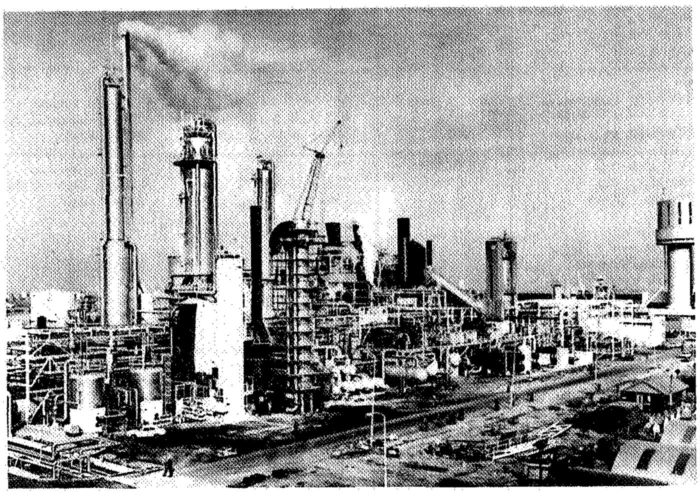
Automatic Trip Systems

This survey of the ammonia industry should prove helpful in deciding whether or not some aspects of a given plant's automatic trip system ought to be re-examined.

P.A. Ruziska
Esso Research and Engineering Co.
Florham Park, N.J.



Before automatic trip instrumentation is decided upon for a large ammonia plant, such as the one shown above, the possibilities of needless plant shutdowns must be balanced against the possibilities of severe equipment damage.

In the 1970 Symposium on Ammonia Plant Safety, an open discussion of ammonia plant automatic trip systems was held. There appeared to be plenty of interest and much divided opinion. At the conclusion of the session, it was resolved to conduct a survey of the plants to obtain more detail on the automatic trip circuits employed in the industry. In all, 60 companies responded to the survey questionnaire: 53 operating plants, 4 engineering contractors, anu 3 plants not yet in operation. This article summarizes the major points of the survey. The full details are contained in Tables 1 to 5.

The interest in automatic trip system use stems from the fact that, at times, they can be the source of operating difficulties. They can cause needless plant trips and, as a result, contribute to such things as a costly production loss and excessive wear and damage to the equipment. Consequently, there is a real interest in limiting the use of trip circuits to only those areas having a need of automatic protection. Defining the areas having this need is the key point. It is generally believed that these are areas where a rapid response to a process upset or equipment malfunction is required in order to avoid:

1. Endangering personnel
2. Costly equipment damage
3. Prolonged unit downtime

Both the concept of rapid action and, either personnel safety or major cost damage, are important in determining the need for automatic trip protection. For instance, many process upsets would, if left unattended, result in unit damage of major proportions. But, the unit response is usually slow enough so that the operators can take the necessary action to recover or make the decision to shut down before conditions reach a hazardous situation. Alarms are provided in these cases and operators are trained to respond to deviations in normal operating conditions.

It is interesting to note that virtually all ammonia plants have automatic trip systems on certain process equipment, and the use of circuits on compression equipment is virtually universal. However, except for the compressor oil system trip circuits, there is little agreement on which process upsets require automatic trip protection.

It is accepted that certain unique design characteristics in a given plant may require special considerations. But, there are enough similarities among the ammonia plant designs (plus certain portions of hydrogen and methanol processes) that the survey findings should point out several areas where industry consensus accepts or rejects automatic trip protection. Consequently, this information may be helpful in deciding if some aspects of a given plant's trip system should be re-examined in light of the overall industry opinion.

Based on the data shown in Tables 1 through 5, it is felt that automatic trip instrumentation used in fewer than 10% of the plants must be considered either as dictated by the particular plant design, or as an unnecessary degree of protection that others have not found a need to employ. Indications of the usage of an automatic trip circuit in over 50% of the companies reporting use of the associated equipment indicates some possible justification, and usage in over 60% can indicate a need for serious consideration.

