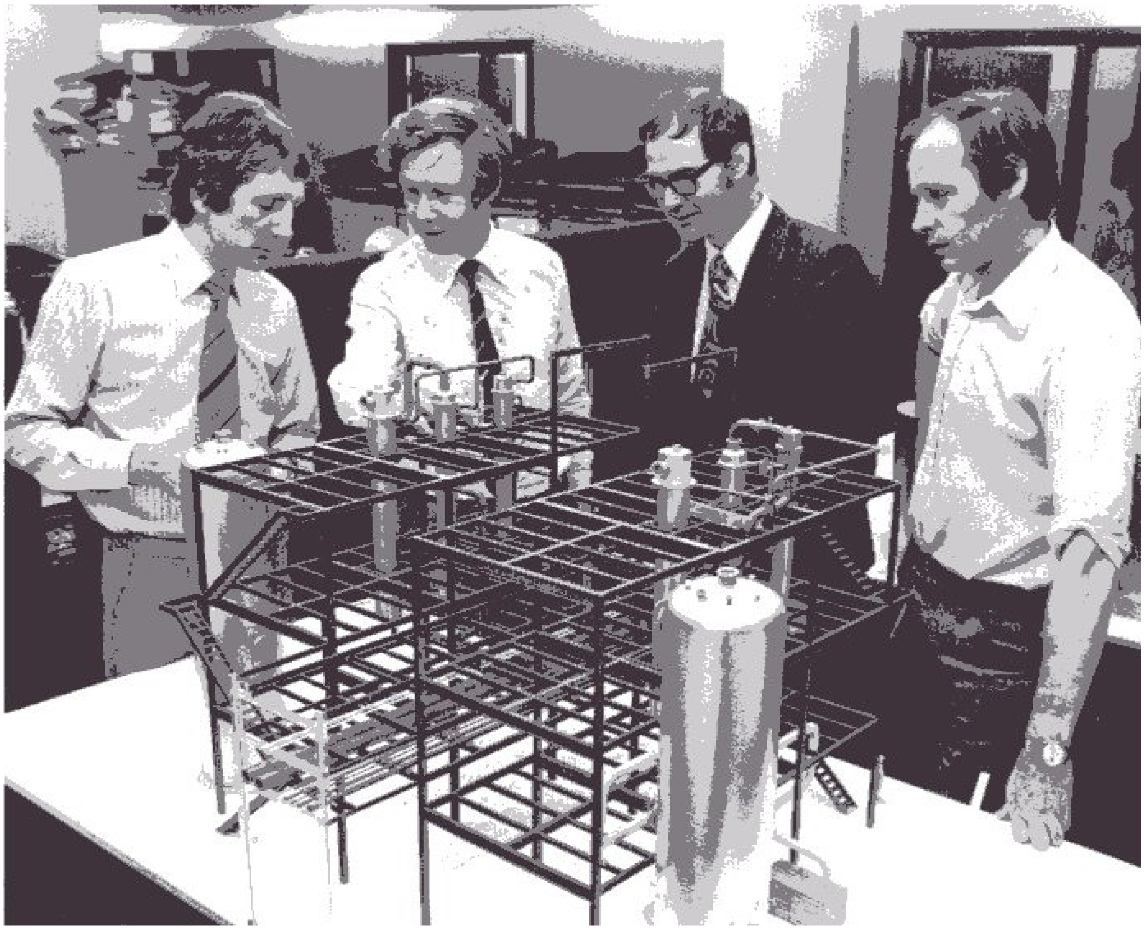
SAFETY NEWSLETTER

No. 129
SOME QUESTIONS TO ASK ABOUT NEW PLANTS



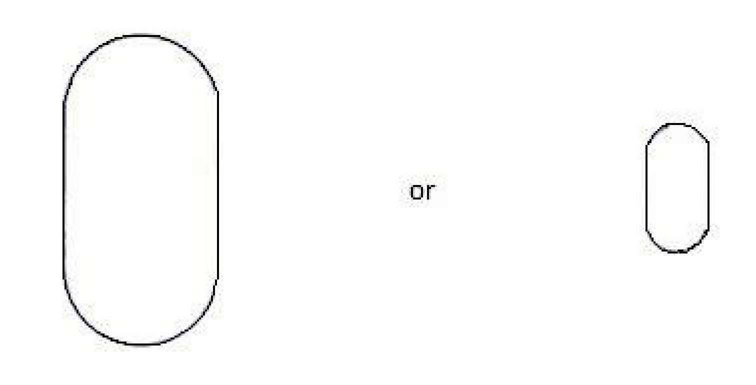
As explained in Newsletter 124/7, we are trying to look more critically at new designs *in the early stages*. This note suggests some of the questions that might be asked, particularly about the process, the location and the layout. Not all the questions apply to every project and the emphasis is on large-scale continuous processes.

