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Technical Workshop on Latest Development of IEE Wiring Regulations BS7671 and Harmonic Standard ER G5/4 (Session 1)

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Harmonic Standard ER G5/4 Engineering Technical Report 122

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- **Joint Harmonics Working Group**
- **Grid Code Review Panel Distribution Code Review Panel**

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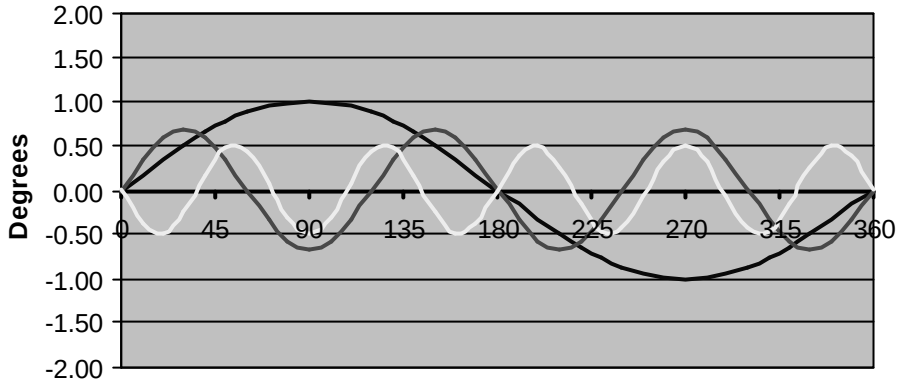
Outline of presentation

- What are harmonics and why do they need controlling?
- The Electromagnetic Compatibility concept
- The IEC 61000 series of standards
- The development of ER G5/4
- Features of G5/4 and the 3-stage process
- Examples of the application of ER G5/4
- Engineering Technical Report 122
- Comparisons with other standards
- Summary

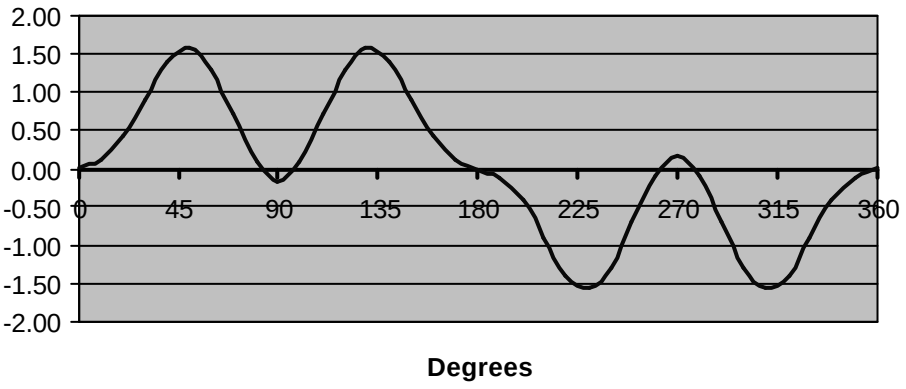
What are harmonics and why do they need controlling?

- They arises because non-linear loads are connected
- Typical non-linear loads are rectifiers, power supplies for electronic equipment, and variable speed motor drives.
- Because of the impedance of the network, the total harmonic current from a number of such loads results in the voltage waveform being distorted as well
- Harmonics are a mathematical representation for the non-sinusoidal current or voltage on a power network

How harmonics make up a distorted waveform



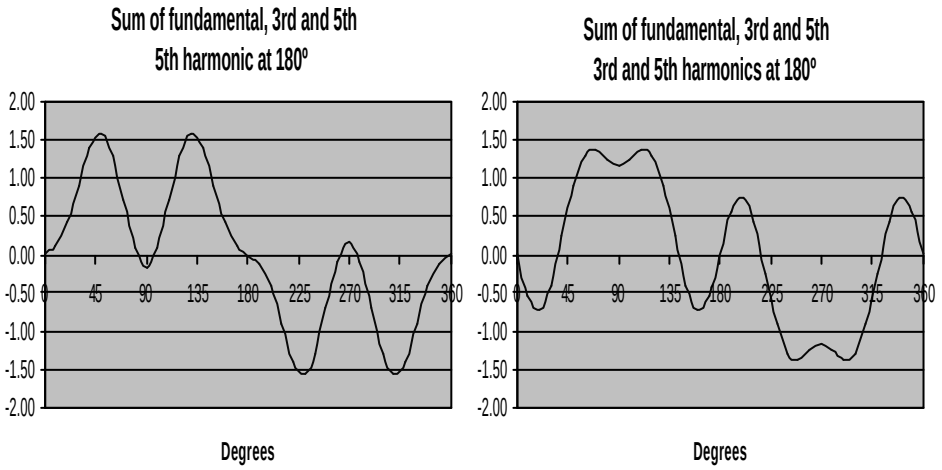
The summated harmonics give a waveform with many zero crossings