Reformer furnace trips

Table 1 contains the survey findings regarding the trip circuits employed on the reformer furance. Protection against loss of draft in induced draft furnaces (trips no. 3 and 4) is used in 82% of the companies reporting. The signal actuating the trip circuit is either a measurement of low draft, or a detection of a shutdown of the induced draft fan. Slightly over half use draft measurement, while

TABLE 1

REFORMER FURNACE

Type of Trip	Usage Statistics % In Use	% Removed	Trip Signal	Units Tripped	Instrument Failure Action	Time Delay	Bypass
1. Fuel Loss (Radiant)	74%	8%	96% - Low Fuel Pressure 4% - High/Low Fuel Pressure	100% - Fuel Valves 50% - Feed, Process Air, (Steam to Process Air Line) 12% - Syn Gas Compressor 10% - Minimum Primary Steam 9% - Methanator 9% - Air or Feed Gas Compressors Msc. - Feed Preheat (Vaporizer) Furnace, Fan Trips, Damper Trips	74% - Trip	76% - No Delay 22% - 1 to 5 sec. (1 Plant) - 15 sec.	42% - No Bypass 49% - @ Control Room 9% - Local
2. Fuel Loss (Convection)	56%	11% (1)	98% - Low Fuel Pressure (1 Plant) - High Steam Pressure	60% - All Fuel 25% - Feed, Process Air, etc. - - - - - - - - - - - - - - - - - 38% - Only Convection Fuel	74% - Trip	78% - No Delay 18% - 2 to 5 sec. (1 Plant) - 15 sec.	50% - No Bypass 25% - @ Control Room 25% - Local
3. Loss of Draft (2)	45%	6%	70% - Low Draft 30% - Slight Positive Pressure	67% - Fuel 29% - Feed, Process Air, etc. - - - - - - - - - - - - - - - - - 33% - Only Steam Ejector in Stack	64% - Trip	45% - No Delay 45% - Under 30 sec. 10% - 1 to 3 min.	42% - No Bypass 46% - @ Control Room 12% - Local
4. Induced Draft Fan Shutdown (2)	39%	11% (3)	55% - Motor Failure 30% - Fan ΔP (1 Plant) - Limit Switch (1 Plant) - Overspeed (1 Plant) - Low Oil Pressure	64% - Fuel 40% - Feed, Process Air, etc. Msc. - Forced Draft Fan, Steam Ejector, etc. - - - - - - - - - - - - - - - - - 8% - Only Spare Fan On/Dampers 12% - Only Steam Ejector in Stack/Dampers 8% - Only Damper Adjustment 8% - Only Forced Draft Fan/Dampers	80% - Trip	67% - No Delay 24% - Under 10 sec. 9% - 25 to 30 sec.	58% - No Bypass 34% - @ Control Room 8% - Local
5. Forced Draft Fan Shutdown	40%	8%	73% - Low Fan ΔP or Discharge Pressure 27% - Motor Failure	83% - Fuel 58% - Feed, Process Air, etc. - - - - - - - - - - - - - - - - - 17% - Only Damper Adjustment	80% - Trip	56% - No Delay 33% - Under 10 sec. 11% - 25 sec.	36% - No Bypass 48% - @ Control Room 16% - Local
6. Feed Loss	57%	19%	88% - Low Flow 10% - Low Pressure (1 Plant) - Low Vaporizer Drum Level	93% - Process Air, (Steam to Process Air Line) 52% - Feed Valves 40% - Fuel 12% - Air or Feed Gas Compressors 12% - Minimum Primary Steam 10% - Syn Gas Compressor 8% - Methanator Msc. - Feed Preheat (Vaporizer) Furnace	78% - Trip	71% - No Delay 23% - Under 10 sec. 6% - 10 to 20 sec.	33% - No Bypass 61% - @ Control Room 6% - Local
7. Steam Loss	67%	12%	68% - Low Flow 30% - Low Steam to Feed Ratio (1 Plant) - Low Steam Pressure	96% - Feed 73% - Process Air (Steam to Process Air Line) 63% - Fuel Msc. - Air, Feed Gas & Syn Gas Compressors, Methanator, etc.	60% - Trip	68% - No Delay 27% - Under 10 sec. 5% - 30 to 40 sec.	11% - No Bypass 82% - @ Control Room 7% - Local
8. Boiler Feed Water Supply Loss	30%	5%	61% - Low Flow 28% - Low Pump Discharge Pressure (1 Plant) - Pump Trip (1 Plant) - Low Deaerator Level	20% - (Full Plant Trip) - - - - - - - - - - - - - - - - - (1 Plant) - Fuel Only 75% - Only Spare Pump Start	64% - Trip	58% - No Delay 32% - Under 10 sec. 10% - 1 min.	54% - No Bypass 27% - @ Control Room 19% - Local
9. Loss of Steam Drum Level	21%	11%	87% - Low Level 13% - Low or High Level	60% - (Full Plant Trip) - - - - - - - - - - - - - - - - - 27% - All Fuel Only (1 Plant) - Convection Burners Only (1 Plant) - Process Air Only	58% - Trip	62% - No Delay 38% - 3 to 15 sec.	39% - No Bypass 61% - @ Control Room
10. Loss of Boiler Circulation Flow	34%	6%	78% - Low Flow 11% - Low Pump ΔP (1 Plant) - Process Gas High Temp. (1 Plant) - Pump Trip	25% - (Full Plant Trip) - - - - - - - - - - - - - - - - - 20% - All Fuel Only (1 Plant) - Convection Burners Only (1 Plant) - Process Gas Vent Only 45% - Only Spare Pump Start	72% - Trip	31% - No Delay 31% - Under 10 sec. 31% - 10 to 20 sec. 7% - 1 min.	56% - No Bypass 32% - @ Control Room 12% - Local

