PROTECTING ON-SITE PERSONNEL CONTROL ROOM LOCATION-DEAD CENTRE?

Paul Clarke
Allianz Cornhill International Division

Over the years, the location and protection of control rooms continues to be a major source of discussion internationally.

It should be stressed that control rooms are there to provide operational control, and safe shutdown/start-up of processes. If a control room is designated as a "safe haven", or is exposed by areas it controls (or others) too fire, explosion, or other damage, that is a location-related issue.

This paper aims to outline (with an insurance perspective) the areas of current practice for control room location and design. It covers the aspects of property and personnel protection, whilst at the same time, discussing potential interruptions to business.

WHAT IS A CONTROL ROOM, AND WHAT IS IT NOT?

A control room is there to provide operational monitoring and control for a range of processes. In many cases, it acts as the central point of focus for maintenance in the area, as permits to work are issued. Because of this, a number of people are regularly expected to be in this area at any one time.

At the same time, the location of the control room also drives what functions should and should not be carried out in such an area. What should not be the case, is that personnel are located closer to hazardous operations, than is needed by the role they must perform. At the same time, only those people who have a need to be in a more hazardous area than normal, should be there. For example, it is not necessarily the best place to have an emergency control centre, or to have general office staff in such a building.

BACKGROUND FOR CONCERN

As a young engineer, I stood in a control room looking out at the darkening sky, as the flames soared above the columns of an adjacent process unit. On hearing the first 'whoompf' as the release ignited, I had returned to the control room to confirm they were aware of the incident, and perhaps also because the unit on fire did have the potential for an explosion to occur, and where was a safer a place to be, than in a control room?.

As the emergency procedures swung into action, and as I gazed out at the roaring fire, I took more note of my surroundings. No blockhouse concept this, but glazing, and revolving doors, to the outside process area. An explosion was still a realistic possibility, and there I was, standing behind what I realise now was quite a weak shield. In fact, there was a danger from glazing shards, if an explosion had occurred, and the pressure wave had hit the building, which I now realise was all to possible. As it happened, the fire was eventually extinguished, and the control room I sheltered in never had to be tested what sort of resistance it had to explosion, but it is a memory that lingers still.

Phillips, Pasadena, (1989), Hickson & Welch (1992), Pemex (1998)are examples of where the process hazards caused destruction and death in the control room. Having said that, while the control room is an important part of site operations, it is more often 'sinned against rather than sinner'. I mean that fires or explosions damage the control room, which is occupied, rather than the control room itself being the cause. Nevertheless, the potential where the control room is the problem does exist, and, as such, it can be the origination point of the incident.

TYPES OF CONTROL AREA

- "Cabin" by process plant
- Local control room (for one unit)
- Complex control room for a variety of units, one of two or three
- Main control room for site operations

ISSUES

Location/Location/Location

As in most cases with buildings, the most important thing about a control room is its' location. Location drives the protections that are needed for the building, the functions the building can perform, and the people who can use it on a day-to-day basis.

Too close to a hazardous process unit, and a blockhouse becomes the need, so substantially increasing cost. Too far away, and maintenance monitoring becomes 'long range', with the need for local operator shelters, and separate problems.

.

Exposures

When looking at the position of the building, exposures cover both own and third party issues. The good spacing that is eroded by the persistent flammable liquids drum storage by the side, or the regular positioning of trailers where gaps used to be, with or without tractor units. The effort to separate the control room from the process, by putting it against the boundary fence, which shows itself to have a similar or worse hazard right by it from the next door site. This could just as easily be from road or rail sidings.

Role

The role of the control room can be any or all of the following:-

Control centre

Provision of process control functions, logging, and monitoring on a shift by shift or day by day basis.

Permit issuing area

Control area for the maintenance work to be signed on, halted, and signed off, from work in the area of the control rooms' responsibility.

Designated safe area (for those other than working in the building)

In the event of an emergency, staff would be expected to shelter in the building

Office/ accommodation

Where the business of general administration is carried out. This can occur easily even when the building was not originally designed for this, but when reduction in control equipment size frees up space for "other uses".

