TRIP SYSTEMS DISCUSSION

Gilbert Rowe, Esso Chemie N.V., Netherlands: To review quickly and set the stage for this discussion—trip systems are like women; you can't live with them or without them. There are two basic points of view that operators have taken. The first could be characterized as - suppose the Control Board man has a heart attack? We must have the unit in a fail-safe condition to avoid a catastrophe. And these are the people who have supported, and tend to use, more trip systems.

The other point of view is that trip systems cause a great number of nuisance shutdowns, that you can't afford the loss of production that comes with trying to work the bugs out of them, and that you may never work the bugs out of them. A second, and perhaps as strong, argument is that trip systems take a responsibility from the operators, who thus may be considerably less well prepared if a disaster situation shows up and if a part of the trip system doesn't function. So these are the two sides, and each operator has developed his own philosophy. What we've done for this discussion is to prepare a list of typical places where operators may have used automatic trips. We'll go through them and find out what sort of feeling there is in the panel. Hays, if you agree, within the limits of time, I think we ought to let everybody else be part of this discussion too, and enter in as we go along. OK. With that, shall we start down the list?

Q. Is it important to have a trip on low lube oil pressure?

Rowe: It's generally felt that you must have the trip because you can't afford the damage that'll occur if you don't. A second trip is needed on seal oil level, or the differential pressure on seal oil, both for the protection of the machine and personnel.

Anon: I do believe that in the use of overspeed trips more care should be taken in determining the overspeed trip setting. If you take a specific example - an induced draft fan - let's say that this fan's going to run at 900 rev./min'. and then they arbitrarily say "Well, we'll trip it at 990, 10% above this."

In actuality, the fan might be capable of operating at 1200 rev./min., and every part of the component might be capable of operating at 1200. If this is the case, in my opinion, the fan and other pieces of equipment in many cases should have the trip setting at the highest mechanically safe speed—not as some predetermined multiple of an operating condition.

In the case of the induced draft fan specifically, some accident to the steam system, which will give you heavy changes in steam flow to the turbine, if you don't have some marginal speed, then the fan can and has, in some units - actually speed up and trips out, so that it becomes a real serious problem for the plant.

Rowe: The next one we have, and here, i think, we might get some audience help, is vibration or axial displacement instrumentation. Most people've become familiar with the newer kinds of probes - proximity probes and things of this sort which are being used to measure machine movements.

I have the impression that most of the people on the panel had the feeling that this instrumentation was not yet reliable enough to use in a shutdown system, and so, where they used them, they used them for alarm situations. I'd like to consider using this instrumentation in shutdown systems?

Anon: I think that one of the problems that one faces with vibration instrumentation is that unless they are recorded, one doesn't know what the safe limits are, or what its history was before it went to where it is now. Now this type of recording instrumentation is being used, and it is monitoring the operation of the rotating equipment.

In our plants, we have not yet - as far as I know - put automatic shutdowns on these high levels of vibration or anything else, but they are alarmed, they are monitored, and decisions are made about what to do if there's a sudden change that might be catastrophic. Now if you have a 2/10ths of a micro or mil or whatever, vibration is normal, and it goes to 3/10ths, it becomes a hazard, to our people. If you're at 4/!0ths, and it stays there, nobody gets excited. So it's a matter of what the history of the machine has been, rather than what its momentary vibration may be, and what limits you've put on whether you can run it safely or not.

We haven't yet chosen to shut the machine down automatically. Now, our onstream factor has been rather good, and I'm not so sure that we are wrong. It's a subjective point of view, in most cases. We feel our operators are sufficiently reliable at this juncture to make sure that they are monitoring it in a steady fashion.

James E. Collier, Factory Insurance Assn.: I agree that perhaps in the earlier days the sophistication of this type equipment was somewhat questionable, and obviously the alarm-manual shutdown features certainly had to be recognized. I am familiar with not an ammonia plant, but a parallel type operation. This is a billion pound per year ethylene plant. It's a monstrous thing, like many of the ammonia plants are, and it's also it's a single train type plant where all the equipment is very critical. Oftentimes equipment is not spared, so therefore you must have as much reliability as possible.

