

Recommended Actions following the Bureau Veritas report on the Electrical services at ING, ORM site.

Taking into consideration the items listed in the Bureau Veritas report against the official technical instructions for low voltage installations (Instruccion Tecnica Complementaria para Baja Tension: ITC-BT-05 Verificaciones e inspecciones) the majority of faults would be classified as slight (Leve).

Minimum fault

In which does not present a danger to people or equipment, and does not disrupt the operation of the system, and in which the deviation in respect to the regulations does not have a significant value for the effective use of the system function.

Defecto Leve

Es todo aquel que no supone peligro para las personas o los bienes, no perturba el funcionamiento de la instalacion y en el que la desviacion respecto de lo reglamentado no tiene valor significativo para el uso efectivo o el funcionamiento de la instalacion.

Indeed some of the faults listed within this category fully comply with the Institution of Electrical Engineers U.K. requirements for electrical installations under which the ING telescopes were constructed.

There are some items which should be addressed which will enhance the safety of our installations and others which would remove possible circumstances of electrical risks for staff who are actually involved with working on electrical circuits (and these have been supported for carrying out). Importantly within the report or during the actual inspections no item or incident was found that could be considered as a serious risk to personal or equipment.

The following actions are intended to provide a practical and responsible means of improving the electrical systems of the ING telescopes, these in themselves will not provide the certification. To obtain that certification I understand that we would have to follow all Bureau Veritas recommendations. So as these can be judged against the required effort I have tried to provide estimated costs for both actions. As individual faults are often repeated in the Bureau Veritas report I have tried to address these collectively so as not to make this document too cumbersome to read.

1. Replacement of circuit breakers

Most of the requirements are for the reduction of the size of the M.C.B.s (protection devices) which would limit the current capacity of the final sub-circuits. This is good practice as it reduces any possible overloading of cables. However, as was explained during the inspection, in most cases our final sub-circuits have been installed in the form of a ring (a circle) this in effect doubles the cross section area size of the cable. So if a circuit is installed with a 2.5mm cable (within a conduit) it has a maximum rated load current of 24 Amps, but if that same cable is connected in a ring form its rating increases to 48 Amps. Therefore the existing M.C.Bs have already been calculated for their

correct size. Additionally many of the ING radial (direct fed) circuits are wired in mineral insulated cables (commonly referred to as pyro cables) these cable are purposely designed for robust environments and have a very high current carrying capacity. For example a 4.0 mm mineral insulated cable has a current capacity of 60 Amps in comparison to 32 amps for a P.V.C. insulated 4.0 mm cable. Therefore reducing the rating of the M.C.B.s of these circuits wouldn't provide any better protection or offer any improvement, as the cables are of sufficient size and capacity to carry the designed load.

Another very important factor regarding the protection of all ING sub circuits, which should be considered yet was seemingly ignored in the report, is the inclusion of a fuse in all the electrical items plugged into these final sub-circuits. Including Spanish / UK adaptors. The rating of this fuse not only protects the item in use but also prevents any overload of current being taken by the circuit supplying it.

Note: Although we have spare breakers (M.C.B.s) on site, we do not have sufficient numbers to replace all those listed in the Bureau Veritas report. Inquiries with the supply company have confirmed that the existing type is no longer manufactured which would result in the necessity to replace the actual distribution boards. Of 24 distribution boards that have been listed if we take a conservative figure of 290 Euros for materials to replace each individual board and a labour cost of 320 Euros for there replacement the cost would be 14,640 Euros.

2. Cables colour coding

Another general comment is for the correction of the cable colours noted for most of the existing distribution boards. European standards for a number of years have been harmonising the colours used for electrical cables and our buildings have a mix of colours some arising from the original installations right up to alterations and newer installations which do comply with current regulations. I am of the understanding that cables installed before the European colour harmonising legislation do not need replacing only that the new directives are followed for subsequent installations or major alterations. However, the regulations do state that cables must be easily identified and as there is possible confusion within the main distribution board I propose these are changed from white to blue. This is work which can be carried out in house. As for the other cables within existing distribution boards these are easily identified in regard to correct phasing neutral and earthing and do not present a hazard to any electrical competent person. If it were considered necessary this could be achieved by coloured heat shrink covers which although are inexpensive would be disruptive in respect of downtime required to fit the covers and costly in labour to carry it out. I estimate a total cost of materials and labour at 3,120 Euros.

3. Emergency Lighting

Bureau Veritas state that we require emergency lighting illuminating a minimum of 5 lux at all fire extinguisher points and at various distribution panels in our buildings. I haven't found any regulation concerning this in either the Spanish or U.K. electrical regulations so I presume this must be a building regulation. The ING policy is to provide emergency lighting for the safe evacuation of the buildings in the case of the loss of both UNELCO

and site generated electricity. For which we have installed maintained and non-maintained emergency lights situated over exit points or indicating the exit point routes. The main supply and the three generator back up (which operates within 2 minutes of a mains failure) is very reliable and in my nineteen years of working at the ING I have never been required to work on electrical panels equipment supported by only emergency lighting, a situation which in itself could be dangerous given the minimum 5 lux requirement. The recommendation also includes installing emergency lighting on electrical panels located in the dome, **which in turn would affect observations if operated by mistake or under fault conditions.**

To provide emergency lighting for all fire extinguisher points and the panels indicated with in the report I have calculated 18 electrical panels and a further 14 fire points. Emergency lighting units most recently purchased from Amida at a cost 203.98 Euros per unit and allowing a contractual figure for their installation at approximately 60 Euros per fitting, the total cost would be 8,447.36 Euros.

