor in choice of door type for a power plant although the loss of heat is significant especially in the hotter areas.

- Reason No. 4 is the one least understood. Many power plants with high sulfur gases have ducts and gas cleaning equipment downstream from the air heater where the installed doors are not well suited to the application.

It is equally important to consider the details of the insulation on the equipment wall. Using the same insulated door for different purposes and wall configurations will hardly give satisfactory results. Fig. 4 shows schematically a few combinations of typical insulated doors on different, insulated walls.

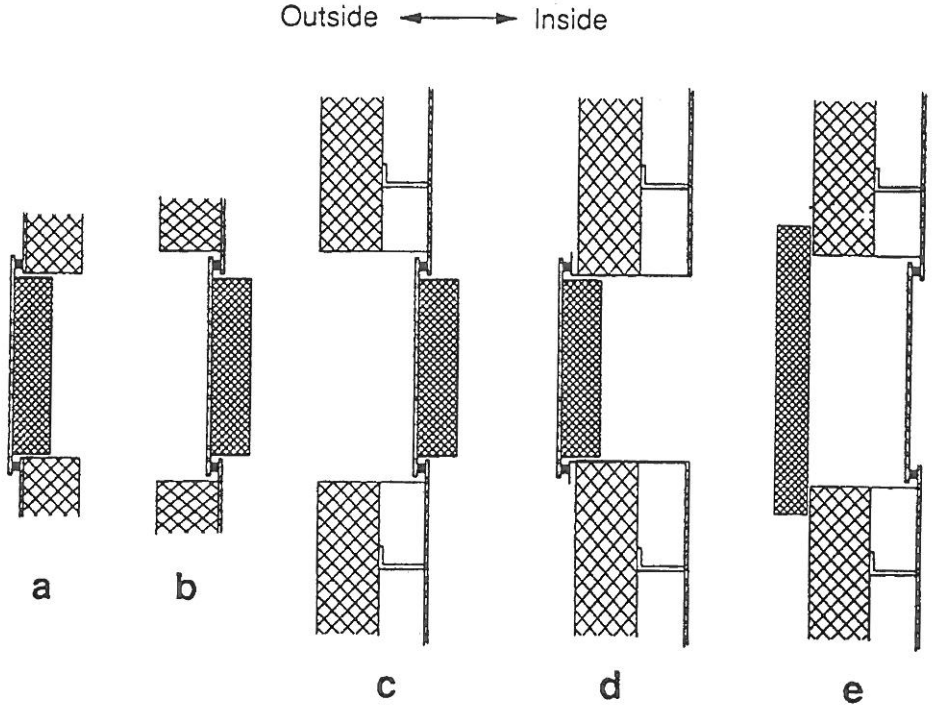


Fig. 4

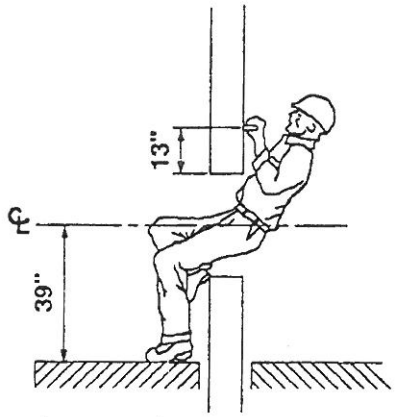
Fig. 4a and 4b shows typical insulation combinations for single doors as used for the high temperatures in the boiler. Fig 4c and 4d shows single doors as used for the economizer down to the airheater. Unfortunately, these arrangements, Fig. 4c and 4d are also frequently found on gas ducts and equipment downstream from the air heater, where it can cause severe problems. The door insulation may prevent corrosion of the central portion of the door. However, the frames and even the casing plate around the door are likely to corrode away in a short time. Only a double door as shown in Fig. 4e can prevent such corrosion problems in equipment with cool corrosive gases in a cold climate.

Where such double doors have an exterior door or a removable panel, it is important that the design is sturdy enough to take the abuse through years of service. It is also important that there are carefully designed provisions for finishing the insulation and cladding around the outer, insulated doors. Such dedicated features can significantly reduce costs in the installation and thus offset the high price of the more expensive doors.

Doors must be easy to get through

Many decades ago when the equipment was much smaller, it was common to use "manholes" just large enough for a person to crawl through. Some of these small access openings are still being furnished on today's large equipment, but the trend is to use doors that are minimum 18" wide and 30" tall. A door of this size allows an average size person to "step through" the door rather than "crawl through", provided it is installed in the correct elevation over the walkway. See Fig. 5.
Adequately sized doors are not only helpful for the plant personnel. They are also advantageous for

Fig. 5



craft personnel during the construction phase. The larger size doors can play an important role in safety because of confined space work rule requirements.

