

The editors of COMBUSTION found Mr. Cowan's report stimulating, challenging, even provocative. Following traditional editorial policy we present the author's story as received and will be happy to give space here to those who will certainly agree with him and to those who will just as certainly disagree.

Furnace Protection—Caveat Emptor

By F. COWAN

Compact Controls Co. Inc.

THE furnace explosion problem increases in intensity as boilers become larger and more expensive. Many ways of easing the problem have been offered. Some are helpful, some unrealistic for today's problem. The most important angle—the participation and responsibility of the purchaser—has not yet been investigated. A basic analysis of the situation from this viewpoint develops some interesting points.

A large utility steam generator suffers a furnace explosion. Hundreds of megawatts are lost to the system for months and millions of dollars are spent for repairs. In Illinois a furnace explosion destroys the only steam generator in an industrial plant. Total plant production is lost for weeks and thousands spent for repairs on a panic basis. In California an industrial boiler undergoes three furnace explosions in one year. Across the nation lives are lost and countless millions of dollars wasted in lost production, repairs and rising insurance costs—and still the devastation goes on.

It is less than amazing that under these conditions a boiler company executive can ask, "Why do we seem to have more furnace explosions now when most units have flame safeguards?"—and fail to get an answer. It may also come as a shock that another boiler manufacturer has pointed out in recent meetings that "More than 80 per cent of the explosions studied occurred on units with flame safeguard devices installed."

Details Are Revealing

When we begin to look into details we are in for an even greater shock. In one case where a flame safeguard device was advertised as absolutely fail-safe, it was found that the device continued to indicate flame in the furnace even after the flame sensing element was removed from the circuit! Should this device have been advertised and certified as "fail-safe" without a thorough environ-

mental test? I think not. This problem was not artificially created but came about under actual operating conditions.

In the Midwest a package water tube boiler suffered near total destruction of the furnace envelope in a gas explosion even though it was protected with an approved flame safeguard. Gas supply was momentarily interrupted and when flow was re-established—before the slow acting safety device could trip the fuel stop valve—explosive ignition was triggered by hot refractory. The pilot had been turned off as soon as the main flame was lit in the approved sequence of operation. Three salient points are made here:

1. So great was the confidence in the flame safeguard device no one bothered to install a fuel trip interlock on gas supply pressure.
2. The slow action of the safety device was accepted without question.
3. Worst of all the pilot was turned off once the main flame was established. Had it been left burning the explosion could not have happened.

Let me anticipate here the reader's objection. He may be thinking, "But under high air flow conditions the pilot might not have ignited the main burner anyway." It must be said in reply that a pilot or ignitor is not worthy of the name if it can not reliably ignite the burner every time under any and all combinations of air and fuel flow. There are good reasons to believe turning off the pilot is the key to understanding the entire furnace protection situation. There was no need for it since gas was the main fuel and hence abundantly available. It was turned off for two reasons.

1. The scanner couldn't tell whether it was "seeing" the pilot flame or the main flame so the pilot

flame had been eliminated in the interests of main flame supervision.

- The sequence, including turning off the pilot, had been approved by the underwriters groups and was therefore accepted.

We can begin to see at this point that this unhappy situation could never have developed had not the purchasers and users of this equipment exhibited some of the less admirable characteristics of sheep. So long as we allow ourselves to be pulled and tugged at the whim of so-called "accepted" sequences or specifications, so long as we permit vendors to ignore our question "Why?"—that long will we have to suffer with inadequate, dangerous furnace safeguard systems. There is one added responsibility and that is to let safety precede price. Once it is decided intelligently that a device or system is actually required and is right for a special need there should be no haggling over a few dollars.

It is essential to realize that a cheap system is often worse than no protection system at all. When the system is installed the operator is trained in a set routine. His responses to warning signals atrophy through lack of use and, to make things worse, emergencies arise in new and peculiar shapes as his new protective system disintegrates. It will seldom break down the same way twice and in short order the unit is plagued by frequent outages and can very well be more hazardous to operate than before controls were installed.

A "cheap" system can be almost as dangerous as a poorly designed one—and the cheap jobs are frequently bypassed entirely because the many outages simply cannot be tolerated.

What to Do?