The effects of harmonics

- The harmonics add to the rms and peak value of the waveform
- This could mean that equipment could receive a damagingly high peak voltage and could therefore be susceptible to failure
- The waveform and the effects are very dependant on the phase angle. The rms value can be the same but depending on the harmonic phase angles, the peak value can be different

To show the effects, the 3rd harmonic phase angle has been altered by 180º

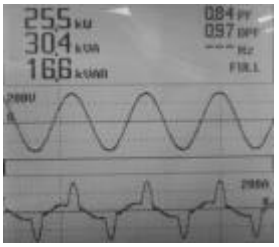


Harmonic current waveforms from various loads

- Various types of harmonic loads have characteristic harmonic contents:

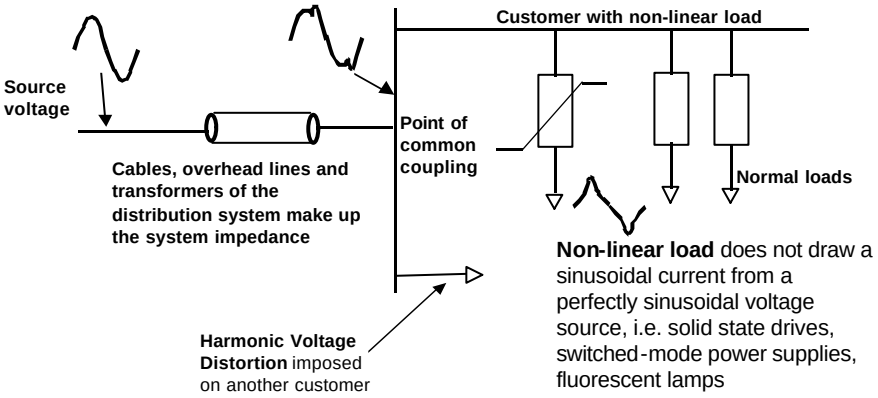
6 pulse converter	22.5%
Rectifier power supply	70.8%
Switched mode power supply	77.2%

A rectifier power supply has this current waveshape when a sinusoidal voltage is applied



Source of Harmonics

Harmonic currents flowing through the system impedance results in **Harmonic Voltage Distortion** at the point of common coupling



Non-linear load does not draw a sinusoidal current from a perfectly sinusoidal voltage source, i.e. solid state drives, switched-mode power supplies, fluorescent lamps

Why do harmonics need controlling?

- Controls are required to ensure that all connected equipment operates correctly
- Since 1970 there has been an exponential increase in the use of electronic equipment in commercial and residential environments
- In particular switched mode power supplies have become extremely common in computers, and home entertainment equipment
- A paper published in Japan shows that there is an increase in equipment failures at a Total Harmonic Distortion (THD) level of 8% and above

Adverse effects

- There are adverse effects from heating, noise, and reduced life on:
  - capacitors and surge suppressors
  - rotating machines
  - cables and transformers
  - MCBs and fuses
  - customers' equipment ranging from telephones to clocks, to interference with radio and television
- Distribution companies are particularly concerned that distribution transformers may need to be de-rated to avoid premature failure

How have they been controlled in the past?