But in the case I'm thinking of - an ethylene plant - where there is critical equipment this is all centrifugal rotating equipment, cracked gas compressors, ethylene/propylene refrigeration systems in single units. They have installed the vibrational interlock to actually shut the machines down, and certainly from the insurance standpoint, we feel that this is the only logical and safe way to go.

Anon: I can't help feeling that in many cases, the insurance companies, in protecting against the loss of a machine, are actually injecting into the operation a shutdown which in the case of ammonia can easily result in very serious damage to the plant and long downtime. I'm quite familiar with equipment purchased within the last two years. We have made a determined effort to make it work, to the extent of taking qualified people and sending them to the people that made it, going over their service procedures, and I assure you that the cost of making this an automatic trip system would be prohibitive.

Out loss of production would - would just be completely unwarranted, and I think really the hazard would be greater.

Barney O. Strom, Department of State: This is a subjective position in most cases. However, I think the operators who are farseeing enough recognize that even with fail-safe positions you will damage machinery, and therefore proper storing of spare parts in such a manner that one can replace quickly a damaged machine is more reliable in terms of lost production and total cost than any other thing - any other way of doing things.

For example, I've had experience with the high pressure steam turbine, which has always been a hazardous turbine, and we know it's a difficult turbine to replace the rotor on; it takes days and days, if you can do it in situ or in the field.

We had elected to carry a complete spare case, turbine rotor and all and we could change out a damaged turbine in relatively short order and go back onstream while the damaged part was repaired at leisure. Now this kind of planning of spare parts will determine to what extent your damage leads to extended down periods, and one should invest in these spare parts in some manner that would overcome the real hazards.

We, for example, carried in a spare parts pool situation with a number of plants up to a million dollars or more of spare parts, which we share, and transport to and from, and this has made our onstream factor more reliable, and less difficult for the insurance company to insure us.

Rowe: The next one is high level in suction or interstage knockout drums. Do we have automatic shutdowns of compressors for this one? Before I turn it loose I give my own feeling, which is in many cases at our plant we've eliminated this particular kind of trip. We've said first that centrifugal compressors don't take the kind of beating that recips used to take if you send a slug of liquid to them. We've also said that most of the streams we're using we have pretty good control on, and don't expect liquid collection. For example, we've a very dry natural gas feed; we have a knockout drum for it, but don't expect to find anything.

We blow continuously from the drains on our air knockout drums, and waste a little of our air machine capacity. So with approaches like this, we've eliminated several of these knockout drum - shutdowns. We do have high level shutdown on our ammonia refrigeration compressor.

Ken Wright, Hills Chemicals: We still have the contractor-installed low - high level knockouts on our compressor drums, and our experience with them has been very good. The few times that they've had to actuate, they have been needed to actuate, and we wouldn't change them.

Strom: There is a sort of a mixed way to look at this. I know that the high level that would necessitate a shutdown is I think reliable and important to have, but there is a lower level alarm that's actuated, so one knows that this is happening, so that the shutdown never takes place. Now this has worked out real well. Now you have a lot of water to remove in the air compressor, which is the big bad actor in this, and in our plants we had what we call steam trap removal systems. Now they tend to plug up, and a bunch of other things happen to them, and the low level alarm is sounded and somebody goes out and opens a bypass and blows it off, until he gets his trap functioning. I think this is a reasonable approach to where you avoid unnecessary shutdown.

Tom Carroll, American Oil Co.: We normally use this high level shutdown not only in our ammonia plants, but in all of our oil equipment also. But we also use the other feature that Barney speaks of. We normally have a level point, and sometime two level points, as alarms before you reach the shutdown. This is an attempt to avoid unnecessary shutdowns. Now we've had some instances (one, on one of our ammonia plants this last year) where the shutdown device was set too close to where the normal liquid level was. The design of the ammonia plant drum was such that we just physically could not get a good separation from the normal liquid level in the shutdown device, so we inactivated this device after it shut us down twice. We've modified that drum now and put a nozzle at a higher level. We definitely believe in having these shutdown devices as a last ditch safety device. But we want the alarms ahead of them.

