

# Control Room Distractions: Recipe for a Catastrophic Disaster

[Apply this Methodology to Reduce the Risks by Controlling Distractions.](#)

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## Abstract:

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The advancement in technology has enabled today's control systems to become fault tolerant, include self-healing networks, carry sophisticated instrumentation and be able to respond to a system unrest. However, even the most modernized and efficient control system is dependent on human operators for its smooth operation. A control system's CPU, which only relies on the process data, can never match the decision making power of a human brain which is fed by multiple human senses. This makes the control room operator a key factor for successful day to day operations.

Individual humans have their own comfort zones, where they perform best. A breach in this comfort zone results in distractions leading to loss of concentration and affecting the ability to take correct decision.

At an Oil & Gas facility, distracted control room operators may be the least noticed hazard but pose significant risk of a catastrophic disaster. Just like you don't want to be on an airplane being landed by a distracted pilot, you won't like to be on an FPSO with distracted operators during an offloading operation. In this paper, we'll study some of the controllable distractions with cost effective solutions to reduce their impacts.

## Introduction:

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"Analyze and Respond", the most common phenomenon of our everyday life. Each day, we come across many examples of this phenomenon. For example, some of us only wake up in the morning when the alarm clock beeps, but how does the alarm clock knows when to beep, it follows the same analyze and respond technique as it compares the current time with the preset alarm time and when the analysis result is true, it starts beeping. Likewise, our cars and our computers respond once some sort of analysis has occurred and this analysis could be a stroke of the ignition key or a correct password.

Every intelligent device that humans have built uses the same basic phenomenon, analyze and respond. But due to our limitations, we have not been able to come up with something as fast, as much analytic, as responsive, as what we have in our head: the human brain. And I believe, no matter what we do, we cannot create something like a human brain and no machine can match the sensitivity and variety of senses that we humans have.

While talking about the analyze and respond phenomenon, at times, consciously or unconsciously, we start analyzing so many things in parallel that we tend to lose the response of each analysis, this is when we start to stray and our ability to respond diminishes. I must say that under this scenario, some of us who have developed extra ordinary concentration skills may still outperform others, but their response time still becomes higher compared to their own performance under normal circumstances. This is exactly what I call distraction, a productivity killer. The most common distraction of our office life is the email popup message that appears and almost all of us at least look at the popup message no matter how important work we are doing.

### Distractions in a Control Room:

Control Room, the hub of operations for any field, either be an Air Traffic Control Tower or a Central Control Room of a plant, can easily attract many avoidable distractions. Why do I call them avoidable? Since most of these can be easily controlled through simple solutions.

Based on the human senses, some of these distractions can be categorized under:

- Visual (like bad illumination, inappropriate graphics, too many colors etc.)
- Audible (like loud conversations, nuisance alarm sounds, etc.)
- Discomfort (like uncomfortable chairs, un-ergonomic posture)
- Smell (like irritable odor)
- Or even Mental (like stress)

First four of the above categories can be effectively controlled in the short term via cost effective solutions, while the mental distractions may take longer to overcome and may even require medical attention.

We'll discuss the first three here with some possible remedies to overcome these types. More emphasis will be on the automation related distraction while briefly touching the rest.

### Visual Distractions:

Most important of all control room distractions is the visual distraction that can impede the human mind. Continued exposure to this form of distractions can lead to discomfort that

may cause the brain to prioritize its responses on negating the discomfort's effect. In a control room, visual distractions are usually caused by either bad illumination or inappropriate graphics.

*“Optimize control room’s illumination by using moderate lighting and eliminating reflections”*

In order to promote a productive, safe and distraction free work place for operators in a control room, ambient light is a must. Even though these days most of the control rooms are well lit using diffusive lighting instead of the spot lighting, the control room lighting and environment requires a balance with the graphical displays’ luminance as well, so that operator fatigue and eye strain can be minimized, reducing the distraction of visual discomfort. It is very important to have a moderate level of light so that when the operator moves his/her eyes between different desktop monitors, wall or roof mount displays, and the surrounding walls or surfaces, there are minimal variations in the brightness. Surrounding wall colors or any charts or decals mounted on the walls also play an important role in this brightness variation since our eyes can take up to several seconds to adapt to the new lighting condition. Typically, a room’s lighting is designed when the room is empty and later the room is filled with the furniture and large displays that create shadows and impact the brightness uniformity, hence a second analysis of the design needs to be performed once all the equipment has been installed in the control room, considering the work spaces and operator’s locations.