- The damage from excessive levels of harmonics was foreseen and controls introduced - Problems were from 2nd harmonic as a result of half-wave rectifiers in television sets
- British Standard BS5406 (based on IEC 555 part 3) was used to control harmonic emissions from small domestic equipment
- The most well known document is probably ER G5/3, which has also been the basis of standards in some other (mostly Commonwealth) countries
- US standard IEEE 519 has been the basis of standards in some other counties

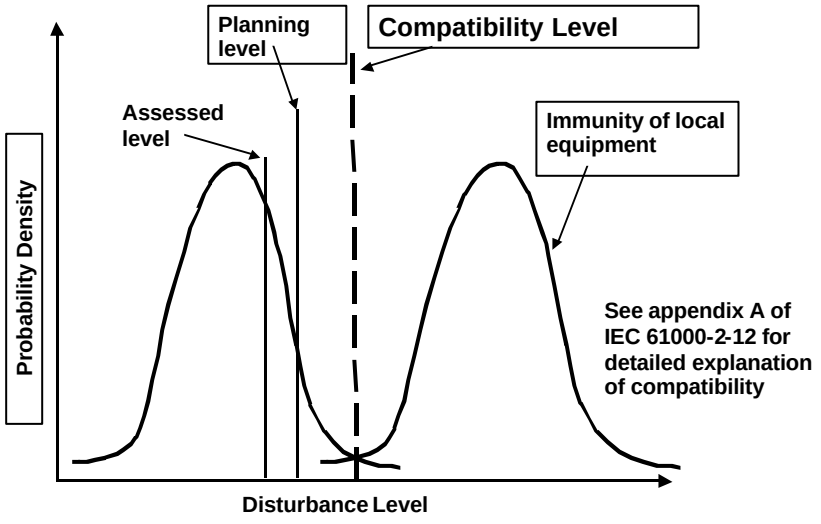
Why revise G5/3?

- The introduction of the concept of Electromagnetic Compatibility and the EU Compatibility Directive
- Developments in the IEC 61000 series of Standards for electromagnetic compatibility (EMC)
- Levels in UK at 132kV and above are higher than the Grid Code allows at a number of locations
- G5/3 didn't include notching and burst harmonics
- There is now better information on network harmonic impedance
- To ensure that harmonic emission standards apply to all industrial or commercial equipment

The Electromagnetic Compatibility concept

- Satisfactory operation of electricity supply systems and users' equipment is only obtained where electromagnetic compatibility between them exists
- Emission limits thereby help fulfil this objective
- But, just as important is the immunity of equipment to harmonics present on the supply
- There is a level between the emission levels and the immunity levels where there is a low probability that equipment will mal-function

Compatibility in diagrammatic form



Electromagnetic Compatibility (EMC) IEC 61000 series of standards

- IEC 61000 Contains 6 parts each with standards and technical reports
- Part 1 - General - 2 documents cover application and interpretation aspects of EMC
- Part 2 - Environment - 10 documents covering classification of the electromagnetic environment and compatibility levels for different environments
- Part 3 - Limits - 8 documents covering emission limits for harmonics and other disturbances

- Part 4 - Testing and measurement techniques - 21 documents describing standard methods for testing equipment for emission of and immunity to the different disturbances
- Part 5 - Installation and mitigation guidelines - 6 documents covering this field
- Part 6 - Generic standards - 4 documents covering immunity and emission standards for residential, commercial, industrial and power station environments

Harmonic aspects in the IEC 61000-2 Environment series of standards

- IEC 61000-2-2 - Harmonic compatibility levels for public lv systems are included
- IEC 61000-2-4 - Harmonic compatibility levels in industrial plant are included
- IEC 61000-2-12 - Harmonic compatibility levels for public mv systems are included (in preparation)

Harmonic aspects in the IEC 61000-3 Limits series of standards

- IEC 61000-3-2 - Harmonic current emission limits for equipment connected at lv and < 16 A per phase (Currently 3rd edition is being prepared)
- IEC 61000-3-4 - Harmonic current emission limits for equipment connected at lv > 16 A per phase (to be replaced soon by IEC 61000-3-12 - Harmonic current emission limits for equipment connected at lv < 75 A per phase)
- IEC 61000-3-6 - Assessment of emission limits for distorting loads in MV and HV power systems

Harmonic aspects in the IEC 61000-4 Testing and Measurement series of standards

- IEC 61000-4-7 - Guide for harmonic and interharmonic measurements and instrumentation (to be replaced by the 2nd edition in due course)
- IEC 61000-4-30 - Power quality measurement methods (New standard in preparation)