Rowe: The next item is one some of the compressor manufacturers have recommended which is a shutdown when you underspeed the machine and start backing into the critical speed ranges. We don't use one of these. Does anyone else?

Strom: This is an old story. We had the original Kellogg plants, and even had an air compressor whose shaft was rather limp and a bunch of other things, and there had to be constant care taken when we do underspeed. Now it turns out that not only do you worry about critical in the cases, but you worry about surge. The machine has a characteristic that at a certain speed you have to vent off the first case.

Well if you have a tripout, your machine goes down in speed, you find yourself surging going down, and the surge characteristics are not easily understood, and neither does anybody know why they fail when they do surge once or twice. So in our plants we had put on solenoid tripout devices which at a preset lower speed open interstage vents, so that it doesn't go into surge in going down to a dead stop. It's a rather sophisticated device, but it works, and there's no danger of it, because you've tripped out anyhow, and it doesn't affect the process.

Rowe: I want to respond to the last of Barney's points. Almost none of these trips are harmful to you if they work the way they're supposed to work, because then they'd do exactly what you'd preplanned them to do. However, every time you put in one of these devices, it can work at the wrong time, and vent gas out, or shut down the machine, or close off - well, whatever it's programmed to close off, and that's when the trouble occurs.

And I think that you have to get a little more sophisticated than the first blush to overcome some of these problems.

Wright: We did have a problem with the low speed device on our air compressor, and we've changed it into an alarm. We also had a problem with the low speed on the syn gas machine, wherein, due to malfunction of the instrument air supply to this particular machine, the machine was slowed down to an unordinarily slow speed.

We have since installed a corrective device to prevent this operation.

Anon: There is a danger always in a solenoid - operated trip valve in the effect of a power failure, which may be momentary or of some duration, because the valve will jump open, and there's nothing one can do. Well, you overcome that by putting the solenoids on a DC source with battery operation, so that at least you get power to it and a power failure doesn't do this to you.

Q. Wouldn't it be easier to keep some air venting from the condensate traps because they're quite subject to plugging?

Rowe: That was the method I had mentioned we use. We do blow a little air steadily out of drains to make sure that we keep the knockout drum empty. Barney, maybe you ought to consider that.

Strom: The advantage that these centrifugal machines have for us is that there is no oil in the condensate, and while the condensate has been always a bad actor as far as steam traps are concerned, our steam traps, as far as we knew, were functional most of the time.

There is no real hazardous activity that we discovered with it. Now there was a time when we had an exchanger past the methanator, where there was a substantial leakage in tubes, so that the suction drum to the syn machine filled with water very quickly, and there we had to get rid of it, because the trap was too small to handle this quantity of water.

But we couldn't live very long with it and we had to shut down and fix it. But aside from that, the trap operation has been rather successful.

Q. Has anyone seen a need for backing up a lube oil pump on a high speed centrifugal machine with some additional redundancy for the times when perhaps the main pump is out for servicing, and you're running a spare. So you feel you can safely secure the machine? Let it coast down with no oil to the bearings at all? And has anyone provided a third pump for these situations?

Anon: We have run during the initial startup periods without a spare pump on our high pressure seal oil pump. We do not provide a spare. I know that at another plant when they had such a problem, they did install a spare. A third oil pump.

Anon: A - a third pump - actually a spare for the spare. We've had an incident of failure on one ammonia plant, where the main pump was out for repairs, and the second pump did fail, and we had some rather extensive damage. One other thing I might mention on the level situations. Our designers do a fine job giving us alarms in certain spots, and then generally when we have a trip located somewhat above this, I imagine to keep from spoiling us too badly, they'll eliminate the alarm feature for the trip. We've had several occurrences, of course, where the alarm may be taken off of a level control signal or something, and it may be miscalibrated, or just wrong, and we get a trip, and in the first five frantic minutes or so no one has an earthly idea of what caused the machine to go down.