- For side access doors the free opening should not be less than 30" tall.
- The width of the door opening is much less critical. An 18" wide opening is sufficient, unless larger items have to pass through the door.
- The height from the walkway to the door is very important for convenience. A good rule of thumb is 39" to center of the door opening.
- A sturdy grab handle should be installed approximately 12" above the door opening, especially if the door size and installed location is less than ideal.
- For roof and hopper doors it may be acceptable to use a smaller door opening than advocated above, unless a ladder has to also be placed through the opening to provide access.

Other miscellaneous items.

Other door design features which are easily overlooked are:

Unless the inner face is about flush with the inner casing wall, there could be a build up of material in a pocket inside the door as shown in Fig. 4d. This build up must be removed to gain access or it may spill out when the door is opened.

- The exterior parts of the door should extend beyond the side wall as little as possible to assure good clearance on passing walkways.
- Door sag may inhibit easy closing. Even if "alignment bosses" are provided at the bottom of the door, this may cause misalignment of closing surfaces and leaks, especially in combination with the "knife edge" seal shown in Fig. 2a.
- Corroded or not, carbon steel lugs require tools for opening and closing and cause breakage and bothersome repair.
- Overall rugged design is necessary to take the many years of abuse and heavy handling during outages when heavy tools and parts are passed through the opening.

Discussion of door application examples

Following the gas passage from the boiler to the stack, we can briefly discuss the special requirements for doors in these different applications.

Boiler doors.

A boiler door for the highest temperatures is almost always installed in an opening in a boiler water wall. The wall tubes are bent out to form the opening. The matching door is usually a very heavy, cast or fabricated design. It has forced cooling by air or water and/or interior refractory or it has a requirement to brick up the opening after each use. Opening and closing such doors can take several man-hours. In the rare cases where these doors are installed in the hottest areas of the boiler, they must withstand not only the almost 3000^0F gas temperature, but also the radiation from the burner flame.

In boiler areas just outside the reach of the most severe flame radiation, it may be possible to avoid the forced water or air cooling by using a patented FLEXISEAL boiler door which can be opened and closed in seconds.

All boiler doors are very expensive, but the high price comes primarily from the cost of the matching tube section which gets very complicated for wide doors. See Fig. 6. For this and other reasons, it is important to keep the width as small as possible.

Boiler doors for more moderate gas temperatures up to 1800°F can be made less complex and less expensive since they do not require the same exacting fit and detail to function reliably.

Boiler Penthouse doors.

Since internal temperatures in boiler penthouses are rarely above 1000°F, it is feasible to provide rather large doors in penthouses which are sometimes equipped with just manhole size doors. In many power plants, it is still routine that outage work starts with a crew cutting out a large opening in the casing wall to gain access for personnel and equipment. This work can be avoided by installation of large penthouse doors which can be opened in less than one minute. Fig 7.

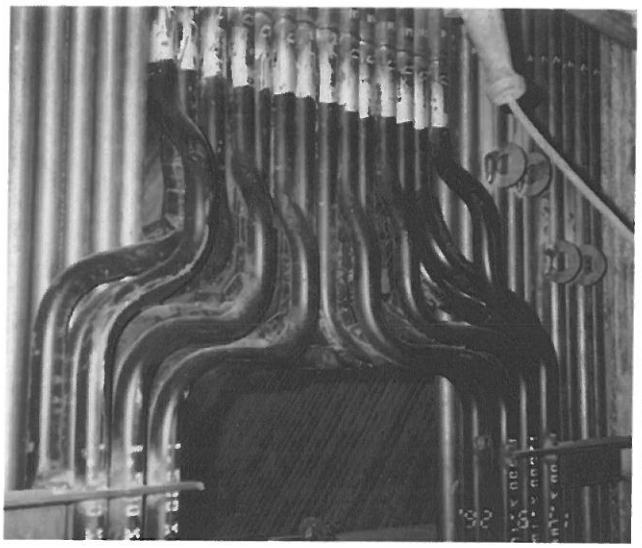


Fig. 6

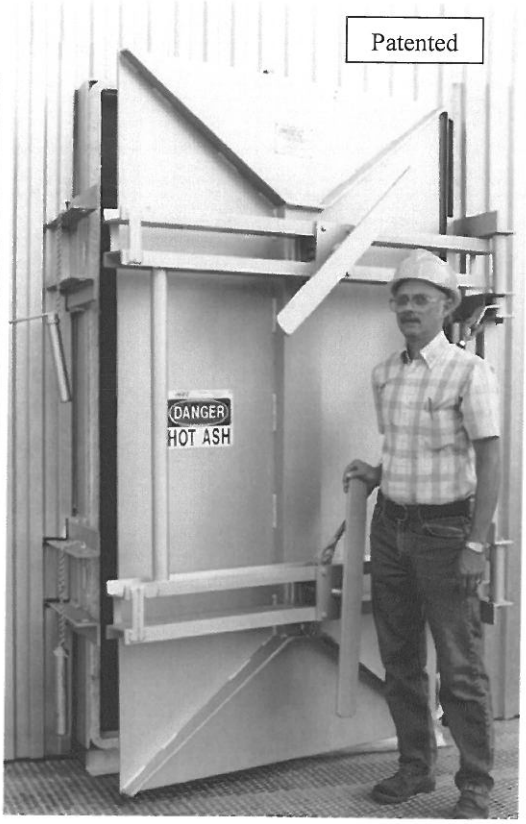


Fig. 7

At some plants, the major motivation to install large penthouse doors is to cool the penthouse many hours faster. Especially in the case of a forced outage, which can cause huge losses in revenue, the faster cooling can pay for the large doors in just a few hours saved in downtime.