- See IEC web site for latest information www.iec.ch

The Harmonics Working Group

- Joint Harmonics Working Group of the Grid Code and Distribution Code Review Panels was set-up with representation from generators, grid and distribution companies, connected parties and manufacturers trade associations (BEAMA and GAMBICA)
- We carried out a users' survey and review, and recommended that G5/3 be revised
- The outcome is Engineering Recommendation G5/4 and the Application Guide ETR122 which is to be referenced in the Grid and Distribution Codes

The purpose of ER G5/4

- The new standard G5/4, published in March 2001, seeks to limit harmonic voltage distortion levels on public networks at the time of connection of new non-linear loads to ensure compatibility of all connected equipment
- It does this by seeking data from the customer and then making an assessment to see whether the planning limits are likely to be exceeded at the time of connection
- The enforcement of this is via the Electricity Supply Regulations, the Grid and Distribution Codes, and the connection agreements between NOCs and customers

Features of G5/4

- G5/4 defines planning levels and introduces compatibility levels for individual harmonics and THD over the voltage range from 400v to 400kV
- Emphasis placed on voltage distortion levels in Stage 2 and 3 assessment (compared with other standards)
- The three stage assessment process of G5/3 retained
- Information on harmonic impedances for use in network modelling has been updated
- Description material and examples moved to the Application Guide ETR 122

- Uses IEC standards wherever possible
- Introduces specific emission requirements for numbers or aggregated lv equipment
- THD assessment required up to 50th harmonic
- 5th harmonic current emissions levels reduced
- Harmonic combination rules clarified to account for harmonic phase angles likely to be
- Harmonic emissions modifiable relative to fault level
- Introduces a flow chart to help users through the assessment process

Differences between Compatibility levels and Planning levels

- Compatibility levels given in IEC 61000-2-2 and 61000-2-12, for 400V and 6.6kV to 33kV systems are based on the immunity of capacitors as they are susceptible to harmonic voltage distortion and are in common use
- The margins between planning levels and the compatibility levels vary with voltage level and range from 3% at lv and 5% at mv to 0.5% at ehv.
- These margins are necessary to make allowance for system resonance and for loads connected where there is no consent required from the DNO.

Gaps between compatibility levels and planning levels - ER G5/4 for THD harmonic level

Voltage Level	Compatibility Level	Planning Level
400v	8%	5%
6.6kV to 20 kV	8%	4%
>20kV to 36.5kV	8%	3%
66kV to <145kV	5%	3%
275kV and 400kV	3.5%	3%

The 3-Stage assessment process

- The assessment procedure for non-linear load follows three stages
- The objective of this three stage approach is to balance the degree of detail required by the assessment process with the degree of risk that the connection of the particular load will result in unacceptable harmonic voltage levels occurring on the supply system if it is connected without any mitigation measures

The 3 Stages

- Stage 1 - Lv connected equipment
  - Single item of equipment that meets IEC standards
  - Larger or aggregated equipment needs to meet defined lv harmonic current emissions (Table 7)
- Stage 2 - Larger lv equipment not meeting Stage 1 or mv equipment connected at <33kV
  - mv equipment connected at less than 33kV that meets defined mv harmonic current emissions (Table 12)
  - lv and other mv equipment are assessed using a simplified impedance model
- Stage 3 - equipment connected at mv or higher where a full harmonic impedance model must be used

Stage 1

- Applies only to lv connected loads
- Converter equipment that met ER G5/3 sizes can be connected without assessment
- Other equipment requires reference to IEC documents:
  - IEC 61000-3-2 emissions from lv connected equipment <16A
  - IEC 61000-3-4 emissions from lv connected equipment >16A (to be 61000-3-12)
  - Technical Report IEC 61000-3-6 can be used for advice on combination rules

Aggregate loads

- G5/4 requires that aggregate non-linear loads be considered
  - An individual non-linear equipment complying with 61000-3-2 can be connected without consideration
  - Groups of non-linear equipment with aggregate rated current <16A and each complying can be connected
  - For aggregate rated current>16A, either 61000-3-4 or 61000-3-6 should be used to assess emissions using diversity rules from 61000-3-6 if necessary