Reflections of any type, from either indoor or outdoor lighting, are another factor that can blur vision and cause distractions. The easiest solution to this is to avoid using spot lights, cover reflective surfaces and change light angles. Ideally the operator console should be placed in a way that no light is reflected from any of the monitors or displays.

*“Enhance operator’s visual comfort by creating individual profiles for graphical displays.”*

On a plant, most of the time Operators have to look at the monitor screens to observe the process, which at times translates to continuous staring if they need to monitor an abrupt situation closely. Constantly looking at the monitor screen may result in discomfort in the eyes, leading to itchy, watery or tired eyes. An operator having slight redness in the eyes at the end of a shift may point towards inappropriate display settings. The remedy requires that display settings be adjusted for optimal viewing to reduce this discomfort. This includes resolution, brightness & contrast, positioning and color modes. However, there is no absolute configuration that can be regarded as optimal settings, specifically because every person’s eyes don’t act the same; some may feel comfortable when contrast is a bit higher while others may like it to be the least, while the room illumination may differ during the day shift vs the night, causing the same display settings which looked perfect during the day to become uncomfortable during the night. What should we do in this case? Should we let the operators spend 5 minutes at the start of each shift to adjust these setting? Or should we just have two different monitors, one dedicated to the day shift operator and the other for the night shift operator?

The simplest and most cost effective solution to this problem is to utilize the graphics cards. These days most of the computers and servers come with preinstalled graphics card and even if a system doesn't have one installed, procuring and installing a good graphics card does not require a huge effort. You may or may not be aware that in a graphics card panel you can create different profiles. Just adjust the setting once for yourself and save it with your name, later if someone did change the settings, simply open the graphics panel and load your saved profile within a few seconds.

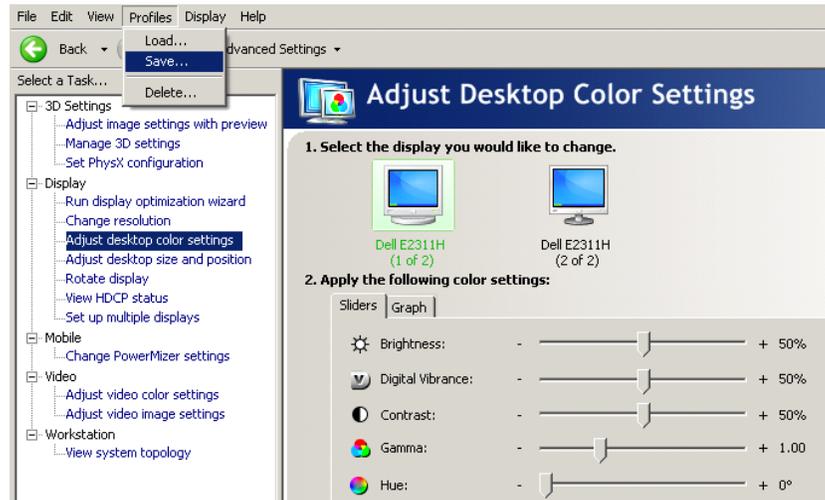


Figure 1: Graphic Cards Settings

So if there are two or more operators working at the same monitor during different shifts, they can create and save their own profiles once and load it at the start of their shift, spending less than 30 seconds to do so.