Notes:

(1) Convection fuel loss trips removed were either "full plant" or "all fuel" trips.

(2) 82% of the plants reporting had either a "loss of draft" trip or an "induced draft fan shutdown" trip.

(3) All induced draft fan shutdown trips removed were "damper adjustment only" trips.

(4) Some additional trips reported:

(a) Low atomizing steam (air) pressure trip of liquid fuel.
(b) High radiant coil outlet temperature trip of plant. (Also a trip on low coil outlet temperature.)
(c) Vaporizer furnace high coil outlet temperature, low fuel pressure, high stack temperature, etc., trip of vaporizer fuel and occasionally full plant.
(d) Loss of instrument air pressure trip of plant.

TABLE 2

OTHER PROCESS EQUIPMENT

Type of Trip	Usage Statistics % In Use	Usage Statistics % Removed	Trip Signal	Units Tripped	Instrument Failure Action	Time Delay	Bypass	Prealarm?
1. Air Loss to Secondary Reformer	45%	14%	86% - Low Air Flow 10% - Low Air Pressure 4% - High Air/Feed Ratio	76% - Air Valve Closed 41% - Steam Injection to Air Line 28% - Unload or Trip Syn Gas Compressor 14% - Unload or Trip Air Compressor Msc. - Close Methanator Inlet, Bypass LTS	74% - Trip	68% - No Delay 32% - Under 10 sec.	22% - No Bypass 74% - @ Control Room 4% - Field	72% - Yes
2. High Secondary Reformer Temperature	10%	8%	85% - High Bed Temp. 15% - High Exit Temp.	78% - Air Valve Closed 56% - Steam Injection to Air Line 22% - Trip Air Compressor (1 Plant) - Bypass LTS	85% - Trip	100% - No Delay	38% - No Bypass 62% - @ Control Room	85% - Yes
3. High LTS Temperature	2% (1 Plant)	4% (2 Plants)	(High Inlet Temp.)	(1 Plant) - Bypass LTS (1 Plant) - Vent Upstream LTS (1 Plant) - Process Air Trip	-	-	-	-
4. Loss of CO_2 Removal Solution Flow	25%	4%	86% - Low Flow 14% - Low Pump Discharge Press.	22% - Methanator Trip 14% - Solution Valve Closed - - - - - - - - - - - - - - - - - 64% - Spare Pump Start Only	33% - Trip	55% - No Delay 33% - Under 5 sec. 12% - 30 sec.	36% - No Bypass 27% - @ Control Room 37% - Field	64% - Yes
5. Loss of CO_2 Tower Level	25%	2%	94% - Low Absorber Level	73% - Rich Solution Flow 27% - Methanator, Syn Gas Compressor 20% - Air to Regenerator	73% - Trip	87% - No Delay 13% - Under 5 sec.	27% - No Bypass 49% - @ Control Room 24% - Field	87% - Yes
			12% - Low Regenerator Level	100% - Solution Pumps 33% - Methanator, Syn Gas Compressor				
6. Methanator High Temperature	79%	11%	98% - High Bed Temp. 2% - High Exit Temp.	80% - Methanator Inlet 9% - Methanator Bypass 18% - Unload or Trip Syn Gas Compressor	61% - Trip	85% - No Delay 15% - Under 5 sec.	45% - No Bypass 51% - @ Control Room 4% - Field	95% - Yes
7. Ammonia Converter Startup Heater Fuel Loss	55%	-	80% - Low Fuel Pressure 10% - High/Low Fuel Press. 21% - Flame Detector	100% - Fuel Valves	81% - Trip	88% - No Delay 12% - 2 to 4 sec.	78% - No Bypass 22% - Field	82% - Yes
8. Loss of Process Flow to Ammonia Converter Startup Heater	63%	(1 Plant-Electric Heater)	100% - Low Flow of Process Gas	100% - Fuel Valves	84% - Trip	95% - No Delay 5% - 10 sec.	80% - No Bypass 10% - @ Control Room 10% - Field	67% - Yes