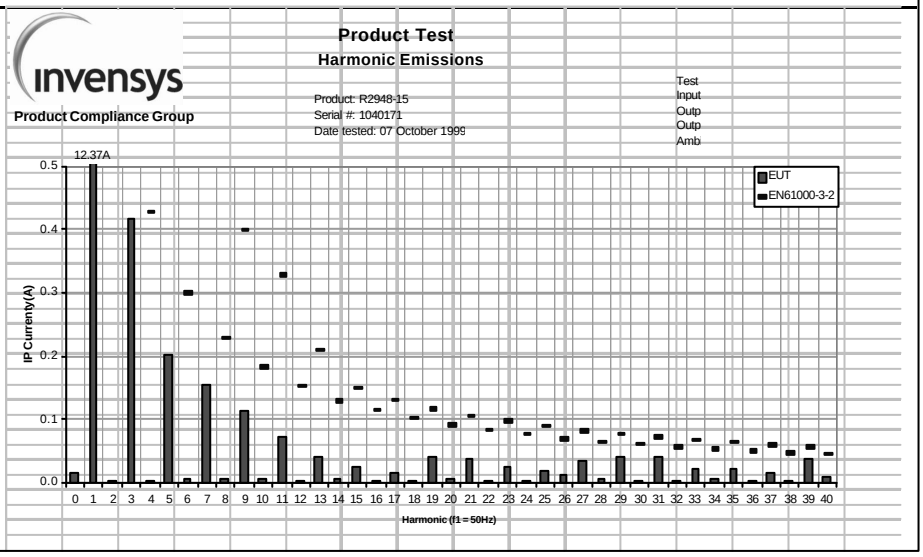
Example of application - the problem

- Connection of communication centre equipment
  - 15 off rectifier equipment type R2948-15
  - each equipment is rated at 12.37A
  - each equipment meets EN 61000-3-2
  - the connection will be at lv and single phase
  - future expansion expected to 30 units
  - existing levels less than 75% of planning limits
- Can they be connected?

The solution

- The customer says that no data on emissions is available. However, data will be available - the equipment would not be able to claim EN 61000-3-2 compliance otherwise
- Data was obtained by e-mailing the New Zealand manufacturer
- Simplified calculations were carried out on a spreadsheet to check compliance

Product data sheet



The calculations

- As a first estimate the current emissions are multiplied by the number of units, and the result compared with the values in Table 7 of G5/4. This shows that there is no problem
- The spreadsheet calculations would show that the future increase to 30 units would give values of emissions greater than the limits for triplens above 21st

Table 7: Stage 1 Maximum Permissible Harmonic Current Emissions in Amperes RMS for Aggregate Loads and Equipment Rated >16A per phase

Harmonic order 'h'	Emission current I_h	Harmonic order 'h'	Emission current I_h	Harmonic order 'h'	Emission current I_h	Harmonic order 'h'	Emission current I_h
2	28.9	15	1.4	28	1.0	41	1.8
3	48.1	16	1.8	29	3.1	42	0.3
4	9.0	17	13.6	30	0.5	43	1.6
5	28.9	18	0.8	31	2.8	44	0.7
6	3.0	19	9.1	32	0.9	45	0.3
7	41.2	20	1.4	33	0.4	46	0.6
8	7.2	21	0.7	34	0.8	47	1.4
9	9.6	22	1.3	35	2.3	48	0.3
10	5.8	23	7.5	36	0.4	49	1.3
11	39.4	24	0.6	37	2.1	50	0.6
12	1.2	25	4.0	38	0.8		
13	27.8	26	1.1	39	0.4		
14	2.1	27	0.5	40	0.7		

Sample spreadsheet

Harmonic number	Emission from EUT	Emissions 15 units	Table 7 emissions	Emissions 30 units
3	0.42	6.3	48.1	12.6
5	0.5	3.1	28.9	6.2
7	0.16	2.3	41.2	4.7
9	0.11	1.65	9.6	3.3
15	.03	0.4	1.4	0.8
21	.035	0.525	0.7	1.05