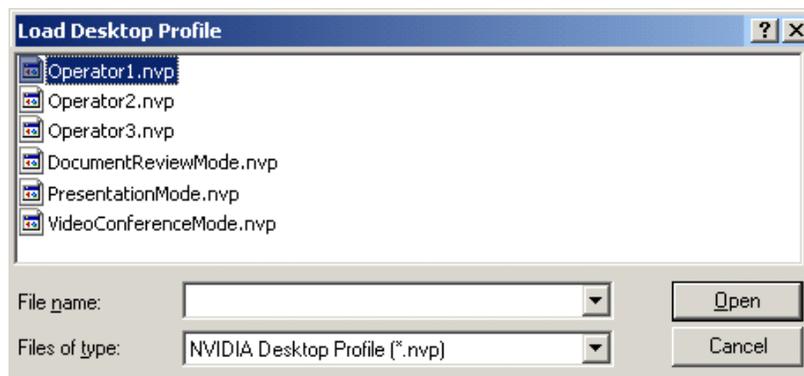


Figure 2: Saved Graphic Profiles

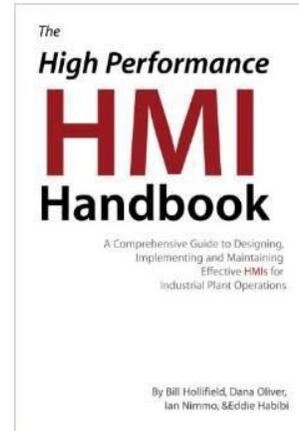
Even if you want, you can create your own multiple profiles on your laptop, one for reviewing documents, one for working with graphics and one for watching presentations and just load these as required, saving your own eyes and time.

*“Introduce High Performance HMI techniques”*

Process monitoring, though mostly done automatically these days by the DCS and PLCs,

requires the operators to keep monitoring the HMI graphics for any possible instability in the making. This requires the HMIs to be efficient enough to present the information in a format which helps the operator to quickly identify any prevalent risks and take immediate actions to mitigate it without the need to do any data manipulation or browsing through different graphic screens to identify the risk. Also, HMIs should be intelligent enough to filter through the data and only highlight the risk situations. For example, some graphical HMIs show closed valves or stopped motors with red color, even if that is their safe state. Doing so makes the operator's life more difficult since red should only be used for the unsafe or instable situations.

This paper will not delve into the details of what a High Performance HMI is, or how effective it could be, but will list some of the techniques on how to migrate towards the High Performance HMIs while keeping all stakeholders, especially operators, happy and content with this migration. For more details on the High Performance HMIs and their implementation techniques, I would encourage you all to go through “The High Performance HMI Handbook” which details how high a performance HMI looks like and what steps are required to migrate towards it.



### *“Should the traditional HMIs be switched with High Performance HMI right away?”*

Changes, mostly inevitable, must be gradual, since most of the times abrupt changes are not welcomed at all. For example, your company uses Microsoft Outlook email client that you have been working with for more than 10 years and now the company has decided to move to IBM Lotus client, you were informed well in advance about this change and were given an orientation on the new mail client with the caution that there will be no overlap period between the two, i.e. some specific Friday will be the last day for Outlook and from the Monday afterwards you will need to work with Lotus with no Outlook installed. What will you do on that Monday? Spend half day figuring out similarities between the two? Or while setting up a meeting request start browsing the options this new client has? If the new Lotus client is missing a feature that you frequently used in Outlook, you may even get frustrated with this change. The same will happen if you try to upgrade your traditional HMIs to the High Performance HMI in a single go.

### *“Step by Step upgrade to a High Performance HMI”*

A translation from the traditional HMI towards a High Performance HMI should be gradual. Any operator, who has been working on a traditional HMI for years, may right away oppose the upgrade to a High Performance HMI only because it will require him to put in extra effort in becoming familiar with the new graphics first and may also require much more time to develop a complete understanding. On the other hand, gradually converting a traditional HMI to a High performance HMI will keep everyone happy and will

require lesser time for the operators to get used to the new graphics.