An Engineer's Casebook — Checking blocked or holed pipes

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PETROCHEMICALS DIVISION

QUESTIONS ABOUT THE PROCESS — 1 INVENTORIES



Is there an alternative process using safer raw materials or intermediates?

What is the inventory of flashing flammable or toxic liquids and compressed flammable or toxic gases?

Does it have to be so high?

How could it be reduced (thus reducing plant size and cost as well as increasing safety)?

Can operating conditions be changed so that the liquids are no longer flashing?

Do not forget to include heat transfer media and refrigerants in the list of hazardous materials. If you are using a flashing liquid as a heat transfer medium, could you use water instead, or a higher boiling liquid? Could you use a non-flammable refrigerant?

These questions should be asked at two levels:

Can we reduce the inventory by changing the process?

Can we reduce the inventory by changing the unit operations, for example by using a different distillation column tray or packing?

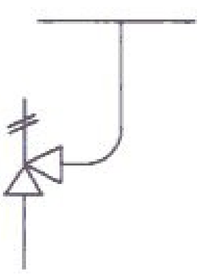
For more information see:

“What You Don’t Have, Can’t Leak”, *Chemistry and Industry, 6 May 1979, p 287.*

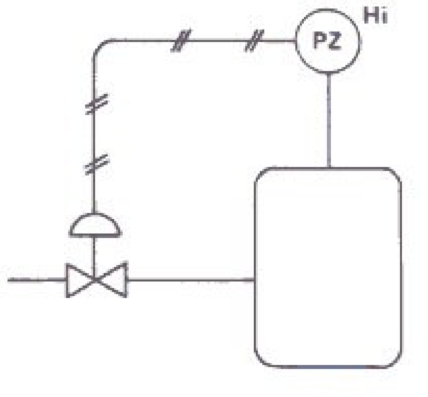
“Towards Intrinsically Safer Plants”, *Design 79, September 1979.*

“Seminar: Development of Intrinsically Safer Plants and Processes, October 1976”, Report No HO/SD/740009/8B.

QUESTIONS ABOUT THE PROCESS — 2 RELIEF



or



If a large flare system (or vent scrubbing system) is included in the design, can its size be reduced by using stronger vessels or by using instrumented protective systems (trips)? These can be used in several ways:

(a) If we use very reliable instruments we may be able to dispense with the need for process relief valves. Fire relief valves may still be required but these can often discharge to atmosphere.

(b) If we use slightly less reliable instruments, but still good enough to make the chance of the relief valve lifting only once in a few hundred years, then we may be able to allow ordinary relief valves to discharge gas or vapour to atmosphere. (Pilot operated valves can discharge to atmosphere at all times if the discharge velocity is high enough to give jet mixing).

(c) Since flare systems rather than relief valves cost a lot of money, we may be able to install full size relief valves but size the flare header on the assumption that trip systems will prevent more than one of the relief valves lifting at the same time.

The cost of installing and maintaining these instruments has to be balanced against the cost of installing relief valves and flare headers.

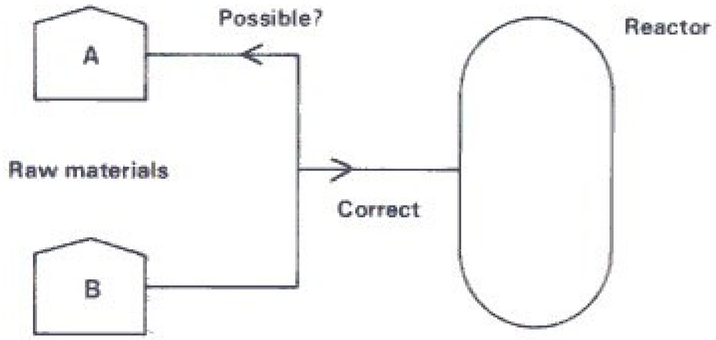
Can we reduce the number of relief valves required by avoiding spare or parallel equipment which can be isolated with the plant on line?