Presently, sites are often looking to remove non-required staff out of the determined exposure areas within the sites, and in a number of cases, outside the boundary fence that separates process, and administrative functions.

CONSTRUCTION

The design of a control room should really be based on separating people from hazard. When it is a new control room, then this task is theoretically easier. In practice, there are a number of constraints. At the same time, taking an older building, which has less than the desired characteristics, and upgrading it can also be a challenge. Even then, there are interim measures, which can be taken, to improve the situation, prior to the desired design being installed.

Types

"Blast Proof"

The use of inverted commas is deliberate, as blast proof was a label for buildings designed to cope with an overpressure wave from an explosion of 10 psi. Naturally, there is the possibility that higher overpressures could be reached. The logic of this design is normally for a major control room in the centre of a refinery or petrochemical complex.

"Blast resistant"

Blast resistant was a label for lower exposure protected buildings, and would tend to have a resistance to some 3 psi overpressure . While the "blast proof" construction is a veritable blockhouse, the "blast resistant" construction would sometimes include small windows, and often some sort of mounding.

Blast wall(s)

Blast walls have often been used as a method of directing the impact of a blast into a safe area. This has also been used for protection of control rooms, but has to take into consideration the specifics of the release and subsequent potential explosion, to cover the needs of the other sides (and roof) of the building not otherwise protected.

Particularly when looking at the design criteria for such blast resistance, it is important to include the fact that blast waves fluctuate, and so will be causing static and dynamic forces. In the passing of a pressure wave about a fixed object such as a wall, there are both positive and negative pressures, in a cycling sequence, and the design must be able to cope with these fluctuations.

Other

Examples of these would be: -

- Georgian wired glass
- Shutters

Subdivision of the building

While it is normally the case, it is worthwhile commenting that the control building should be subdivided, even if the whole are is protected. These would be into: -

- Control area
- Rack room
- MCC/Switchgear room
- UPS area-Battery areas should have different venting characteristics between sealing and non-sealed units.
- 'Rest areas' such as kitchen, locker room, toilets, etc.

The reason for such subdivisions is that by providing them, an incident in one area can potentially be contained, so reducing the overall impact of the loss. Obviously, the subdivisions should actually be true partitions, not only in the areas normally seen. Examples can be breaches in walls, above false ceilings and below false floors, or no provision of shut-down in the air conditioning, or fire cut-off of the cable ducting. In these cases, fire/smoke or fumes can spread into additional areas.

Does size matter?

Buildings used for control purposes are often designed for expansion originally, and then get filled up. Older control rooms were designed for older-style equipment, and often have cavernous amounts of space where it is not needed.

For the most part, the building styles are: -

1-storey
2-storey
1-storey with basement

While none of these are wrong, the characteristics of each building should be considered. In multi-storey buildings, subdivision between floors needs to be evaluated, particularly if only partial blast resistance is being considered. When constructing with basements, the ground conditions, including the potential for ground contamination must be studied, taking into consideration the water table.

PUTTING THE "CONTROL" IN CONTROL ROOM

The control room is often a 24-hour working environment. In doing so, there must be enough information and access for the shift crew to be able to monitor the processes, and conversely, enough shift crew to be able to monitor the information and access ports. For example, with an advanced, distributed control system, there need to be information display screens. There should be enough to allow process and alarm monitoring, as well as some trending of data, and analysis. Given the centralisation of control rooms, enough operators for the screens, including cover, becomes one of the pre-requisites of the planning.

The availability of Alarm display panels, and the planned prioritisation of these alarms, to avoid saturation / information overload, are issues that have been known before, but were highlighted again in the Health & Safety Executive report on the 1994 Milford Haven loss.

As a separate point, the logging systems for when Emergency shutdown systems, interlocks and alarms are disabled has to be as clear and auditable as possible, to allow for correct interpretation of what will and will not happen in an incident.