9. High Temperature, Ammonia Converter Startup Heater	13%	-	75% - High Stack Temp. 25% - High Process Outlet Temp.	100% - Fuel Valves	75% - Trip	100% - No Delay	75% - No Bypass 25% - Field	50% - Yes

slightly under half use fan failure. About 66% of the companies employing this type of trip use it to shut off all reformer furnace fuel. About 35% shut off feed and air with the fuel. About 24% of the companies employing this type of trip use it only to actuate a steam ejector in the stack. However, it was noted that half of the companies having a steam ejector indicate that it has either been removed from the trip system, or else the steam valve has been limited to a partially open position when tripped. Limiting steam flow was reported to be necessary because otherwise the trip could cause an upset in the steam system. It was also noted in some of these cases that the ejector provided questionable protection at this limited steam flow condition.

Low pressure on the radiant section burners (trip no. 1) is employed to actuate a trip of the reformer fuel valves in 74% of the companies reporting. This category alos includes low pilot gas pressure, if pilots are used. Half using this trip also trip feed and air.

Low pressure on the convection section burners (trip no. 2) is used to actuate a trip in 56% of the companies using convection firing. Sixty per cent of those using this trip shut down all reformer firing, while 38% trip only the burners affected.

Loss of feed (trip no. 6) is used in slightly more than half of the companies, mostly to trip secondary reformer air. Feed and fuel valves are also tripped in about half of the plants using a feed loss trip.

Loss of process steam (trip no. 7), actuated by low steam flow in most cases, is used in 67% of the companies, mostly to trip feed. Air is reported tripped with feed in a majority of the companies, and fuel is shut off 63% of the time.

Looking at the philosophy exhibited by these data, we find the following sources of danger:

1. *Furnance overpressure* – Hazard is that when positive pressure occurs, the hot fuel gas will escape from the furnace casing. This is a personnel hazard, and could also result in damage to the furnace itself.

2. *Momentary fuel loss* – Hazard is that an explosion could occur if fuel is reintroduced without reignition of the burners.

3. *Feed loss* – Hazard is that the secondary reformer catalyst can become overheated and fuse if air flow is continued when feed flow is lost.

4. *Steam loss* – Hazard is that the primary reformer catalyst can be lost due to coking if feed is not shut off when the steam flow is lost.

Process steam generation

The last three trips in Table 1 cover the process steam generation equipment usually associated with the reformer. Thirty per cent report trips on loss of boiler feed water flow to the plant (trip no. 8), but in most cases this is used to cut-in the spare BFW pump and not as a plant trip. Only a few companies use the automatic system to trip the plant About 20% of the companies report using low steam drum level (trip no. 9) to trip either the reformer burners alone or the full plant.