For more information see:

“Are Safety Valves ‘Old-Hat’?”, *Chemical Processing, September 1974, p 77.*

“High-Pressure-Trip Systems for Vessel Protection”, *Chemical Engineering, 12 May 1975, p 81.*

QUESTIONS ABOUT THE PROCESS — 3 WRONG REACTION



Most fires and explosions are caused by leaks of materials out of the plant. Are there any special hazards which could cause a fire, explosion or other runaway reaction *inside* the plant? Examples are:

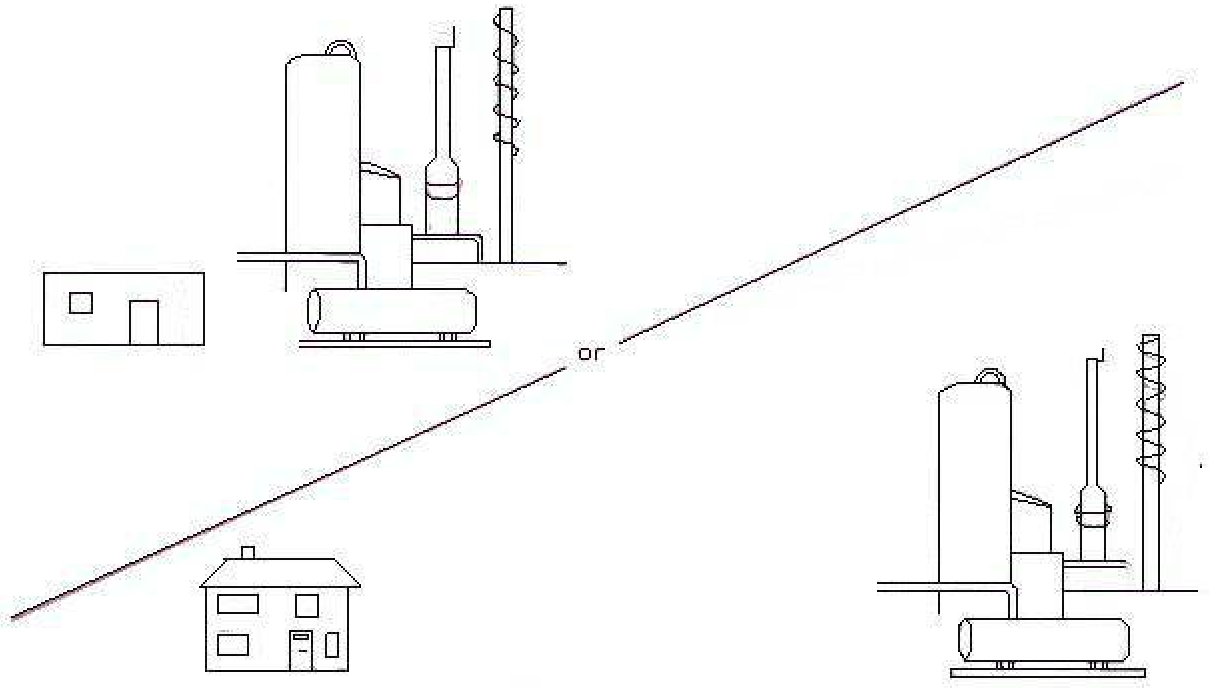
Addition of too much reactant, especially air or oxygen, or addition of a contaminant.

Back flow from a reactor to a storage vessel.

Errors in the change-over of a catalyst bed or drier from ‘make’ to regeneration.

If so, will a hazard analysis of the protective system be necessary? First estimates usually underestimate the amount of instrumentation required. Instead of controlling the hazard with instruments, is there any way of avoiding it? For example, can reverse flow be prevented by an energy barrier of some sort? Could we use mechanical interlocks instead of electrical ones to prevent the wrong valves being operated during changeovers of catalyst beds or driers. (It has been suggested that if ICI designed a hand-grenade it would have a box of instruments attached instead of a pin).

