Supplement to the HISTELEC NEWS No. S73
December 2019

CONTROL ROOMS THROUGH THE AGES

by David Hole

David Hole, who served as Chairman for four years and is now our Vice Chairman, made his career as a Control Engineer, starting with the CEGB at Plymouth B Power Station and then moved over to SWEB. We are indebted to David for remembering what changes ensued over those many years.

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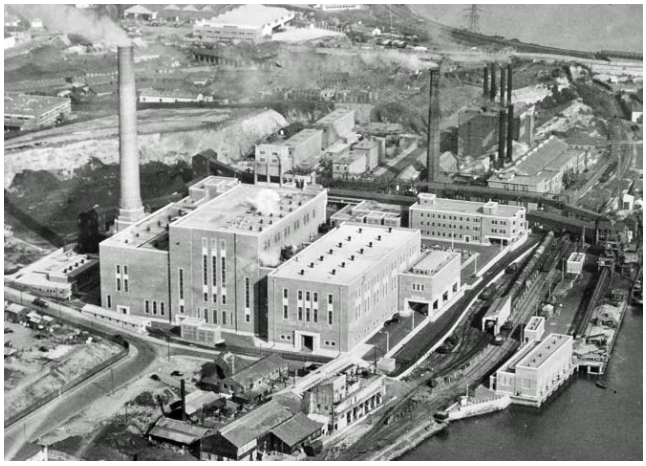
These days we take it for granted that our lives rely continually on automation. Aircraft fly on "Auto Pilot", driverless trains carry us around London, at home, fridges and freezers start and stop, and washing machines wash while we are elsewhere. Even our vast and complex electricity supply system runs itself 24 hours a day, mostly without human intervention. Auxiliary plant starts and stops, controls adjust, and instruments indicate remotely, all thanks to automatic control. When things go wrong alarms give warning and, if required, protection disconnects the faulty system or plant, frequently restoring normality following transient faults. It is quite probable that one could go into any of our control rooms, anywhere, and at any time and not find anyone actually controlling anything at that particular moment!

However, in spite of all of this, control rooms have become larger and more necessary since their responsibilities and capabilities have expanded, reducing the need for more and more staff. We are able to observe, to adjust, to rectify and take over control when the need arises. This has all come about as a result of the same advances in technology which, one might think, should have replaced them. To bring this situation about many changes have occurred, some during my career, and it is of interest to recall some of them.

My first encounter with a power station control room was when I joined the industry at Castle Meads (40MW) in Gloucester. However, since that was in 1961, there is not much that I can recall other than that the room was small and cramped with no apparent consideration having been given as to what needed to be accommodated within it. I do remember being given a demonstration of the use of a "breathing apparatus" in the control room, where it was kept. Our unfortunate tutor discovered that, having donned the apparatus, the gaps between the panels were too narrow to permit his exit, a demonstration of the need for change even then. At that time control rooms primarily were provided just to control the generators, station auxiliary switch gear, a limited amount of remote substation switchgear and little else. Hence, "outside" there were stokers, turbine drivers, auxiliary plant attendants, the coal gang etc. etc.

However things had already changed when I joined Plymouth "A" and "B" power stations, in 1963. There was no problem in size. The "A" Station had no control room as such, just a collection of slate panels bearing a lot of live bare copper, surface mounted meters (the size of saucepans) and coloured glass indicator lamps (the size of teacups). However the "B" Station (early 1950's) was an impressive building with a magnificent, "cathedral like" turbine hall and a large, equally impressive, control room. All the generation in the "A" and "B" stations (8 turbo alternators and a "black start" diesel generator) was controlled from a large horseshoe shaped desk. There were also station auxiliary switchgear control panels plus some remote 132 kV substations L.S.C. cubicles (Limited

Selective Control). The memorable thing was the size of everything. Switchgear control panels large enough to walk into, generator control desks about the size of the old London Underground ticket machines and meters, flush mounted by now, but still the size of dinner plates. All of this in a grand style plus a printometer and relay room and even a 24 hour "nuclear attack" alarm.