Loss of boiler drum circulation (trip no. 10) is used in 34% of the companies to actuate a trip. As in the case of trip no. 8, about half merely cut-in the spare pump, while the other half trip either reformer fuel alone or the full plant.

Actuating shutdown of process equipment due to a failure in the onsite steam generation service is usually used to protect the heat exchange equipment from operating dry and overheating. However, the fact is that this type of automatic protection is employed in only about 20% of companies. This seems to indicate that most companies believe operator action can be as effective in protecting the equipment as an automatic system.

Table 2 lists the other automatic trip systems frequently used in the ammonia plant, excluding compression equipment. Slightly under half of the ammonia plants use a trip circuit activated by loss of secondary reformer air (trip no. 1). This is usually used to shut the air valve, probably in order to prevent a surge of air flow when the air supply is recovered. Depending upon the plant design, some units are required to protect an air preheat coil by introducing steam upstream of the coil when air is lost. This also serves to keep a positive flow in order to prevent backup of combustible gases into the air line. A small number of plants also trip the syn gas compressor.

A few plants employ a trip of the methanator on loss of CO_2 solution flow (trip no. 4). This is not common; rather, several plants instead maintain an automatic spare pump start.

Loss of level in the carbon dioxide absorber (trip no. 5) is used to actuate a trip circuit in 25% of the companies. Usually, the rich solution letdown valve is closed, or a block valve is shut in the rich solution line. This serves to protect the CO_2 regenerator system from damage caused by loss of liquid seal in the bottom of the absorber and escape of pressurized syn gas. Some plants use the trip to shut off air injection at the regenerator so as to protect against a possible explosive condition.

Seventy nine per cent use a automatic trip on high methanator temperature (trip no. 6) to shut down the reactor, to trip the downstream compressor, or both. This provides protection against reaction runaway. Although catalyst damage can occur as a result of a runaway, the prime consideration should be the possibility of vessel overheating and rupture.

The fired startup heater in the ammonia synthesis loop, when used, is frequently protected with automatic trip circuits (trips nos. 7, 8, and 9). In this unit, a coil rupture can result in a serious fire due to escaping high pressure synthesis gas. Sixty three per cent protect against coil overheating caused by loss of gas flow, such as would occur when the recycle gas compressor shuts down. Fifty five per cent also protect against the possibility of an explosion caused by momentary fuel loss. We find that 90%

TABLE 3

CENTRIFUGAL COMPRESSORS

Type of Trip	Usage Statistics % In Use	Usage Statistics % Removed	Instrument Failure Action	Time Delay	Bypass	Prealarm?
1. Lube Oil - Loss of Pressure	100%	-	55% - Trip	84% - No Delay 6% - Under 10 sec. 6% - 10 to 15 sec. 4% - 30 sec.	60% - No Bypass 24% - @ Control Room 16% - Field	95% - Yes
2. Loss of Seal Oil - Low Level or Low Pressure (Combustible Gas Service)	100%	-	55% - Trip	83% - No Delay 14% - Under 10 sec. 3% - 10 to 15 sec.	58% - No Bypass 33% - @ Control Room 9% - Field	91% - Yes
3. High KO Drum Level	83%	2%	55% - Trip	96% - No Delay 4% - 10 to 15 sec.	59% - No Bypass 36% - @ Control Room 5% - Field	94% - Yes
4. High Discharge Temperature	11%	2%	67% - Trip	100% - No Delay	100% - @ Control Room	100% - Yes
5. High Oil Temperature	5%	-	100% - Trip	100% - No Delay	100% - @ Control Room	100% - Yes
6. Vibration/Axial Displacement	26%	8%	40% - Trip	89% - No Delay 11% - 10 to 15 sec.	67% - No Bypass 33% - Field	82% - Yes
7. Underspeed	5%	-	0% - Trip	50% - No Delay 50% - 4 sec.	100% - @ Control Room	100% - Yes

Notes:

(1) 18% use low suction pressure or high casing ΔP trips; 3% removed this trip.