So far the picture is grim and may indeed seem hopeless. What then, can you, the purchaser, do about it? That we must have safe, continuous operation is obvious. As boilers become larger and more expensive so do accidents become more costly and the dollar losses of curtailed production become more painful. Something clearly must be done to protect the purchaser or user of furnace protective systems. The answer is hard but simple—you must protect yourself.

Step 1. To lapse into the vernacular is to "shake the sheep habit." Nothing should be taken for granted except the power of the purchasing dollar and the answers that power can produce.

Step 2. Next, take an active interest in the development of the safety system and face the fact that some real work must be done by you.

Step 3. Move over the "THINK" sign on your desk and add one that says "WHY?" Make sure it's plainly visible to vendors of systems and components. Don't accept answers like "Well, that's the way everyone does it," or "Because it's approved." Just point to your sign and insist on a reasonable answer.

Step 4. With these attitudes in mind the development of a logic diagram can begin. This is a diagram like Fig. 1 that spells out each step in the sequence of operation in one-syllable words. No magic symbols are needed and even the Chairman of the Board should be able to understand it.

During step (4) the question "why" must be asked—and answered realistically—many times. Starting with

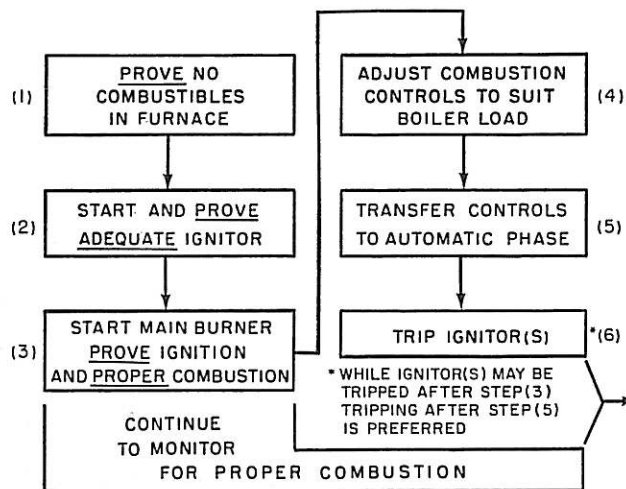


Fig. 1 Basic logic diagram applies to any system, any fuel, any burner. Actually performing steps in each box will require many added functions

the purge for instance, one might ask at the outset, "Why purge now—should something else be done first?" The answer will come back, "Yes indeed. It does no good to purge while fuel is flowing into the furnace. Let's prove that all fuel flow is shut off before we purge."

Following this procedure, the question must be asked, "Why turn off the pilot when the main burner has been lit?" If you're using a bottled gas pilot fuel the answer "Economics" will probably justify turning the pilot off. But at least you won't be eliminating a support for the main flame just to give a scanner a chance to "see" the main flame.

In a continuing process then, the logic diagram is built, and the question "Why" should be asked at every step. "Why two fuel trip valves in series?," for instance. Why not one good valve? Why can't the valve manufacturers furnish a valve to do the job? Why, if one valve is so prone to fail can't both of them fail together during normal operation? How frequently should they be checked?" "Every month" you say? Why not every week? Every day?

And on and on go the questions. "Why should I purge for 30 seconds? Why not 3 minutes, 5 minutes, 10 minutes? Why should I have an adjustable purge? Any mechanic, with one turn of a screwdriver can cause damage in the thousands or millions and maybe cost lives. Why can't I know what's right before I buy?"

You may have innocently acquired a "helpful" sample specification that advises alarm and indication of flame failure. Flame failure only? You want indication of the cause of every fuel trip or shutdown. Each safe trip should be treated as though it were a major catastrophe (it well might have been), and immediate steps should be taken to rectify the trouble. And *never* should a unit be started up without knowing why it shut down. This means at least a simple annunciator and annunciators cost money. So do explosions—an awful lot more money.