Because someone didn't want to spend a little money to put an alarm on the independent trip device itself.

Anon: The compressor or alarm panel in most of these plants are very complicated with lots of alarms sitting all over the place, and we have decided in the past and I think everybody should look at it, because it's not very expensive, to have a first out trip light which tells the guy when the machine is down which trip did the damage of shutting the machine down. You go to the panel and there it is - that's the light that stays lit.

And this is the answer to finding out what actuated the shutdown in the first place.

Q. Can someone discuss trip operation of the discharge valves in the syn gas machine?

Anon: In the system installed in our machine, in the event of compressor tripout the oil pressure switch will automatically close the synloop block valves. As I understand, another plant had a problem where this didn't function. Or it did function while you were running, much to your regret. I would like to touch one other thing, and that is on the tripout on vibration. You're dealing with a bunch of big machinery here, which can affect your steam system anywhere from 100,000 to over 500,000 pounds an hour, and when this machine comes off, you're going to create problems somewhere else, and in my approach to the vibration is that when a vibration occurs, your damage has already begun to the machine, and if this is not a real vibration such as the idiosyncrasies of this pickup equipment, then you have knocked off a big hunk of hardware, you've endangered the steam flow to your reformer, and you've created problems throughout your whole plant.

Q. Do you have an automatic trip that shuts down the reformer furnace in case of high furnace firebox pressure?

Strom: We had a position where the reformer is not controlled by malfunction of any shutdown devices. We felt the reformer tripout and general safety of the plant is more reliably maintained if you keep it onstream longer and safer. Now, the only failure that I recall that would be any consequence was an ID fan tripout, which happens once in a while, and the people restarted the fan without ever seeing any blip in the system. That got everybody pretty confident that this is the way to go.

After 4 years of operation I'm sure that we feel that the confidence is not misplaced. I know that the insurance people have been very adamant on this position, to the point where blood was on the floor in discussing this. I don't know where the resolution has come - or gone - but in some cases the insurance people were changed out with other insurance companies, so that we didn't have to have these tripouts.

Q. Does anyone trip a furnace due to loss of flow or low flow of any of the feed streams going to the furnace? This could be air through the air preheat coil, or feedgas, or one of the various kinds of steam flow, such as steam through the steam superheater, or boiler feedwater through the economizer.

Anon: Our system operates on the premise that low steam flow in turn will trip the feedgas flow. In addition, loss of any feedgas flow will in turn trip the air flow to the secondary. The system works pretty well. The only drawback is that you can—when running at high rates—have a sudden loss of steam with a resultant delay in reduction of gas flow creating a carbon condition or a dangerous condition in your furnace. In other plants we've used a steam-carbon ratio shutdown device. It operated by comparing the steam and gas flow and then stopping the gas flow if this got out of balance.

Caserta; American Oil: We have trips that would automatically shut down the reforming furnace on low steam. On our large unit, the 1500T/D plant, we have run with this trip in bypass position all of the time. This has averted at least two shutdowns for us that I'm aware of, on instrument malfunction.

We do plan to back up our electronic steam instrument with a second instrument. We have done this on our No. 1 plant, the 600 T/D, where we have electronic as well as pneumatic flow indication on steam to the reformer.

Strom: The boiler level control has been fairly reliable in our plants, although we backed it with a TV camera, and use it for what it's worth. The only thing that really has to be done if you lose level and you can't get it back - due to a malfunction of a boiler feedpump, or something similar is to take the air out of the system, and then you're fairly safe on the waste heat boilers. That's the only thing that's in trouble, at that point.

And when he can't get back on, he gets an orderly shutdown. I'm not so sure that we've had cases of boilder feed pumps tripping out, level dropping, and the spare pump starting up and getting you back onstream without any difficulty. If we tripped out because of that, we'd have more trouble.