The design, layout and ergonomics of the control room, also have their part to play, from what areas the control room is split into, to the characteristics of the lighting. The more thought that goes into this as an area where people are regularly working , the less modifications/compromises need to be made, to make the room work as needed. It is these compromises which can then defeat safety systems installed to protect the very people they are there to protect.

Examples include:-

The blast door left open because it is too heavy to open/close.
The low air pressure on the HVAC alarm disabled because the regular traffic of staff meant it was always in alarm

Training

When we talk about training, every company will confirm that there is a training programme in place for their operators. Operating procedures will be identified, and these will include some form of emergency, or non-standard condition procedures. It is also true that the shift crews will be expected to be able to troubleshoot the process, and that the procedures and piping and Instrumentation drawings are key to this. This makes it all the more important that such P&IDs are updated and to "as built" standard.

Particularly with the advent of advanced, distributed control systems, and process simulation packages, the use of simulators has mushroomed. However, these have run into problems in the past. They have been often generic, and so of use only for the principles of the process, or are so exact a representation, that any change in the process meant a slow and often costly modification to the model. Some companies have addressed this by actually using the Management of Change procedure to include updates, not just to Procedures, Piping isometrics and to P&IDs, but also to the simulation package, and for this to be accessible from the control room, as well as incorporating training modules.

Utilities

Power

The loss of power obviously has a major impact, but this is normally circumvented by having an uninterruptible power supply (UPS). Even then, the UPS should be checked to ensure that the system could cope with transient overvoltage or power spikes.

Air

Instrument Air

This is still seen in a number of sites, and there is planning that the loss of air causes valves to fail safe. Having said that, both Plant air and Plant Nitrogen have been used in the past to provide a back up to instrument air. These have air quality (water content) and control room safety issues (confined space) respectively to address.

Breathing Air
Control rooms are often equipped with Self Contained Breathing Apparatus, for rescue/fire fighting operations, but Air lines to allow operators to remain at station and shut down the plant have been in place in some locations. The ability of this resource to cope with or not be affected by the original incident is imperative.

Transformers

Still mainly oil-filled for this type of occupancy, it is important that the transformers are separated from the electrical room, at above and below ground, and that they are also separated from each other. In the case of major transformers, full height walls, and even deluge systems are a defendable precaution.

PROTECTION
As you would expect from someone with an insurance perspective, I have come to the section on protection, but you will see, that this covers some of the wider dimensions as well.

Any control room that can expect to be in a hazardous area should expect to have a full range of the following: -

- The building should be **pressurised**, with a low pressure alarm
- **Gas detection** (both toxic and flammable) should be installed on the air inlet. If activated, the action would be to put the air handling system on closed circulation.
- **Fire detection systems**.

Early fire detection systems of an air sampling or aspirating type are often good in detecting fires, in the incipient stages, but testing in place is needed. The system is worthless without some form of trained, local response unit, who can attack the fire, before it does the main damage. Examples of these types of systems are: -

VESDA/HART units.

When protecting a control room, Point smoke/fire detection in sub floor /false ceiling/main area should be considered as a bare minimum, often with additional protection being a better option. If there is no adequate, prompt response to an alarm, then some form of protection must be considered, or the response upgraded.

- **Gas extinguishing systems**-This has historically been one of the most regularly installed systems. The approach in the past in the past has often been for Total room flooding, using Halon 1301, but this is now being phased out, or has been removed due to environmental considerations.

-Total flooding gas systems can still be found, as examples are identified below: -

Inert - Inergen
Argonite
Argotec

Or

Halocarbon gases- FM200
NAFIII

In these cases, it has proved a wise choice to carry out a risk analysis on the choice of replacement material, or if the equipment is being upgraded. The reasoning is that new types of equipment can have greater or lesser exposure to fire and similarly greater or lesser impact on business interruption than previously
These days, protection in control rooms can be Total Gas Flooding, if the need is there, but is often Partial, using fire/smoke detection, in the main areas (where there is continuous presence of operations staff), in the false ceiling, under the raised floor and in the HVAC system.
Smoke detector-activated gas systems (even including CO2 as one of the option gases) could then be used in non-accessed areas such as in-cabinet (where the control equipment is), and under floor (where the cabling normally is).