Economizer doors.

Most economizers have gas temperatures up to 800 - 900^{0}F and have plate casing walls with exterior insulation. Single, insulated doors as shown in Fig. 4a through 4d can be used in this area, but to protect the personnel working around the area, it may be preferable to use a double door with a heavy, insulated Outer panel as shown in Fig. 4e and Fig. 8. These types of doors can be used all the way to the air heater.

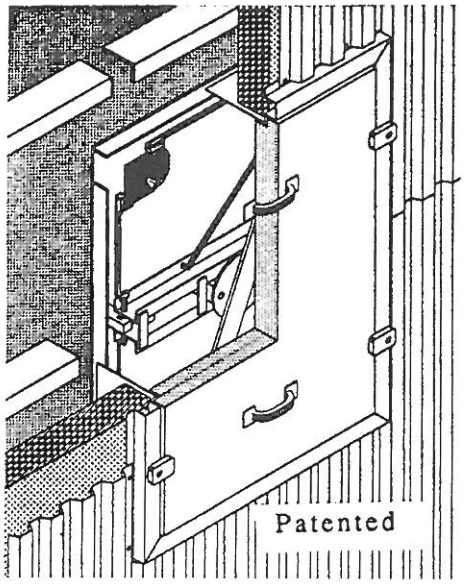


Fig. 8

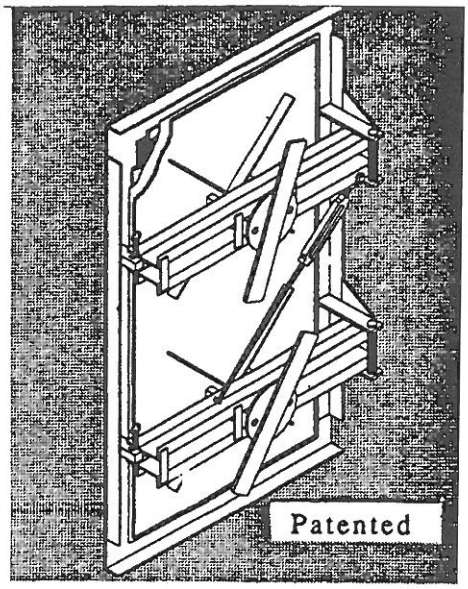


Fig. 9

Access doors for gas temperatures below 400^{0}F.

The ideal doors for this area were described in the above section dealing with Insulation and shown in Fig. 3d and 4e. Made correctly as double doors with just carbon steel for the interior parts and with a separate exterior insulation barrier, these doors will prevent many problems during the lifetime of the equipment. Doors of stainless steel or alloy are only needed in the scrubber/absorber areas.

Scrubber doors

Doors for flue gas desulfurization systems are usually made with the interior surfaces in stainless steels or alloys, capable of resisting the acid attack from the corrosive fluids used in these areas. To save on these very expensive materials, it is possible to cover just some of the door elements with a rather thin sheet of alloy. Future doors will most likely include door elements covered with some of the many types of coatings which have been developed for such purposes.

Since most FGD systems work with a slight positive pressure, only the best doors with the best sealing gasket will prove satisfactory over time. An example is shown in Fig. 9. Again, the doors must open and close quickly allowing fast interior inspection at short outages.

CONCLUSION

Now, ten years after the access door study, Indianapolis Power & Light understand the design requirements for quality access doors. Doors are available that can save man-hours and operation cost. They assure that the tightness and adequate insulation is accomplished automatically, outage after outage, without the need for tools and constant door repairs. Renewal of gaskets, re-welding of rusted, broken lugs and struggling with flimsy, poor fitting insulation covers is unacceptable and unnecessary with good access doors.

Lasting reliability of any type of industrial product begins with the quality and care in design. Proper manufacture and installation combined with the ability and dedication to maintain the equipment is critical to continued reliability. If the ability or dedication to maintain the access doors is limited, it will impact the lasting reliability of even the best designed equipment. If the inspection and preventive maintenance is easy to perform, it is more likely to happen. Maintenance will be neglected if the tasks are difficult, unbearable or uncomfortable.

To get a quality access door the user must clearly understand his requirements. Then he must get expert advise from a reputable manufacturer to select the type and model which will give years of trouble free service.