Rowe: We have a flow meter and trip on the circulation water to our main waste heat boiler. If we lose flow, we feel we must come out, that we're going to do catastrophic damage. We put it in the same league as the compressor kind of catastrophes that can be suffered with low lube oil pressure. Does anyone else use that trip?

Strom: You have forced circulation, don't you Gil? On your boiler? Well the typical Kellogg plant certainly doesn't have that, and that we think is an advantage in that situation.

Rowe: Does anybody else have forced circulation?

Leo C. Smith; Wycon Chemical: My comment is about the low boiler level. After loosening most of the tubes in a boiler, we decided that we'd like to shut down on low boiler level. We did back up the potential instrumentation problem by putting in parallel transmitters for control and alarm/shutdown, so that the operator has two indications to look at. We feel it's absolutely necessary to shut down on low boiler level.

Rowe: The parallel transmitters kind of make you sure you know whether what you're seeing is likely to be true. But do they make a nuisance trip any more unlikely?

Smith: We really haven't had much trouble. We've had this set-up operating for 3 or 4 years, and we've had two or three shutdowns as a result, but we feel it was worth it. We did the same thing on steam flow to the reformer. We had one occurrence when the transmitter froze up, and as luck would have it, it was the side that caused an indicated high steam flow, which then made the valve shut, and we coked up the furnace. We then put in parallel transmitters, one controlling, one indicating and alarming, so that the operator has a chance to check for instrument failure before taking action. We do not have an automatic furnace shutdown on this instrument system.

Anon: I believe one point was made on loss of air flow, as possibly being a dangerous situation. In many units, there's a steam stream which goes in with the air, and is there all the time, so the loss of air flow does not result in overheating of the air coil in the convection section.

The waste heat boilers on the natural circulation system will handle - well, if they've got water in the tubes, will not fail or at least there's some evidence that they will not as long as the air ir not going to the secondary. So that, as Barney mentioned, just taking air out of the system does pretty well eliminate problems with the waste heat boiler and at the same time, with the steam going into the system, you do not have any problem of overheating the air coil.

I'm aware of one unit that was built in the New Orleans area, actually in the city of New Orleans, and the regulations required a shutdown of firing on event of loss of steam level, and this shut the unit down a half dozen times. You know you feel pretty violently about these things, and my opinion at the time was that it was a bloody nuisance and caused a lot of problems.

Anon: I disagree with what you say, that you do have enough steam going through the air coils to prevent a rupture in case you lose your air flow. We ruptured our air coil because we didn't have enough even though it was the designed amount of steam going through, but we still ruptured our air coil.

So we've recently installed alarms on our steam and air coils, so that we don't exceed the maximum operating temperature for the pressure that we're running. We feel it's a good idea.

Rowe: We don't have steam normally in that air coil, but we have a separate trip which has given us no trouble. We have a minimum flow signal on the air line, and if air flow drops below that signal, then we automatically put steam in. This one's never given us any trouble.

We go on, and I think we can take the whole subject together, to the secondary reformer. The question could be stated as: Do you in some way take air out of the secondary reformer due to either low flow of feedgas or steam, or high temperature in the secondary reformer? And to start it, we have our steam and gas on ratio control, and it's actually when the gas drops below trip point, then we slam air shut - we have two valves. On this one we decided we needed both philosophies working. We have an automatic trip-close valve, and we have a pushbotton close valve, so the operator must take care of one of them, and the system's supposed to take care of the other. We're working on the basis that either one of them might not be there when they're needed. We wanted both for this particular service.

Wright: We have the automatic shutoff of air in the event the feedgas is lost for any reason. We have no provision for temperature shutdown.

Smith: We trip our secondary air out on differ basis that either one of them might not be there when they're needed. We wanted both for this particular service.

Wright: We have the automatic shutoff of air in the event the feedgas is lost for any reason. We have no provision for temperature shutdown.