The report does highlight an important point regarding the emergency lighting in the WHT which requires alteration. The initial emergency lighting system has been wired via remote supplies from the ground floor main distribution panel which means that various fittings have a dual supply, one providing electricity for normal switching while the other supplies and charges the battery for emergency lighting. This can be dangerous in respect that if a person is unaware of the dual feed, they may presume the fitting is isolated when in fact it still has a live supply. This can also cause neutral/live feedbacks which have been identified on some WHT distribution boards. My recommendation is the removal of these separated supplies and providing a new permanent feed via the existing switching circuit or where this is not possible to supply additional emergency lighting. Cost to achieve this improvement I estimate a contractual cost at 1,540 Euros.

4. Voltage returns within distribution boards

Notably within the WHT several distribution boards were found to have voltage back feeds on various circuits, these do present a risk as it would be expected that a distribution board would be dead and have no electrical potential if its incoming supply was isolated, as stated in the previous section some of these return feeds are probably due to the emergency lighting remote feeds but all should be investigated and eliminated.

It is difficult to estimate the effort required for these problems as it will depend on where and how the back feed originates but if an average of three hours is applied for all the 6 areas listed I estimate a contractors cost at 540 Euros.

5. Distribution board connections checks

During the inspection one neutral mains cable was found to have suffered overheating due to a loose connection which in turn produced a high resistance. The recommendation for tightening and checking the electrical connections, although the most simplest and cheapest, is **probably one of the most important that we should carry out**, I suggest this is included as part of our maintenance procedures as a two yearly task. A full check should be carried out initially which could be carried out either in house or at an estimated contractors cost of around 780 Euros.

6. Mains Supply earth and neutral bonding

Even though the earth fault loop impedance tests were very low (around 1.5 Ohms) and well below the maximum permitted level. The report recommends that earth and neutral cable are connected together. This connection can be made within our distribution room. It will require the site to run on generators while the connection is made, but can be carried out in house at little cost. Its benefits will ensure a low resistance fault path for all our installations and circuits even if the existing low earth impedance increases.

7. Miscellaneous Items

The report also includes some recommendations to improve the standard of our installations. They include the repairing of existing emergency lights in the INT car work shop, the replacement of a faulty lamp and cable removal from the aluminising distribution panel. Some of these recommendations have been carried out, while the remaining are scheduled for repair.

8. Documentation

Bureau Veritas have requested copies of the following documents

Projects for our installations with dates and information of the:-

Installed Power

Contracted Power

Schematic drawings of protection devices, cable sizes

From the director of works

Address, post code and official school from which they belong

Membership number (College ID Number)

Telephone and Fax number

From the Installation Company

Low voltage directives

Company tax code (CIF)

Telephone number

Authorisation (Boletin)

DNI of the authorised installer

I have been unable to locate the official projects on site or at our sea level office and suspect that these works were most probably organised by the I.A.C. during the construction of the telescopes and so hopefully in their possession. The only project and (Boletin) found at the SLO office, is that of the generators and oil storage tank.

As for the director of works information, I presume that would be Freeman Fox whose details I have seen on technical information on site.

My main concern regarding the documentation is that we won't be able to locate a particular note or drawing and considering the local bureaucracy demands for official paperwork, even if we undertake all the physical improvements we may still not be provided, with the certification for our electrical installations.

Summary

To carry out the recommendations of Bureau Veritas would cost in the region of 26,207.36 Euros this doesn't take into account the down time and disruption of telescope time nor the ING hours neccsacery in liaising and planning the contractual work to achieve it. I honestly believe these works won't provide a safer working environment at the ING telescopes for either personal or equipment.

After carefully consideration, I believe the improvements listed below which will produce a reduction of risk and be of an improvement would cost in the region of 3000 Euros.

1. Change the existing white cables in the generator distribution board to blue, by the actual cable replacement or heat shrink covers. Estimated work time in house at three days, materials cost negligible as we have items on site
2. Correction of the emergency lighting distribution, provision of new feeds and additional lighting and the removal of electrical back feeds in the WHT. Estimated cost of contractors 2,080 Euros probable one weeks work with close requirement of in house supervision.
3. Distribution connection checks of all distribution boards, estimated at one weeks work with ING supervision at around 780 Euros.

Safety is and should always be our highest concern in respect to our work and individual responsibilities, but in recent years it's almost been manipulated in to a fear factor, and companies can pay considerably for certification which in itself demands more than what already is safe system.

Alan Chopping

23/01/08