QUESTIONS ABOUT LOCATION



If a plant contains more than a few tonnes of flashing flammable liquid or compressed flammable gas, then an unconfined vapour cloud explosion is possible if the contents leak out. The plant should therefore not be located near houses or public roads or near other plants containing large quantities of hazardous materials.

What is meant by “near”. The diagram opposite gives a rough indication for a first estimate. For a more accurate estimate see:

Safety Note 77/13B, “Layout and Location of New Plants: How to Take the Size and Probability of an Unconfined Vapour Cloud Explosion into account”, 28 June 1978.

“Plant Layout and Location”, paper presented at the 13th AIChE Loss Prevention Symposium, April 1979.

Note that in the diagram the horizontal scale is *not* the amount of material in the plant but the amount that will escape if a pipe breaks. To calculate this we assume that liquid flows out of both open ends. The theoretical amount of vapour formed is calculated and doubled to allow for spray. An effective maximum of 50 tonnes is assumed.

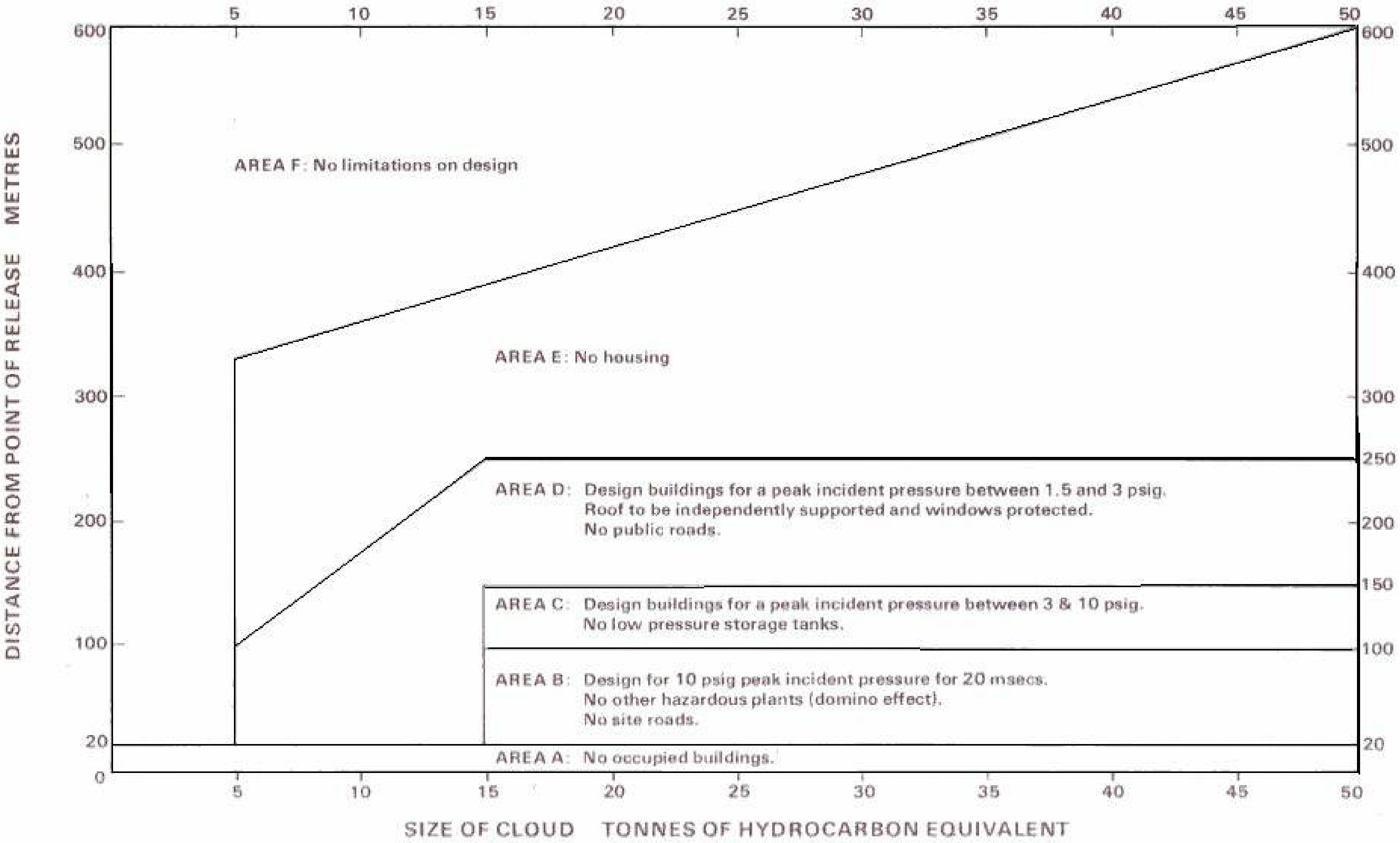
If the total length of pipeline containing flashing flammable liquids is small or if sufficient emergency isolation valves are supplied, then the possibility of an unconfined vapour cloud explosion can be ruled out.