Smith: We trip our secondary air out on differential pressure between air and gas. We arrived at that after a failure on the reformer inlet manifold where we lost the gas flow after the flow meter, but before it got to the furnace. You can fuse the secondary reformer catalyst very quickly that way. We set up a system that trips on either low or high differential pressure between the air and gas, which really relates to flow of either one of them, and we have found this to be very successful.

Rowe: Anybody else have any particular method or experience on this one? I think this is one of the ones that frightens us all. I might mention - before we put in this pushbutton manual valve, we got into trouble with the trip system, not in that case because the trip system didn't try to close, but because we found a 14 inch long file that kept the automatic valve from closing.

Which all the pre-startup blowout procedures hadn't gotten rid of. OK.

Q. I would like to raise one question, when you shut the air off, do you automatically open the anti-surge valve on the air machine?

Rowe: Yes, we have an anti-surge vent on the downstream side of the air coil on the furnace. The trip valves are downstream of that vent. So when the trip valves close, the antisurge vent opens.

Rowe: The next one we have on our list is: Do we have any automatic systems to divert gas from the low or high temperature shift converter due to a high temperature or due to some analyzer reading or some other kind of way of doing this? We have a system that I think is a little tricky, but we've been living with it.

We have an automatic vent on the inlet to the high temperature shift which is controlled by the temperature coming out of the low temperature shift. What we're - in effect - saying is if we get out of balance such that we can't take out enough heat between shift converters to keep the low temperature shift cool, we start dumping gas, so that those boiler feedwater exchangers between the two can do the cooling job required.

Now this one - this one's made trouble for us, 'cause that vent has opened and cost us a lot of grief downstream, and we're not real happy with it, but we're still living with it.

Wright: The only automatic control we have in the shift converter area is an emergency type button which the operator can use to take the low shift out of service. We have no shutdown provision for temperature or analysis. We do have a standing order that whenever the air compressor is lost, that the low shift and the methanator be taken off the line immediately.

Strom: One thing that we had put into the new plant of ours in Donaldsonville was a waste heat boiler after the high temperature shift, which controls temperature to the low temperature shift. The danger of having a high temperature in that area gets reduced by having this waste heat boiler there, and I think it's manageable, and it's an easy operation.

It's a low pressure waste heat boiler - a 50 pound design.

Q. Is this in addition to the - what they call the 103C?

Strom: Yes. That's after 104 C, where you have the mixed gas preheater - methanator preheater, and then we put a waste heat boiler in there, and it does two things. One, if you manage to get good catalyst at the low temperature shift, and that's a big question, always, you're able to run that at 400 F.

And if you do that, you have a longer life on the low temperature shift, and it's a more reasonable approach to keep that longer.

Rowe: The next one we have is in regard to the methanator. Do you have automatic shutdown of the Methanator due to high methanator temperature, or an analyzer after the CO^2 removal unit, or whatever. To start that one off, we have a tight shutoff ball valve upstream of the methanator which has an automatic trip based on methanator temperature, and a pushbutton trip to the same valve. We're so conscious of this that we have never known the operators to be beaten by the automatic trip on this one. This one they know about.

But we do have an automatic trip at that point, again in case of the board man having a heart attack.

Anon: We did have the automatic trip on the methanator, and we have disconnected it. We have the alarm function that remains still, but our experience has been that this is related to a temperature recording or indicating instrument that requires maintenance from time to time, and too many times it has either been inadvertently turned off, which dumped the methanator, or tripped the methanator, or due to failure of a small 25 cent component in the back of the instrument has gone out on us.

One thing I would like to ask is that perhaps our insurance friend could contribute to our conversation here.

Insurance Friend: So far as instrumenting of furnaces is concerned, in general, the official insurance company opinion is that "people are no damned good;" you must use instruments. Every time someone says they use instruments, I mentally applaud. But there's one point that I've not heard made yet, and that is the approach which instead of involving a fixed limit shutdown involves a sudden rate of change. For example, consider the earlier discussion of vibration in rotating machinery. If you're running with a normal amplitude of vibration, you may want to shut down when that doubles, rather than wait until it gets up to a four times normal or five times normal - or whatever your limit is - provided that the approach to the doubling point is rapid.