(2) Also included in trip systems are low steam turbine governor oil trip, and overspeed trip.

TABLE 4

RECIPROCATING COMPRESSORS

Type of Trip	Usage Statistics % In Use	Usage Statistics % Removed	Instrument Failure Action	Time Delay	Bypass	Prealarm?
1. Frame Lube Oil - Loss of Pressure	97%	-	64% - Trip	81% - No Delay 15% - Under 10 sec. 4% - 45 sec.	85% - No Bypass 15% - Field	83% - Yes
2. High KO Drum Level	83%	6%	61% - Trip	84% - No Delay 16% - Under 5 sec.	84% - No Bypass 8% - @ Control Room 8% - Field	90% - Yes
3. Low (or High) Suction Pressure	64%	3%	59% - Trip	100% - No Delay	60% - No Bypass 5% - @ Control Room 35% - Field	90% - Yes
4. Loss of Cooling Water Pressure	29%	3%	67% - Trip	76% - No Delay 12% - Under 5 sec. 12% - 2 min.	89% - No Bypass 11% - Field	80% - Yes
5. High Discharge Temperature	19%	-	0% - Trip	100% - No Delay	100% - No Bypass	80% - Yes
6. Vibration	23%	3%	40% - Trip	100% - No Delay	67% - No Bypass 33% - Field	17% - Yes

Notes:

(1) Also included in trip systems is motor overload trip.

(2) Low level of cylinder lube oil trip is not normally used.

TABLE 5

GAS TURBINE DRIVERS (1)

Type of Trip	Usage Statistics % In Use	Usage Statistics % Removed	Instrument Failure Action	Time Delay	Bypass	Prealarm?
1. Flame Failure	88%	12% (1 Plant)	58% - Trip (2)	75% - No Delay 25% - 1 sec.	33% - No Bypass 45% - @ Control Room 22% - Field	28% - Yes
2. High Exhaust Temperature	100%	-	50% - Trip	100% - No Delay	67% - No Bypass 33% - @ Control Room	100% - Yes

Notes:

(1) Only 8 companies reported on gas turbine driver systems.

(2) 25% reported to use simultaneous failure (or trip) of 2 fire-eyes required to initiate trip.

(3) Additional trips reported are:

- Underspeed: 3 companies
- Low fuel pressure: 2 companies
- High fuel KO drum level: 2 companies
- Vibration: 4 companies

(4) Also included in trip systems are overspeed, low oil pressure, etc.

accomplish this with a low fuel pressure cutout, while 20% use a flame detector instead of, or in addition to, the low pressure cutout. Thirteen per cent protect against overfiring by various high temperature cutouts.

Compressors

Table 3 covers the centrifugal compressor trip circuits most commonly used. Note that all companies use the low lube oil pressure trip (trip no. 1). This trip is for purposes of machine protection. Rapid response to a loss of oil is critical for minimizing damage to the machine. Not only is the cost of the compression equipment a major consideration here, but also important is the fact that a prolonged shutdown usually accompanies major machinery repair.

A trip on loss of seal oil (trip no. 2) is also universally employed. This type of design feature is normally used on combustible gas compression equipment. Trip protection constitutes personnel as well as equipment protection due to the fire hazard associated with loss of seal oil (such a trip is seldom found on an air compressor).

Eighty three per cent of the companies reporting indicate that they employ a trip on high knock-out drum level (trip no. 3). This involves protection of the rotor from excessive liquid carryover due to a flooded KO drum.

Only a small percentage (26%) utilize automatic trips on high vibration or axial displacement (trip no. 6). Most indicate that the sensing equipment is installed and used for alarm purposes. It appears that the big factor preventing use of this equipment as an automatic trip at present is a lack of confidence in instrument reliability.

Table 4 gives the reciprocating compressor trip circuits reported. Again, essentially all companies reporting use a low lube oil pressure trip (trip no. 1). Note that this is frame oil; trips on loss of cylinder lube oil are not normally employed.