- **Fire sprinklers** should be considered- these are effective protection systems, but are not always installed in control rooms, due to the reservations that water and electrics do not mix.

NB: -

- In all of these cases, the relevant appropriate fire extinguishers, portable breathing apparatus, chemical suits, spill equipment, personal protective as well as medical equipment are assumed available according to local legislation and regulations.
  Evacuation and exits as well as signage are assumed similarly available

PERILS OTHER THAN FIRE

Flood

Just because you have not had water lapping over the feet of the operators does not mean the control room and equipment is not vulnerable to flood. Basements and bodies of water or high water tables are an obvious exposure, as are cable trenches, but water pipes in the wrong area can be just as much a problem.

Contamination (e.g. Asbestos/PCBs/Chemicals/smoke)

An example of contamination is the smoke from a fire, containing soot particles, and acidic products of combustion. This can impact on equipment by corrosion.

Subsidence/Collapse
Self explanatory

"MAINTENANCE" OF THE CONTROL ROOM

Once built/installed, a control room still needs to be maintained, and "Management of Change" applies in a control room as much as anywhere else

The use of a site safety audit system can include Housekeeping for operators, Maintenance department & contractors

At the same time, there are things that the company can do to reduce the impact of any fire. The use of low smoke or fire resistant cabling means there is less likelihood of spread, but this is no use if the old cabling is not removed, and there is no programme of cleaning under floors, where dust and rubbish can accumulate. Getting the contractors to run the cabling and seal breaches in fire walls/floors behind them, and auditing for compliance is a key part of this.

Even then, when these are room size, using them for storage of manuals and databooks puts additional fire load in the area, if there is no adequate protection.

BUSINESS INTERRUPTION

How important is the control room to the site operations?. For a number of companies, there is no question but that the safe control and operation of the facility would require the control room to be operational.

In other places, there is sufficient "local" instrumentation that the loss of the control room would not be the disaster it first appears.

Consider the example of the company which consolidates all its' local and remote control rooms, including transfer and distribution and power and utilities, and puts the control area all under one roof. In practice, however, the control systems still use the rack rooms of the old control rooms for the data acquisition, and only send mimic data to the central control room. In that case, loss of the central control room could be mitigated by use of the old local control rooms, even though some additional costs could be incurred.

It can be said that there is a lack of historical data where the control room has been the source of the disruption. Of course, we do not count the times when:-

- the painter pushed the power shut-off button instead of the light switch
- the lightning storm took out the UPS system
- the rat/cat/racoon shorted out the control room transformer
- the washroom drainage flooded the basement
- Chemicals from the surrounding ground contaminated the basement.
- the air conditioning failed, overheating both staff and equipment
- We find out that some of the valves are reverse acting, and –5% actually means fully open on this control scheme.

But even then, control buildings are not what they were. The control rooms of the 50's and 60's were spacious, and the most inflammable items were what was in the lockers, or the sample bottles in the corner. The size of the room was geared towards wall-mounted instrumentation.

As the control systems have now become more sophisticated, they have become closer to computer rooms, or even telephone sub-stations. The floors have become raised and hold data and power cables in abundance. When comparisons are made (quite validly) to this type of occupancy, there is more information, and more reason for concern.

CONCLUSIONS

In the end, the key issues over a Control room and it's safety are:-

- When designing the control room, identify what work needs to be carried out in the building.
- Plan the location for the building.
- Review the tasks and the proposed location versus the hazards, and modify either as necessary.
- Determine the appropriate protection needed for the building both in the structure and internally.
- Once the building is fully operational, periodically review, or review after changes to the plant and building, whether the modifications have catered for the needs of the control room and its operations, as well as for the original reason for the modification.

REFERENCES

1 HSE report on the Milford Haven Loss 1994

2 Report on the Phillips Pasadena loss 1989

3 HSE Report on the Hickson & Welch loss l992

4 Paper by JA Rajan, ergonomiQ 1993