The same way with boiler feed water. If your level starts to fall rapidly, then is the time to do something automatically; don't wait until you hit the low level alarm. And where plants involve computers, this is realtively easy to do.

Rowe: The difficulty, I think, with that approach on some of these is that you get a very rapid change when the instrument goes haywire, and so when a level controller stops working, that's when it drops directly to zero. That's going to give you the high rate of change. And it's when one of these proximity probes breaks loose in its housing - which is precisely when it's not going to tell you anything, but that's when it's going to go through this kind of a trip point.

So it still is very much tied to the reliability of the instruments.

Strom: The methanator temperature increase, which is rather catastrophic, it doesn't do a little, it - tschzzummmm! It goes up very rapidly, and it's mostely due to malfunctioning of your CO^2 removal system pumps from which you get a massive amount of CO^2. Now what we've done, actually, is to have the trip in, because we've had too many occurrences where people would latch it out, and then they'd have a failure and have trouble.

And we have tended to make our pumps more reliable, and the spare pump has an automatic startup to go onstream when the other trips out. Now that's worked very well, and they've had very few upsets in that direction. The trip, though, is necessary although one doesn't know what to do when you do trip it out, and the temperature keeps climbing. It isn't very simple to cool it down.

D.E. Andrews, Dow Chemical of Canada, Ltd.: We have a safety interlock on our amine charge pumps so that in the event of a pump failure the auxiliary pump must be put on line within four minutes or we get an automatic trip on the synthesis gas compressor and the methanator vent.

Strom: We heard a paper earlier where the author described a startup furnace with a control valve after the furnace prior to the reactor converter. Well this to us is a rather dangerous piece of business. We should have no valve on that line, and the flow to the furnace should be ahead of the furnace, with a low flow trip valve for the fuel to the furnace.

The reason for that is very simple: Occasionally we all have had it, I'm sure - this syn machine will trip out, and when that trips out, everybody is flying around and forgets to get that fuel off that furnace. With a trip valve there, it's automatically taken care of, and the furnace doesn't get blown up.

Anon: I would make the comment that there have been at least two very serious accidents with startup heaters in the total industry, and this trip device, in my opinion, needed. Actually, if it doesn't exist on your unit, you probably ought to put it in.

The other thing is that inadvertant tripping does not particularly cause you any problems, I mean you just have to go back out and light it; you're not knocking the unit down when you do something like this.

Jim Sherman, Dupont Co.: Inasmuch as one of our plants experienced a start-up heater explosion, I feel obliged to comment. The original start-up heater at that location was not equipped with a flame failure device. Although the exact cause of the explosion was not determined with certainty, the repairs included a flame failure device among other improvements.

At our Beaumont plant we have the following trip devices on our start-up heater:

Flame failure

High or low fuel gas pressure

Low process gas flow.

In addition there is a high process gas temperature alarm which is adjusted upward as heat-up proceeds.

We believe that trip devices are appropriate on start-up heaters whereas they might be undesirable on a reformer because a false shutdown on the former is not nearly as serious as a reformer shutdown. Also the start-up heater is used intermittently, say once or twice a year; and the operators are not as accustomed to watching the heater as they are a reformer.

W.D. Howard, Monsanto Co.: I'd like to make a few comments on the general subject of instrumentation. Now in these I will say some things that I'm sure are redundant to almost everyone here, but I want to say these anyway, because I think that some of the things that have been mentioned here in the way of occurrences may have been related to some of these points.

First let me say that instruments are not just instruments. Merely having instruments does not go you any good. There are a number of things that we have to consider. First, of course, is the quality of the instruments themselves. And when it comes to instrumenting for safety, we should not spare cost in order to get quality. By the same token, the highest priced instrument is not necessarily the best quality instrument.