Following the techniques listed in the High Performance HMI handbook, an analysis of the existing HMI should be performed, followed by the determination of final goals and objectives, development of design philosophy, style guides and High performance HMI documents, HMI objects and object libraries. Along with these prerequisites, an implementation philosophy document should also be generated that lists the details of the transitional period, gradual migration path and procedures to follow to achieve the final goal. Following these guidelines, a system integrator can easily convert traditional HMIs to a High Performance HMI, however, the key is how to deploy the new graphics in the order to avoid operator's resistance and minimize the operator's learning curve to eliminate the impact on production. This can be achieved with a step by step approach of upgrading the graphics. Most of the HMI software provides the facility to import and overwrite the existing graphic screens; this is a very critical feature for this implementation as during the transition phase, this feature will help the smooth upgrade.

The migration procedure should start by only changing one to two factors at a time, providing the operators enough time to get used to them before proceeding with the next change. For example, start with only upgrading the background color and let the operator become used to this change for a week. Once the operators are comfortable with this change, go on with converting the 3D graphics (vessels, tanks, valves etc.) to simple 2D graphics and let the operator familiarize with this change before proceeding further with the process lines size and color coding update, objects animation and color coding etc.

### *"Step by Step HMI upgrade Example"*

Consider that your company owns a facility where the HMI graphics are similar to the one shown in Figure 3 below which violates almost all the rules and recommendation for a High Performance HMI graphic.

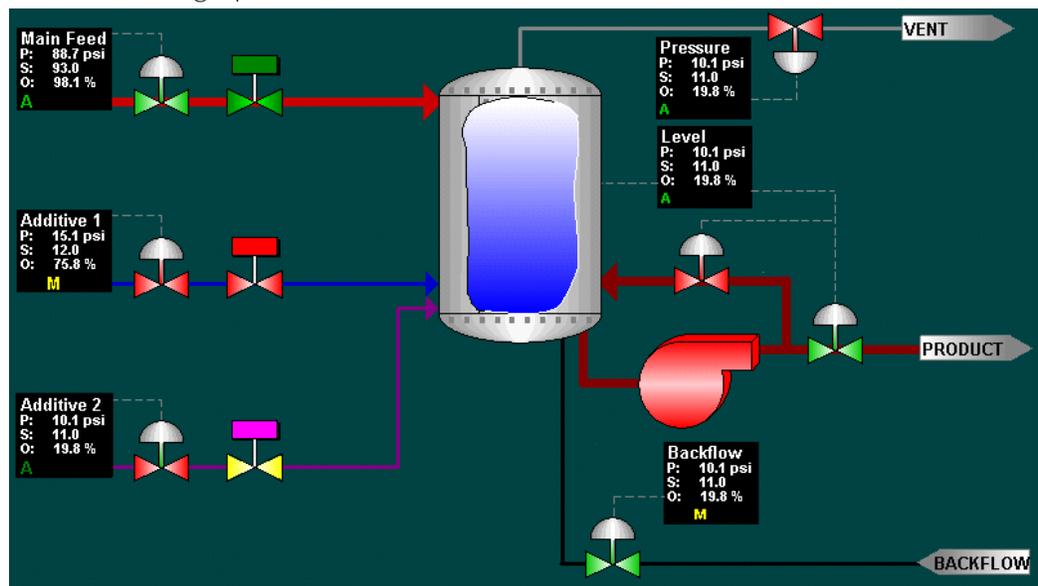


Figure 3: Current Graphic Screen

Based on the techniques of the High Performance HMI, your company plans to upgrade HMI graphics to something similar to what is shown in Figure 4 below.

