Abstract: The interference by ambient 50 Hz magnetic fields on computer monitors or VDUs is an issue which has become prominent in recent times due to the widespread use of personal computers. Various options exist to resolve the interference problem by dealing either with the VDU or with the magnetic field sources including the selection of suitable locations or types of monitor, shielding or modification of equipment. For new installations, appropriate design and installation practices adopted at the outset can reduce or eliminate subsequent costly modifications.

INTRODUCTION

The effects of external 50 Hz magnetic fields generated by electric currents on cathode-ray-tube (CRT) based computer monitors or Video Display Units (VDU) are visually seen as jitter or distortion of the display on VDU screen. In commercial and industrial buildings and occasionally residences the magnetic flux density (MFD) sources often come from equipment associated with internal substations, main electrical switchboards, heavy-current cables and external power lines. Depending on the type of VDU and the ambient field spatial characteristics, a MFD with a relatively low magnitude of about 1μT (10 mG) can interfere with the visual display.

In recent years, there has been an increased use of computing facilities and personal computers in many places in office buildings including in areas near MFD sources that were not obvious to building occupants. The usage of VDU near MFD sources results in many customer or employee complaints relating to the poor readability of VDU, and in some instances this leads concerns about human health effects of magnetic fields.

This paper describes the various magnetic field management measures and techniques that have been developed to reduce or eliminate VDU interference caused by electrical facilities. The options, generally in order of increasing technical complexity and cost include: Characterisation of magnetic field sources and relocation of VDU to desirable locations; Selection of VDU type; Provision of field cancellation or shielding for individual VDU; and Shielding or re-design of major contributing elements of the magnetic field sources. For new electrical installations including overhead lines, magnetic field design considerations can be incorporated at an early stage to minimise the ambient magnetic fields -for VDU interference mitigation purposes [1,2]. Several major VDU mitigation case studies are discussed in the paper to present various aspects of the management of magnetic field environments associated with indoor substations and electrical facilities.

METHOD

The fundamental part of a VDU that relates to the interference problem discussed in this paper is the electron gun and the magnetic deflection system of the cathode ray tube (CRT) located behind the VDU screen. The CRT produces a beam of electrons directing toward the phosphorous layer of the inner surface of the VDU screen where light is emitted due to the collision of electrons with the phosphorous layer. Under the control of the associated magnetic deflection circuitry, this tiny dot of light scans quickly across the screen horizontally, one line at a time, and moves down vertically until the last line at the bottom of the screen. The process is repeated from the top line down again to refresh the video images on the screen. The typical range of horizontal synchronisation frequencies (scanning or refresh rate) of a VDU is 30 to 50 kHz and is 50 to 90 Hz for the vertical synchronisation frequencies.

Since the electron beam movement is driven by the internal magnetic deflection circuitry and the CRT is not magnetically shielded, external magnetic fields of adequate amplitude can also influence the movement of the CRT electron beam. The frequency-difference between the external competing field and the VDU internal vertical scan field frequency is small (eg 10 to 20 Hz) and is visually detectable as distortion or jitter of the display on the VDU screen. Therefore, modification or alteration of the VDU display mechanism or the characteristics of external magnetic fields can reduce or eliminate the interference, and some of these general solutions are discussed below.

Selection of VDU: Computers that use liquid crystal displays (LCD) do not employ the magnetic deflection method and hence their displays are not subjected to interference by 50 Hz MFD. On the other hand, VDUs that use CRT are susceptible to ambient magnetic fields. In recent years, newer VDU types with larger screen, higher display resolution, etc. have become more susceptible resulting in an increased number of complaints.

Higher Vertical Scan Rate VDU: In some instances, changing of the VDU vertical scan frequency to 80/85 Hz can reduce or eliminate the visual effects of the interference. It was found in our recent preliminary study of 10 users, in which VDU displays were interfered by 50-Hz MFD of 2 to 7 μT (20 to 70 mG), the VDU performance was satisfactory for 90% of the users when the VDU vertical scan rate increased to about 80 Hz.

Relocation of VDU: This option where applicable is one of the simplest approaches in which the affected
VDU is relocated or positioned to minimise interference to a level acceptable to users.

**VDU Shielding Enclosure or Field Cancellation**

Device: An external shielding enclosure made of high permeability material or flexible coils with external controlled currents (active compensating loops) can be fitted externally to a VDU to reduce or cancel the ambient fields, hence reducing the interference to a level visually acceptable to users. During the past few years, over 500 VDU Shielding Enclosures have been used in Australia for VDU interference mitigation. This option has been favourable because of the cost advantage and convenience compared to other mitigation options. However in a small number of cases it has not been used due to excessive MFD levels, large affected areas, high number of VDUs involved or aesthetic reasons.

**Shielding of MFD Sources or Electrical Installation:**

Shielding of MFD sources or their containing room can be used to significantly reduce the MFD level external to the sources [3,4,5]. However, for physically large magnetic field sources such as substation's cables, transformers and switchrooms, this often poses a costly option.

**Relocation/Modification of MFD Sources or Installation:**

This is often the highest cost option for an existing installation. The scope of work and the cost vary considerably depending on the number and types of MFD sources involved and the required field attenuation. Feasibility investigations including cost estimates are necessary when this type of option is selected.

**RESULTS - CASE STUDIES**

In special cases where simpler solutions or options are not adequate, modifications to existing electrical installations need to be carried out to resolve VDU interference problems. Several case studies requiring major modification to the installations are reported in this paper to illustrate the field reduction effects of the case studies.

A large proportion of VDU interference problems we have dealt with was related to indoor distribution substations and heavy-current cables in office buildings. The predominant MFD sources were often the LV cables and busbars connecting substation transformers and switchrooms. Relocation and reconfiguration of the cables or busbars with additional shielding (using low cost laminated transformer steel sheets) where necessary has been an effective option. In a small number of cases the interference problems are associated with distribution lines situated just outside office buildings, especially the office areas on first or second-floor that level with the height of the conductors outside. In the cases where an optional solution to individual VDU is not suitable, replacing the external conductors with aerial bundled conductors (ABC) for the relevant spans has been shown to be an effective option. A summary of the case studies conducted in the last several years is given in Table 1.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Modification</th>
<th>Results &amp; Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case # 1</td>
<td>Relocate cables &amp; Shield</td>
<td>Mitigated / 3 - 20 fold</td>
</tr>
<tr>
<td>Case # 2</td>
<td>Relocate cables</td>
<td>Mitigated / 2 - 10 fold</td>
</tr>
<tr>
<td>Case # 3</td>
<td>Relocate cables</td>
<td>Mitigated / 2 - 10 fold</td>
</tr>
<tr>
<td>Case # 4</td>
<td>Reverse phases</td>
<td>Mitigated / ~ 2 fold</td>
</tr>
<tr>
<td>Case # 5</td>
<td>Replace wires by AB Cables</td>
<td>Mitigated / 4 - 5 fold</td>
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<tr>
<td>Case # 6</td>
<td>Isolate pipe ground current</td>
<td>Mitigated / 10 - 20 fold</td>
</tr>
<tr>
<td>Case # 7</td>
<td>Shield cables</td>
<td>Mitigated / 2 - 6 fold</td>
</tr>
<tr>
<td>Case # 8</td>
<td>Shield cables</td>
<td>Mitigated / 2 - 10 fold</td>
</tr>
</tbody>
</table>

**REFERENCES**