Plymouth A & B Power Stations

Loading instructions came in from Grid Control by way of a 16 way telegraph or dedicated telephones. Those instructions for the LP sets were passed on to the turbine hall by "Loudaphone" and telegraph displays, and to the HP Control Centre by intercom. A bank of internal PAX phones connected the control room to the rest of the station and a large, wooden, telephone switchboard connected us to the GPO network in the outside world.

So "outside" on the three 30 MW sets (early 1950's) there were still turbine drivers and boiler operators who stood in front of control panels the size of small shop windows. However the two 60 MW sets (early 1960's), had now advanced to a "unit control centre", manned by a unit operator, and housed in something like a detached conservatory. So already, control was changing. The room was getting smaller but its capabilities were expanding, doing much more with fewer staff.

Another sign of change cropped up at about that time. The work load in the control room varied according to a station's place in the "merit order", top of the merit order - full load 24/7, bottom of the merit order - shut down. In between, the station "2 cycled", starting up and shutting down plant as required and continually varying output in between. Inevitably the idea evolved of devising a system that could, remotely, regulate the output of generators from Grid Control. This was known as the "ACRP" system. (Automatic Control Research Project.) It was incredibly complicated comprising a mix of electronics, mechanics, gear wheels and endless wiring, all housed in more "ticket machine" sized control panels. Regrettably the controllers were so complicated and unreliable that they continually failed and the demands that they placed on governor motors brought many to an early end. Naturally, we rearranged the abbreviation and called it something else, and "the powers that be" gave it up. Nevertheless, here was another early indication of changes to come.

When the power station closed I moved on to my next "Control Room", this time the planning department of Plymouth Transmission District. Instead of controlling plant, I found myself organising resources, engineers, technicians, specialist equipment, transmission outages etc. etc. It was an extremely busy job and I loved it except for one thing. Due to the many maintenance procedures required, and the number of substations involved, my boss had devised a computer controlled program which, once a week, produced a vast paper print out, yards long, listing work due. This was "very early days" for such things and I think the first time it had been done in a District. So, although a useful tool, I have to admit that I struggled. Yet again it was another sign of things to come.

When the 132 kV system changed ownership I deserted the CEGB (Central Electricity Generating Board) and joined SWEB. After a while, I managed to get a job in the Devon Control Room at Sowton. Sometime in the 1960's, the original central control room was established in a building that just happened to have some unused space associated with Sowton B.S.P (Bulk Supply Point). Fortunately for me it had moved to a large, purpose built room by the time I joined. At that time, we only operated the South West's 132 kV system, plus the 33 kV and 11 kV systems for Exeter, Torquay and Plymouth. The size and complexity of the distribution network astonished me and the idea that we actually had domestic customers was new to me. To assist us we had a couple of

"control assistants" during "office hours", and some telephonists taking calls from the outside world, in a separate room nearby.

The four systems were depicted on manually dressed mimic boards, each green "Formica" type boards probably about 8ft. tall and 5ft. wide, arranged side by side. The entire networks had been printed manually onto the boards using "Letraset" materials (a system of transferring lines, symbols, letters and numbers from a sheet onto a surface.) Every switch, isolator, or piece of special equipment had an appropriately coloured stud, glued to the diagram, in its correct place. The studs were dressed manually with different coloured discs showing "open", "closed", "closed to earth", etc. etc. In addition small tiles showed other bits of information such as "A/R off", "SEF off" etc. These tiles were fixed by an essential tool - "Blue Tac". The diagram was continually dressed manually, during switching, to show the state of the network at any given time. However the wall board mimics only showed the main network, spurs and more detail of the 11 kV network being shown on hundreds of paper diagrams, stored in bins adjacent to each desk. These paper diagrams were dressed using small, printed, sticky symbols.

Although crude, the system worked well but there were a couple of MAJOR disadvantages. The actual system is constantly being modified and added to, necessitating changes to the mimic diagram. These changes caused a lot of work upon the mimic, scraping off the old, as well as moving some of the present to provide space for the new. The paper diagrams also required updating, using correction fluid and red ink before involving the drawing office with reprinting.

Then occasionally, a dressing, or stud, would be found on the floor. To maintain the accuracy of the mimic it was essential to find out where it had come from. With such a large and complicated diagram, finding the answer to that question wasn't easy and was very time consuming.