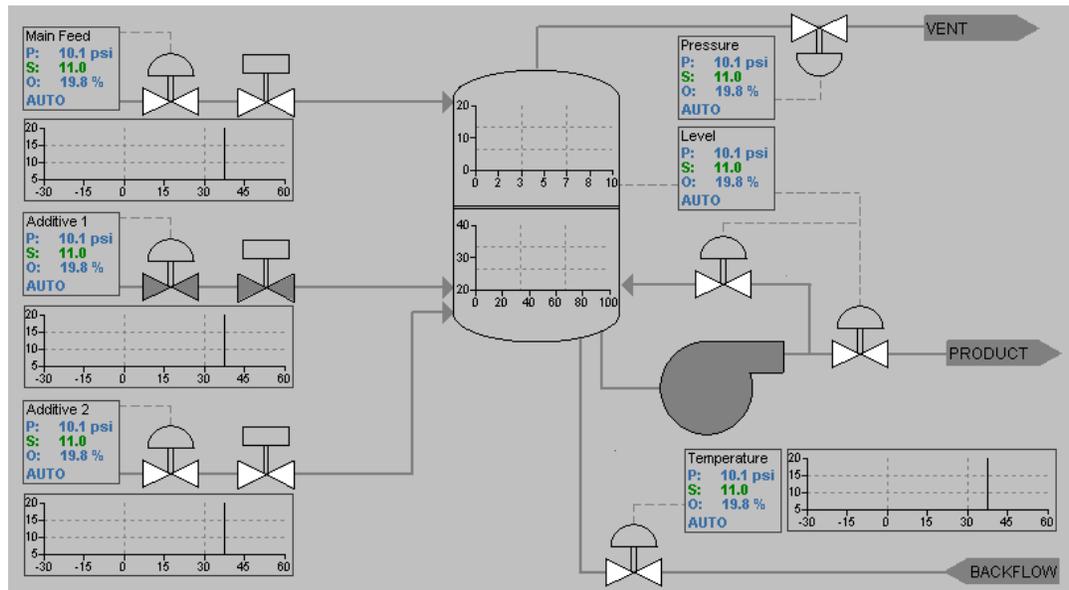


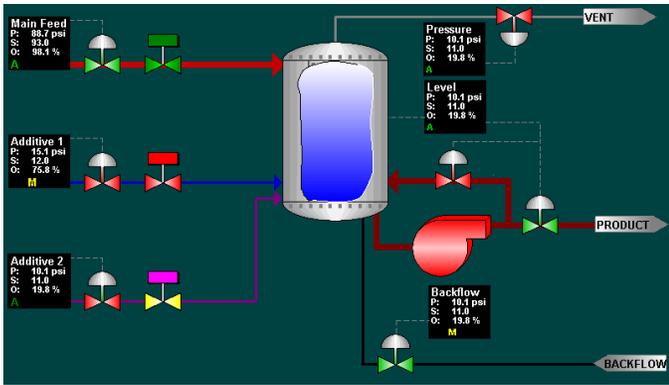
Figure 4: Preferred Graphic Screen following the High Performance HMI Techniques

Considering the case of facility operators, this would be a huge change in their work environment, everything has suddenly started looking dull and grey compared to the earlier colorful graphics. A resistance by the operators to this upgrade would be natural, though the protest may not be that vocal.

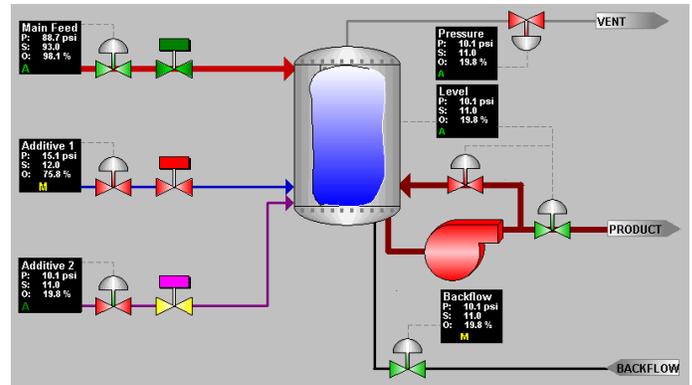
Following the step by step approach philosophy, converting the traditional HMI (Figure 3 above) to the high performance HMI (Figure 4 above) would require multiple sets of graphics that would be imported over time to overwrite the existing graphics. This process might be a bit slower but it would surely help the operators migrate from traditional HMIs to a high performance HMI by introducing interim graphics where operators would feel comfortable and may also provide valuable feedback for further improvements. Listed below are the steps required for this migration with interim graphics examples:

1. The first step would be to change the background color on each graphic and import the new set of graphics.
2. Once the operators are comfortable with the new background colors, the second step would be to change the 3D objects to 2D objects on each graphic along with their color coding and import the second set of graphics to overwrite the first step graphics. Let the operators familiarize themselves with the new 2D objects and their color coding.
3. The third step would be to upgrade the process line colors and sizes, and import to third set of graphics to overwrite the second set of graphics.
4. Once the operators are comfortable with the above static changes to the graphics, objects (such as valves, transmitter displays, control loops etc.) should be upgraded to the recommended color and animation details, this change may require more time for the operators to get used to with the new object models

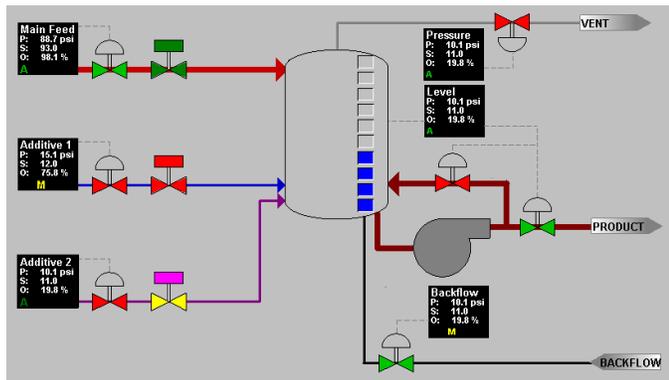
5. Once the operators get fully familiar with the new object animation and philosophy, last step would be to add the new information to the screen, these includes the trends, bar graphs and any additional data which was not available on the original traditional graphics.



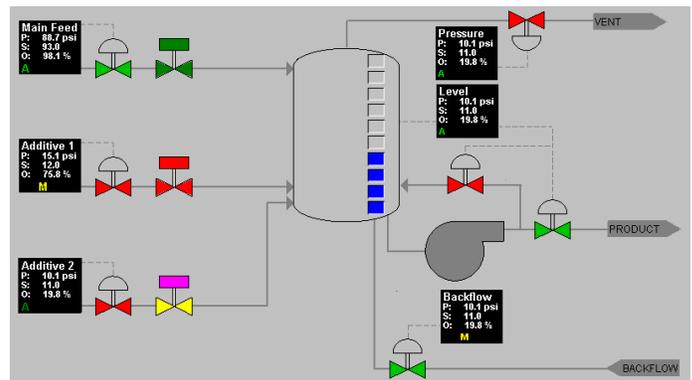
Starting Point: Existing Graphic Screen



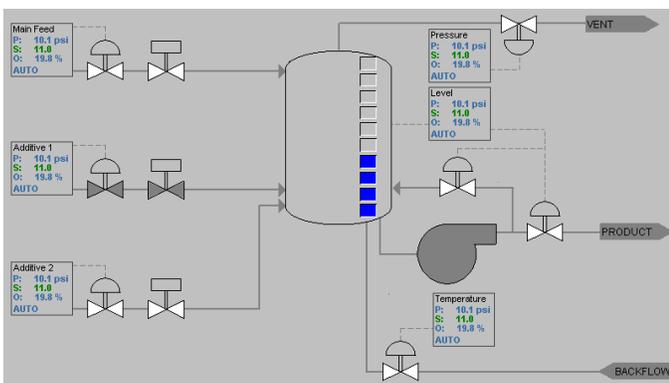
Step 1: Upgrade Background color only



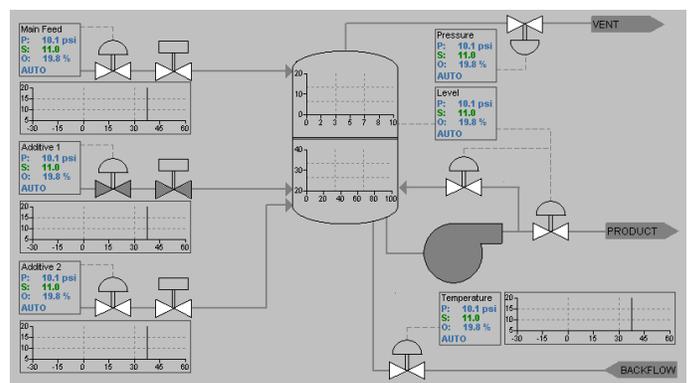
Step 2: Convert 3D objects to 2D



Step 3: Upgrade Process Lines



Step 4: Upgrade object colors and animation



Final Step: Introduce trends and new information

It is important to first upgrade the static objects of the traditional graphics, followed by the upgrade of dynamic objects before continuing with the addition of new information (such as quick trends or bar graphs etc.). Following the above step by step approach may take a bit longer to reach the final goal of implementing a High Performance HMI but it will eliminate the need to spend hours on operator training and then letting them understand