If the plant contains flashing toxic liquids or compressed toxic gases such as chlorine or ammonia, then a method of calculating the risk to the public and thus determining location is given in:

“Quantification of Toxic Gas Emission Hazards” by J G Sellers, I Chem E Symposium Series No 46, 1976, p 127.

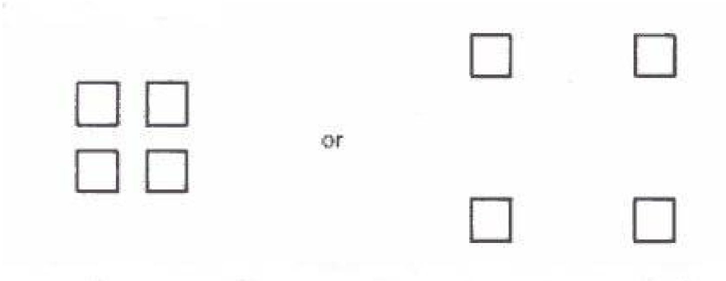
An extension of this method to neighbouring plants is described in Safety Note 78/3, Part I, by J McQuaid, 17 March 1978

FIGURE 1 – A SUMMARY OF THE MAIN RESTRICTIONS ON DESIGN IMPOSED BY UNCONFINED VAPOUR CLOUD EXPLOSIONS



NOTE: Area E limitations apply in areas D-A and so on.

QUESTIONS ABOUT LAYOUT



Is the plant laid out in blocks with gaps between them (15 m is enough unless the structure is very tall) so as to restrict the spread of fire and provide access for fire-fighting? Which is the best way to divide the process into blocks?

Is the ground sloped so that liquid spillages will flow away from equipment? If so, where will they flow to?

Is the plant open so that gas and vapour leaks are dispersed readily by the wind?

Does the plant contain so much flashing flammable liquid or compressed flammable gas that an unconfined vapour cloud explosion could occur if they escaped? If so, the control building and other occupied buildings should be strengthened. See previous section and diagram.

Are loading and unloading areas located so that traffic does not have to pass through the plant?

Can furnaces and other sources of ignition be placed outside Zone 2 areas? If not, will a steam or water curtain be needed?

Can we make Zone 1 areas fewer and smaller, and avoid expensive Zone 1 equipment, by:

Changing the design, for example, spiral wound gaskets produce a smaller Zone 1 area than caf gaskets.

Changing operating methods, for example, not draining hydrocarbons to atmosphere.

For more information see:

“Plant Layout and. Location”, paper presented at the 13th AIChE Loss Prevention Symposium, April 1979.

Safety Note 77/8, “Minimising the Frequency and Affects of Plant Leakages, with Particular Reference to the Use of Steam and Water Spray Curtains”, by J McQuaid, 20 June 1977.

PROCEDURES

Report No PC. 200,897/A, “Process Engineering Within Structured Project Execution”, describes our new procedures for systematically probing new process designs in order to improve and simplify the design and reduce the number of modifications made later in the design process. More time has to be made available in the early stages of a project.

Before we can get planning permission, the planning authority has to ask the Health and Safety Executive for their views (See Newsletter 127/9) so time is saved if we talk to the HSE as soon as our ideas are clear, They are particularly interested in layout and location.

I C Insurance like to know what they are going to be asked to insure:

Engineering Dept Instruction No 2.22 tells us how safety studies should be filed in the Project Safety Dossier.

THE ENGINEER'S TROUSERS

A story, familiar to all design engineers, to show what happens if insufficient time is allowed for discussion of a design at the early stages and modifications have to be made later.

An ICI design engineer ordered a new pair of trousers — to be ready for Christmas.