Next point is the quality of the installation. Recently, I was out in one of our plants where we had a construction job going, and I saw some pneumatic instrumentation being installed. A good job was being done. But interestingly, there were a whole series of key tie-in points which at that time were open. They were supposed to have been capped off. They were open, however, and this was a very dusty location. You can imagine what's going to happen to that pneumatic instrumentation. The quality of installation is very important.

Another is the suitability of instruments for the climate involved. And this particularly relates to field-mounted instrumentation. In some of our plants where we have very corrosive atmospheres, for example, we have had to resort to encapsulated microswitches in order to get dependable functioning.

All of these are very important for what we call "instruments." Now another is the design of the particular instrumentation for ease of maintenance. We can get instruments that are awfully nice, but they're the devil to maintain. Another is the quality of maintenance which we give these instruments once we have them. And I'd like to speak to this in two different ways.

One is checking instrument operability and instrument integrity on a scheduled checking basis, not just a once-a-year runaround to be sure the instrument is still there. And of course hopefully checking as nearly as possible back to the initial sensing element, whatever that may be. Another area in connection with quality of maintenance is the quality of workmanship which we get in the repair of our instruments. How often do we have the experience of people who work on our instruments only to be called out the next day to work on them again. What we need them to do is not just work on the instruments but fix the instruments. There's a difference. For quality maintenance the quality of workmanship is very important.

Another that I'd like to mention is the instrumentation furnished on auxiliaries of major equipment. We have heard discussion on this subject before. One of the important factors here, of course, is the quality of instrumentation on the auxiliaries. Another factor is the problem which we have if the instrumentation provided on auxiliaries is different from the instrumentation which we use in that particular plant. This means that we don't have proper replacement parts, our maintenance men are not familiar with these particular instruments, so they don't really know just how to repair them. These are some real problems when you get into different kinds of instruments.

Another point in connection with instrumentation is response lag. I'm talking here of response lag in terms of the primary element, the transmission means from the primary element, whatever that may be, and finally, of course, the response action of the final device which is to do something for us. Sometimes we don't pay enough attention to the dynamics of our process, and the dynamics of the process transients relative to the overall dynamics of our instrumentation.

Another point here is one which we hate to think about, but it's real nonetheless, and this is the necessary instrument replacement schedule. And finally, I'd like to throw one last one in, and this is the importance of decision in some cases about whether we need - in the case of electrical instrumentation- instrumentation which is continuously energized or continuously de-energized. Sometimes this is a very, very important decision to make.

Rowe: I would mention that normally energized or normally de-energized was a subject that I steered away at least twice during our discussion, because I thought it would double the length of discussion we were having.

Strom: I'd like to second Walt Howard's comments and go a little further. Our experience in instrumentation in these plants has been that we must have a good high class instrument engineer who is responsible for the maintenance and checking of instrumentation. It appears as though just maintenance by maintenance groups is not quite enough. One must have a knowledge of the process and what it does, and how fussy one becomes, and what the instrument's supposed to do, and so on. And a good instrument engineer who knows his process is a bona fide addition to your plant that can do lots and lots of good for you. And I don't think that we should spare the capital in paying for such a man.

P.G. Robinson, Power-Gas Corp.: To pick-up Walt Howard's point on system responses, in Power-Gas, we are very conscious of this problem. During start-up of a plant, particularly, it takes time to observe the system characteristics, responses, and set up one's instrumentation accordingly. On large plants, particularly with involved steam systems, we carry out analogue model studies, and we have found these to be invaluable in the design stage for providing our philosophy, correcting it, and helping us to foresee potential problems.

We have not got to the stage yet of actually proving this in practice but three such plants are currently being built.

Caserta: One of the things that we're addressing ourselves to currently is: As our ammonia plants tend to operate for two or three years, continuously, we wonder what procedure can we implement to convince ourselves that needed trips will work when they are required to do so.

We've had some rather unhappy occurrences where several things malfunctioned in series, and one of these - a vitally important one - was the final element, the trip throttle valve on the turbine driver. We make, probably, as good quality steam as anyone, but after several months of running, the trip throttle valves tend to become inoperable.