and become comfortable with the new graphics, directly eliminating any impacts on the production.

### *“Alarm optimization”*

Today’s control systems provide the feature of getting multiple alarms against a single point. As much as 10-12 alarms can be generated against a single process value, these may include the low, low-low, low shutdown, high, high-high, high shutdown, out of services, bypass, deviation, out of range, discrepancy, transmitter health etc. System integrators as well as the end users tend to get overwhelmed with this enhanced alarm generation feature which results in thousands of configured alarms per system. These alarms might be useful for the post-analysis of any abnormality; however these become nuisance for the operators especially during an abnormal process situation.

Typically, these alarms are categorized based on their nature such as information only, diagnostics, minor, major and critical etc. System integrators usually use these categories and assign different color coding to the generated alarms in order for the operator to visually filter the alarms. Configuring thousands of alarms would probably generate multiple alarms for the same process abnormality, forcing the operator to spend time analyzing these alarms instead of immediately reacting to a single alarm. This adds to the operator’s misery causing distraction and increasing the response time by introducing the analysis factor.

Alarms should only be triggered in situations which require immediate operator attention. Separating events from the alarms can greatly reduce operators’ distractions. Having an event log can help to exclude the information, diagnostics and minor priority events out of the alarms list, providing the operator an optimized list of actual disturbances.

### *“Prioritize alarms so that the operator is intimated as soon as the process starts deviating”*

Operators are usually tuned to give attention to a critical or major priority alarm and ignore any minor priorities. Apart from the alarms priority determination based on the severity of the consequences, it is also a common practice to categorize the shutdown as the critical alarm instead of the situation which initiated the shutdown process. For example, if a process is supposed to shutdown at “low-low” process value, typically the “low” alarm generated by the control system is categorized as minor intensity alarm while the “low-low” alarm which actually initiates the shutdown is categorized as major intensity alarm with the shutdown signal categorized as critical alarm. This approach does not provide any time to the operator to avoid an abnormality by tuning the process parameters. On the other hand, if the “low” alarm is categorized as the major intensity alarm, operator would have time to possibly avoid the shutdown by tuning the process parameters so that the process does not even reach a “low-low” state.

	Process Alarm		Shutdown	Operator response	Outcome
	Low	Low-Low	Signal		
Intensity Level	Minor	Major	Critical	Respond to higher intensity alarm, which has already caused a process shutdown	No chance for the operator to avoid shutdown condition
	Major	Minor	Minor	Respond to higher intensity alarm and mitigate the situation by tuning the process parameters to avoid a process shutdown	Operator may be able to avoid the shutdown condition

### Audible Distractions:

Audible distractions, which may not usually result in as much discomfort as the visual distractions, can have adverse effects on a person's concentration. Consider yourself compiling an important email when suddenly your cell phone starts ringing, even if you turn the cell phone off, you will have to read through the last sentence you were typing before continuing to complete it. The same way, any operator can lose his concentration from any sort of audible distraction, be it an alarm beep, a loud conversation or a PAGA announcement.

Most of the control rooms are designed to be sound proof which minimizes the impact of external noise; however the internal noises are the primary culprit in the loss of concentration.

#### *“Should a control room be used as a meeting room?”*

It is very common to have short discussions and meetings in the control rooms which sometimes don't even require an operator's presence. These may include shift meetings, toolbox talks, work permit discussions or even meetings with integrators or vendor representatives. Considering that each person's voice pitch is different and some have naturally loud voice which at times becomes nuisance for the non-attendees and causes disruption in the concentration.