The sample spec may recommend a 15 second trial-for-ignition period. Why? Maybe you don't want fuel pouring unchecked into your furnace for 15 seconds. Maybe you think a good burner should light off in 5 seconds (so do I). Well, you certainly don't have to settle for a hazard you don't need, but you will if you don't ask why. Another oddity of the typical spec for indus-

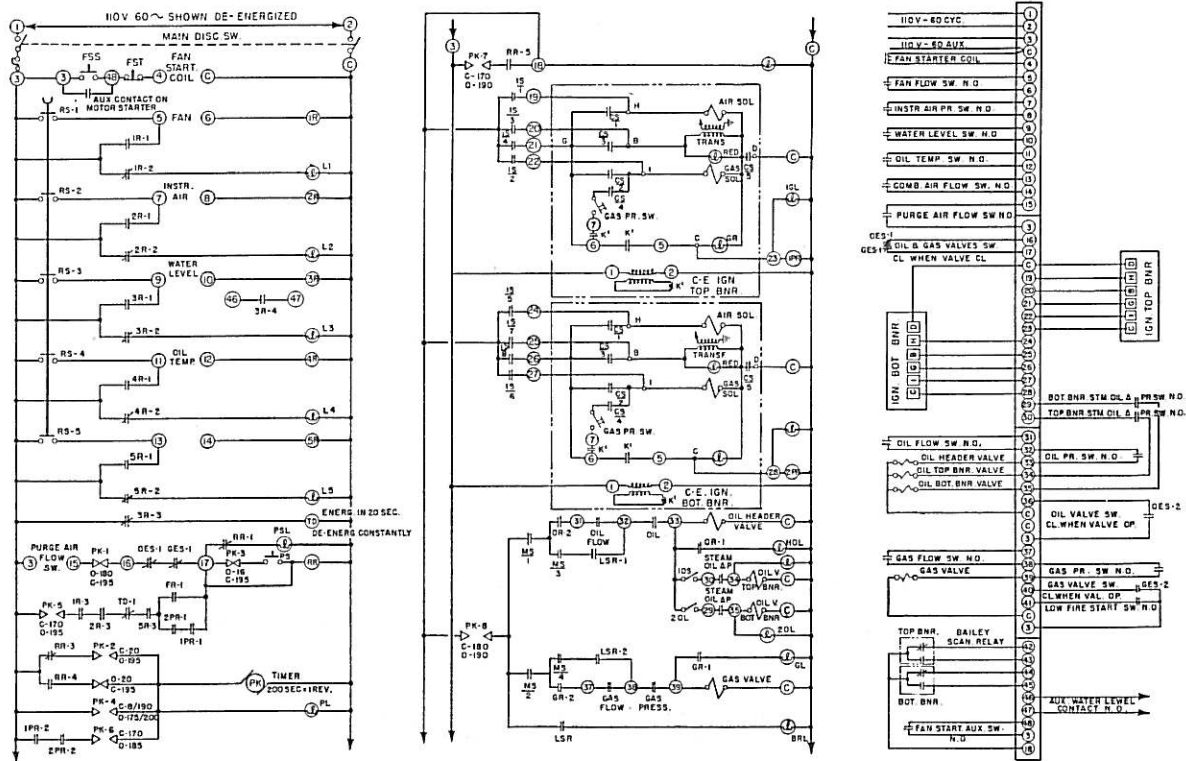


Fig. 2 The complexity of the elementary and field wiring diagram shown above illustrates the need for care and experience in developing practical physical arrangements from logic diagrams

trial units is the post-purge. After flame failure the forced draft fan is required to run a specified time before shutdown. Now its true the furnace must be purged but the time to do it is *not* when it's filled with a fuel saturated atmosphere and hot enough to ignite when supplied with air. The post-purge was originally conceived to supply air for combustion of fuel remaining in rotary cup burners after fuel valve closure and has no place with other type burners.

The list is long and the problem is complex (I said work would be required) but there's no call to be discouraged. The problem must be tackled one step at a time and each step is understandable to the average layman. If your vendor or advisor can't give a logical or reasonable explanation to your "why?" don't hesitate

to enlist some one else's aid. Remember it's lives and dollars you're concerned with. Just keep on with your system approach and when your logic diagram is complete, check it for interference. It's possible to be so safe that the thing can't be started, you know.

At this stage some one with experience in designing and assembling furnace protective systems can help you avoid these interference pitfalls and at the same time translate your logic diagram into a wiring drawing such as shown in Fig. 2 that may be used to request quotations.

Make no mistake, the process is long and requires painstaking effort but the result is well worth while. And next time some one says, "You just can't get a good reliable furnace safeguard system," you can reply with an inner smile, "Why?"