In spite of all this manual effort the wall boards had one HUGE advantage, we could see the "whole picture" instantly, an enormous help when undertaking post fault switching. Although, nowadays, wall-boards have disappeared I would still prefer this simple, manual system to the present day screen displays of segments of the system.

Even with all the visual information provided by the mimic diagram we never knew what was actually <u>happening</u> on the system at any instant. We only learned what had <u>happened</u> when "something", or "someone", told us. The "someone" was usually a customer, reporting no supply, or a "Local Office" reporting multiple "no supply" calls.

The "something" was a remote control and alarm system called "Dataphonic". Prior to the establishment of a central control room, "Local Offices" had their own Dataphonic but when the control room was established the Dataphonic moved there. Each control desk was equipped with its own Dataphonic control panel comprising push button controls and a loud speaker. In the substation there was some sort of tape recording machine with an auto dialer, monitoring conditions. When something abnormal occurred the auto-dialer rang the control room.

Dataphonic Panel

We picked up the call on the Dataphonic and listened to the message:- "This is the automatic Dataphonic Control System at "Somewhere" substation, Standby for conditions at "Somewhere" substation. - OCB 1 (Oil Circuit Breaker) closed, OCB 2 closed, OCB 3 closed," and so on until, perhaps, "OCB 8 open<u>.</u>"

All this took time and, in the event of an "auto reclose" could result in just a report of normal conditions. Nevertheless the system proved to be invaluable, not only informing us of abnormalities but also allowing us to carry out some remote control functions too. (As I recall we also controlled the Princetown gas turbine). However, after initiating a control action one had to listen to the message all over again to confirm that that it had been carried out. During bad weather, several substations would ring in together but it was impossible to listen to all the information coming in simultaneously. So, although "state of the art" at the time, Dataphonic had major limitations. Hence SWEDAT was born (South Western Electricity Data Acquisition and Control, I think!) first in Cornwall then at Sowton.

At Sowton a major advance was made when 2 computers were installed in the "back room", each about the size of a freestanding cash machine, with a "Watchdog" between them. One computer was "in service" continually with the other "on standby". The "Watchdog" ensured that the "standby" machine was kept up to date with system conditions and, upon a failure of the "in service" machine, changed over control to the "standby" machine. On each desk there were 2 large VDU's equipped with keyboards and light pens. Displayed on their "Home Page" was a list of "Bulk Supply Points" and primary substations controlled by the system, probably about 300 in all. With conditions normal a substation's name was displayed in green, with a standing alarm, amber, and a trip, or other urgency, caused it to turn red. Regrettably the system's audible alarm was a cheap, irritating high pitched whistle. It occurred so often and, at times, almost continually, that it could drive one to the point of desperation. (It is said that pilots have been known to fly planes into mountainsides simply because they were engrossed in trying to cancel alarms at times of emergency).

During the great storm of 1990, every substation eventually turned red, the alarm sounded non-stop, and we just gave up, being unable to keep pace with events until the storm abated. After that, thankfully, the whistle was replaced by a "Westminster" door chime.