Control rooms should not be used for such meetings, instead having a small conference room within or next to the control room can greatly reduce the impact of such distractions. If an operator's presence is absolutely required and the operator cannot leave his or her desk, it would be better to have a one to one discussion with the operator instead of calling all the concerned to the control room.

Printers and scanners are one of the most used machines in every control rooms. Both these machines can generate loud noise while operating. Though there is no alternative to these machines, however their location can be debatable. Preferably these should also be in an easy to access adjacent room or partition to minimize the noise levels.

### *“Control Room procedures and work practices”*

Similar to an examination room, operating room or a meeting room, control rooms should have predefined work practices and procedures, especially during an abnormal process situation. It is very common for the operator’s telephone to start ringing back to back, as all the concerned personnel start calling the operator directly to get an update on the problem. Sometimes it gets even worse when the concerned personnel start gathering inside the control room, standing behind the operator, asking questions, browsing screens and monitoring each and every activity of the operator. This attitude simply adds fuel to the fire, not allowing the operator to concentrate on rectifying the problem but making him more distracted and unable to perform his tasks properly.

It is very important to define the protocols and procedures on whom to contact other than the operators and how to get the information during a process abnormality. Having a large roof mounted or wall mounted display showing the overall process picture and critical information; can effectively reduce the operator’s distractions while the concerned personnel self-monitor the process. Having this large display at a location which does not interrupt or interfere with an operator’s task is even important.

These practices and procedure should also include the following as a minimum:

Low volume levels of the telephone/cell phone ring tones

Low and controlled voice levels, no arguing loudly

Small personalized computer speakers to limit the sound and music levels that are only directed towards the listener, except the alarm sounds and beeps

No banging on the doors, windows or desks

### *“Optimize Alarm sounds and beeps”*

Critical or major alarms need immediate attention from the operator, if the alarms are not optimized to limit their number per hour; it is possible for the operator to skip an alarm that can lead to a process shutdown. Associating an alarm sound or beep to the critical or major alarms catches the operator’s immediate attention, however if the same sound or beep is associated with all the alarms and events, this becomes a nuisance that causes distraction and the operator has no way out but to mute the speakers, nullifying the alarm sound feature integrated into the application.

It is very important to assign alarm sounds and beeps to the most critical alarms only, which must get operator’s immediate attention. The alarm sounds must be very clear and unique to properly distinguish from all other sounds in the control room and should be loud enough to catch the operator’s attention even if the operator is not at his desk. Associating a voice message with the alarm can also result in further distraction, it is important not to associate a voice message but an alarm beep with a distinctive tone.

## Discomfort:

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Repetitive strain injuries or RSIs, also known as Repetitive stress injuries, repetitive motion disorder (RMD), cumulative trauma disorder (CTD) or overuse syndrome are injuries to the musculoskeletal or nervous system that may be the result of repetitive tasks and awkward postures. Operators, who need to work in the control room in front of the computers for long hours can easily develop these RSIs if they don't use any precautions. Once developed, RSIs can badly impact an operator's performance by reducing their concentration and increasing their response time. It is very important that the operators should be well aware of the ergonomic practices and procedures and risks of not following these procedures to avoid RSIs. OSHA (Occupational Safety and Health Administration) has developed ergonomics guidelines that help reduce any ongoing discomfort and avoid RSIs. Operators must be educated as per these guidelines to eliminate the risks of distractions arising from the discomfort. A number of software products are commercially available which remind the users to take micro breaks and help practicing the ergonomic exercises to remain healthy, some of the software also record the results through small quizzes and provide recommendations, these products must be used in the control room to avoid RSIs.

## Summary:

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A distraction free control room has a major role in the smooth operation of a facility, it can help reduce the downtimes, achieve high performance by optimized production. An educated control room operator, who is allowed to work distraction free, can be the most important asset of any facility.

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## Bibliography:

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- ["The High Performance HMI Handbook"](#) by Bill R. Hollifield, Dana Oliver, Ian Nimmo
- ["NVIDIA Control Panel"](#) by NVIDIA Corporation