The safety adviser recommended him to wear braces with it, as well as a belt.

The design engineer went to see the tailor and asked if he could have buttons fitted to the trousers so that he could wear braces as well as a belt. The tailor said he would ask the factory.

The factory said there would be a small extra charge and the design engineer agreed to pay.

The factory said they were held up as they had not been told what type of buttons to use. As the design engineer was in America this caused delay.

The factory said that they did not employ any button-sewers as very few customers required buttons, but they were sub-contracting the job to another firm who specialised in this work.

The tailor reported that he was afraid that the buttons would be pulled out of line by the braces and he had therefore asked the factory to strengthen the band round the top of the trousers, to which the buttons were attached.

The factory reported that if this were done the band would tend to pull away from the trousers and the joint between the band and the rest of the trousers would therefore have to be strengthened.

The tailor reported that he had received the trousers but thought the band was too stiff for comfort and was having it replaced by one made from a more flexible material.

The tailor reported that he was awaiting instruction as to whether he should supply a pair of braces or if the engineer would obtain his own.

The tailor reported that braces of the size and colour required were out of stock and he was trying to obtain a pair from another dealer.

The trousers, with braces, were delivered in time for the following Christmas at twice the original estimated cost.

For copies of the publications mentioned or for more information on this Newsletter please 'phone ET (Ext. P.2845) or write to her at Wilton. If you do not see the Newsletter regularly and would like your own copy, please ask Mrs Turner to add your name to the circulation list.

November 1979

An Engineer's Casebook No 29
CHECKING BLOCKED OR HOLED PIPES

The ICI Engineering Codes and Regulations, Group B, Vol 1.4 "Registration and Periodic Inspection of Pressurised Systems" require that periodic inspection be applied to certain vent and relief valve blow off lines upon which the safe operation of equipment depends. Many of these lines are of butt welded construction, without flanges and with several changes of direction. Examination by direct visual means or by dismantling and proving clear is rarely possible. Efforts to demonstrate that lines are free from obstruction by inserting an air hose at one end and then checking for a reasonable discharge at the distant end can give very misleading results. A substantial obstruction over a short distance is unlikely to be detected. Radiographic techniques can often be used but are slow and expensive.

The Central Electricity Research Laboratories of the CEGB have developed equipment in association with Industrial Electronic Services which is based on the use of an acoustic pulse and is now marketed by IES as the Acoustic Ranger 1000. The device was originally developed for the detection of holed heat exchanger tubes for which job experienced operators can examine over 1000 per day.

The equipment is portable and battery or mains powered, though not intrinsically safe. Three pieces of equipment make up the ideal unit: A transducer unit to which the acoustic probe/microphone unit, which is placed in the end of the pipe or tube being examined, is attached; an oscilloscope on which to display the signal response from the pipe or tube system being examined; and a camera to record this response.

In operation an acoustic pulse is transmitted down the tube or pipe system from a probe placed concentrically at the inlet. The frequency and length of the pulse can be varied to obtain optimum response from the system, within diameter limits of ¼ inch to 10 inch bore and to a range of up to 500 feet with larger pipes. The acoustic pulse is reflected at all discontinuities so that flanged joints, bends, obstructions, holes etc. result in some reflected energy. This is picked up by the microphone and displayed on the oscilloscope together with the echo from the open end of the pipe or tube. Distances down the system can be estimated from this or in conjunction with an internally generated marker where the length of the pipe is known or has been measured. The nature of the defect, hole, obstruction etc. is interpreted from the particular wave form of the response.

When used on a vent system it is preferable to take an initial 'signature' photograph of the reflections when the system is new and known to be unobstructed. This 'fingerprint' can then be filed for reference and future comparisons be made against it when looking for blockages. Experienced operators can interpret the signal response from a fairly simple system without reference to a standard trace. Complex systems with branches in receiving vents from other tanks or relief valves can make interpretation difficult or impossible. It is important that operating and system parameters remain constant whilst a system is under surveillance. Results can also be affected by plant noise.

The equipment costs £3000 plus to purchase outright. If you think it could do a useful job on your plant then Jeff Rees is the man to contact on Wilton Site (Extn. 6109). He can comment on your potential application, arrange a demonstration and if there is sufficient demand could mount a site contract service,

E H Frank