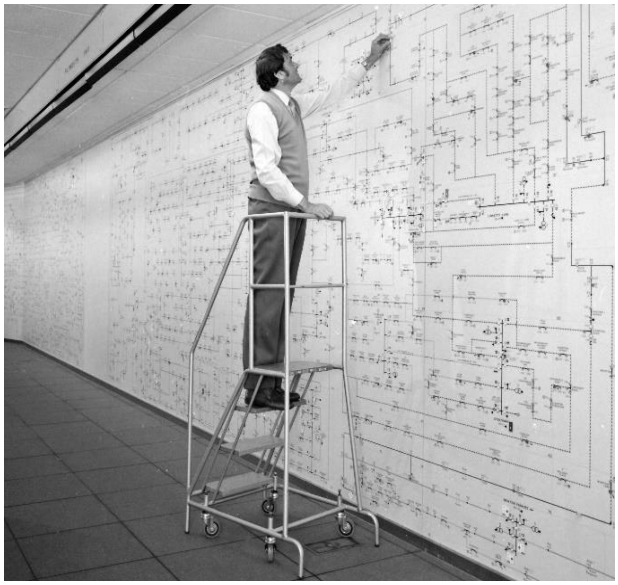
SWEDAT Screens

At last, thanks to SWEDAT's controls and "analogues", we were able to control and monitor the system "live". The "analogues" enabled us to look back to see previous load profiles and hence predict loads in the future, during outages. Our ability to control the system, remotely, saved everyone a great amount of time. Operating so much, so often, however also increased the opportunities for mistakes, or "human error faults". Fortunately, such faults were extremely rare thanks to the considerable effort put in to avoid them. Field operators wrote detailed switching programmes for planned outages and sent them, in advance, to control for checking and, if necessary, amendment. They were then copied, one copy being retained and the other sent back to the local office. I am sure that this laborious procedure has been updated by now and perhaps, even automated.

It is amazing that "SWEDAT" also provided a system called "Mail", which enabled us to send messages to other control rooms, a forerunner of e-mail I suppose. We couldn't think of a use for it and very rarely used it! How times have changed.

As the control room's capabilities increased then the opportunity to close control centres increased. First of all Somerset Control closed, part of their system, around North Devon, coming to Sowton and Bristol getting the rest. Then Cornwall Control went and we got everything, including their infamous ASCs (Arc

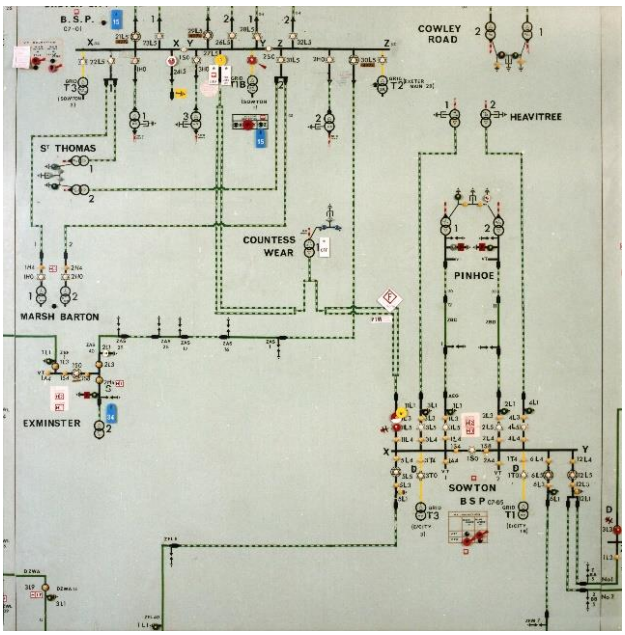
Suppression Coils). All these closures meant that even more wall boards and paper diagrams were needed in Sowton, resulting in hours of work drawing the networks, still using "Letraset". SWEDAT's "Home Page" had to keep pace too.



David Hole attending to the Sowton Control diagram

Alongside all these changes, technology was making huge advances. When I joined the control room in about 1985, we didn't even have a photocopier. Our open radio communication system meant that when "Sowton Control" called a "mobile" all other "mobiles" could hear. Old fashioned perhaps but handy because, during urgent situations, we could appeal to any "mobile" that happened to be near "Somewhere" substation. That was replaced by something known as "PMR" (Personal Mobile Radio), a system enabling us to make "person to person" contact with field staff, via radio sets. There were some advantages, such as no longer the need to use words like "over" or "over and out", but it necessitated yet another VDU on every desk.

Mobile phones were only just beginning to make their presence felt too. I was switching with a chap on St. Mary's, Isles of Scilly one day when we agreed that he should carry out an operation whilst leaving his mobile phone "open." As he walked across a field, there I was, in Sowton, listening to the rustle of his feet in the grass and birds singing on the Isles of Scilly live! I have never forgotten that amazing and incredible moment for me.