As in the case of centrifugal compressors, 83% use a trip on high knock-out drum level (trip no. 2). 64% employ a trip activated by suction pressure (trip no. 3); usually low suction pressure, but on occasions also high suction pressure. This is generally used to protect against rod overloads caused by a suction pressure excursion into an unsafe region.

The remaining trips are used only in about 20- to 30% of the cases. Two are related to temperature; the one actuated by loss of cooling water flow, and the other by high cylinder discharge temperature.

As with centrifugal compressors, about one-quarter employ a trip on high vibration. Again, difficulties with instrumentation are a prime reason against the more frequent use of this type of trip.

Table 5 correlates some of the information received on gas turbine compressor drivers. Only eight companies reporting had experience with gas turbine drivers. The majority utilize flame failure and high exhaust temperature trips to protect against combustion upsets. The additional machinery-related trips utilized in half, or fewer, of the cases are listed in Note 3 of the table.

Trip removal in operating plants

In addition to the trip usage data, some additional information was developed in the survey. Tables 1 through 5 include data on the trip circuits reported as discontinued. Most were those associated with the reforming section. Nineteen per cent of the companies having loss of feed trips have discontinued their use, as have 14% of those with loss of process air and 12% with loss of process steam. About 10% of those having a reformer furnance draft trip have discontinued its use. This interest in removal of reformer trips is due to the fact that, when a unit upset occurs, a major aim is to keep at least the front end onstream. Consequently, removal of automatic trips in the reforming section has a greater significance than removal of other trip circuits. However, as seen from the number of companies still using these circuits, operator opinion is divided on the necessity of maintaining automatic protection for the upsets indicated.

Compressor vibration and displacement are a separate consideration. As indicated before, there has been a concern over instrument reliability, leading in many cases to removal of the automatic trip feature.

A number of other points concerning instrumentation were developed in the survey and are contained in the tables and discussed below:

Instrument response on failure of either power or air supply is of interest. It indicates how willing companies are to undergo a nuisance trip in case of a localized instrument system failure, compared with the "fail safe" protection concept. The only signficant differences observed were that slightly more of the process trip circuits would cause a trip on loss of power (or air supply) than would the compressor trip circuits.

Time delay between detection of a trip condition, and initiation of the trip, is of interest. This amounts to a time period during which the plant can return to a non-trip condition without having the trip occur. This is very useful in order to allow for instrument swings, or to allow for operator recovery of a unit if he can respond in time. Alternatively, in cases requiring rapid equipment shutdown, this further delays the achievement of a safe condition. Significantly, more use a time delay in the reformer trip systems than for the other circuits, such as methanator high temperature, startup heater, or compressor trips.

A bypassss switch in the control room can be useful in avoiding a trip due to an instrument malfunction (if caught in time), or to prevent a unit shutdown if the operator judges he can recover given some more time. The risk is that the operator will decide against the trip and then not be able to recover, but will instead extend the "unsafe" condition long enough to cause damage. Most of the control room bypass switches used are on the feed, steam, and air trips. Slightly under half have bypass switch in the control room for reformer furnance fuel loss and draft loss.

A small percentage of companies employ a control room bypass on the startup heater and centrifugal compressor trips, and almost none use this on reciprocating compressor trip circuits.

Trip circuit testing

One final area not included on the tables is worthy of mention, and that is the practice of testing and checking the trip circuitry. Over two-thirds of the companies reporting indicate that they check-out the trip circuitry on the compressors during each shutdown, or as part of the restart procedure. For instance, some companies use a checklist as part of the startup procedure for the compressors that includes trip instrument checkout, plus simulating the trip action of some of the circuits.

Regarding the process trip systems, only about half report any planned checkout procedure. Two-thirds of those reporting a planned checkout procedure do this as part of the turnaround program. The rest conduct a circuit check at some regular interval while the unit is in operation. It appears that this is done by putting the trip system on bypass and checking to see if the sensing elements respond to a trip condition.

It appears that in both cases, a majority prefer to work on the trip systems during a unit shutdown. This permits not only a check of the sensing elements, but also allows a full trip circuit test including simulation of the trip valve action. #

RUZISKA P.A.