A Portion of the Sowton Diagram

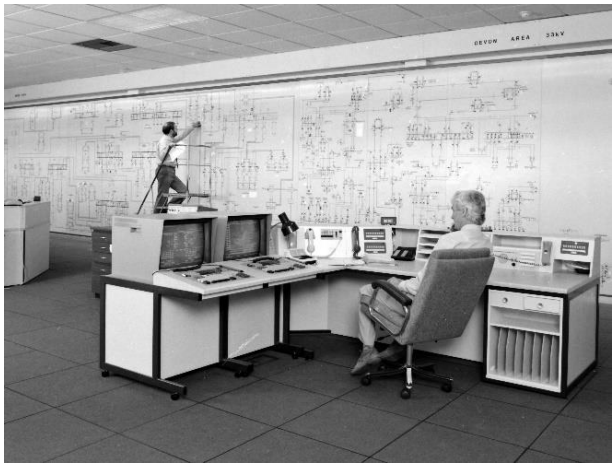
Computers were also beginning to become more common at that time too. The worst thing about multiple faults during bad weather was not the operational work involved but the dreaded "NAFRS" (National Fault Reporting Scheme) reports required later. "NAFRS" was a scheme intended to highlight unreliable components which most often caused system faults. Often it took longer to complete the forms than it did to restore supplies. Inevitably a computer terminal was supplied for this purpose but it gave rise to even more paperwork when printed error messages were returned after a few days.

Eventually the desk mounted, reliable, easy to use telephone "key and lamp" units were replaced by modern phones capable of doing all sorts of things that we didn't need. All that we required was an indication that a call was for a particular desk and the ability to pick it up anywhere. The "key and lamp" units did this admirably. The new phones, covered in buttons, and full of superfluous facilities were, in my opinion, a nightmare, a matter of change for change's sake.

Over time procedures changed, benefiting customers and field operators. One of our own Society members, John Dike, came up with an idea which reduced customers "no supply" time following a fault considerably. He simply suggested changing our mind-set from worrying about fault repair to one of restoring customers

as soon as possible. “Target 60” was born. His idea was simple, as all good ideas usually are. “Circuit Restoration Action Plans” (ignore the abbreviation) were devised, nominating a strategic switch, the “Target 60” point , where a circuit could be split, midway along. Some customers could thus be restored possibly within an hour. The idea cost little but was most effective. “Fault Indicators” and the increased use of mobile generators further reduced customer minutes lost.

“Field Control” was introduced, another simple but most effective idea. Field operators were able to take over the control of spurs or sections of mainline, once it had been reconfigured to form a spur, isolating, proving dead, earthing and issuing the P.T.W’s (Permits to Work) without further involvement of control room. This change saved time both in control and out in the field and was appreciated by everyone involved.



Later picture with SWEDAT Screens, the Late Pat Bilyard at the diagram and Roger Higman at the desk

The final change for me was probably the most important of all. In December 1990, as we all know, SWEB was privatized and eventually we landed up in the ownership of our American friends and W.P.D. was born. I had no doubt that the “lights would go out” soon after, they didn’t! I believed we would descend into chaos very quickly, we didn’t! I was convinced that our new owners would quickly sell us for a profit and move on, they didn’t! In fact they did what they said they would, they turned us into the best distribution company in the country. I was wrong with my predictions and I confess that, actually, I am quite proud to be associated with it all even as a pensioner.

In 1997 I retired, making way for staff from Bristol control room which was soon to close. Once again I thought that “the lights would go out”, this time due to my departure, but they didn’t! The truth is the control room and its staff are only part of the picture. We all rely on others but, in our everyday work, we relied most on our field colleagues. One is in a strange position in the control room, knowing so many, but only meeting a few. I am grateful to them all for their help and guidance over the years.

Sowton inherited the Bristol system but then later closed itself when everything moved to Cardiff. I have visited that control room, also the control rooms at Langage power station and Exeter’s “Energy from Waste” plant. Purpose built and bristling with screens and modern technology they are most impressive. When one thinks that Castle Meads (40MW) probably had a staff of about 250, Plymouth “B” (210MW) about 350, yet Langage (885MW) had a permanent staff of only about 43 then one can see what advances in technology have done, and control rooms have clearly played their part.

Would I like to work in one? I am not sure. I think I would still prefer a wall diagram and “key and lamp” units. However, I must admit that, even without them, or me, everything appears to be under control.