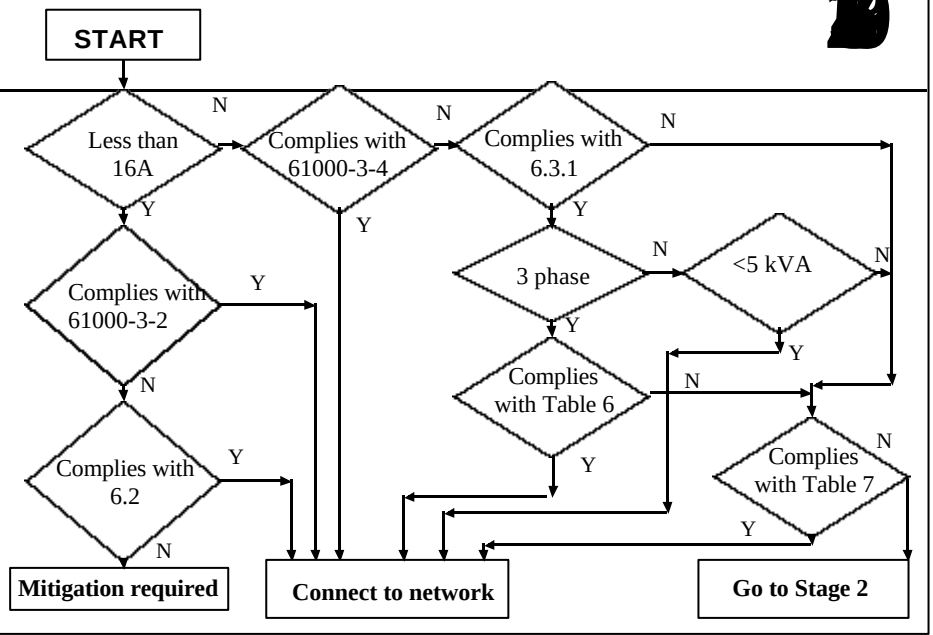
Emissions in Amps

Assessment issues / mitigation measures

- The emission levels given in Table 7 may be modified by reference to relevant fault levels rather than the notional one of 10MVA used to derive the emissions. The levels are directly related to the fault level
- A three phase supply could be used and the loads balanced across the phases. Emissions per phase will then be reduced. Note that there will still be very high levels of triplen harmonics in the neutral conductor as they sum from the three phases rather than cancel out

- Diversity of use between the equipment can be used - are they all in use at the same time? However, in the case of a communications centre with constant load, then diversity considerations may not be applicable
- A Stage 2 assessment will be required if none of these mitigation measures are sufficient
- Generally, there will be a UPS between the rectifier equipment and the public network. UPS equipment has much higher levels of emissions than the rectifiers and usually a Stage 2 connection assessment will be required for such an installation

Example flow chart for lv connection



Harmonic impedance

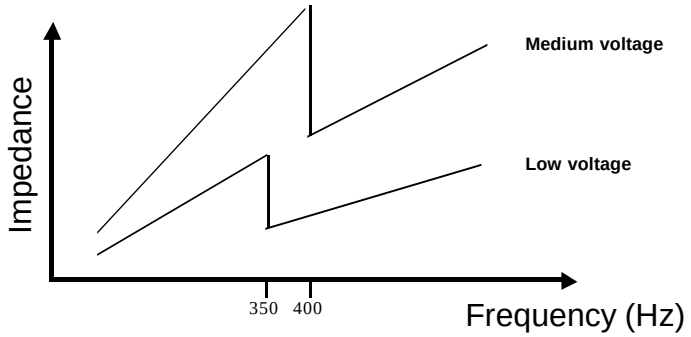
- Network impedance assumed to vary linearly with frequency - The harmonic multiple 'k' varies with frequency as per G5/4 Table 8

$$Z_h = khZ_1$$

Supply system voltage at the PCC	Harmonic order			
	h ≤ 7	h ≤ 8	h > 7	h > 8
400V	1		0.5	
6.6, 11, 20 and 22 kV		2		1

- At final distribution voltages, the network capacitance has a significant effect with the first parallel resonance - being in the 250Hz region

Harmonic Impedance - diagrammatically



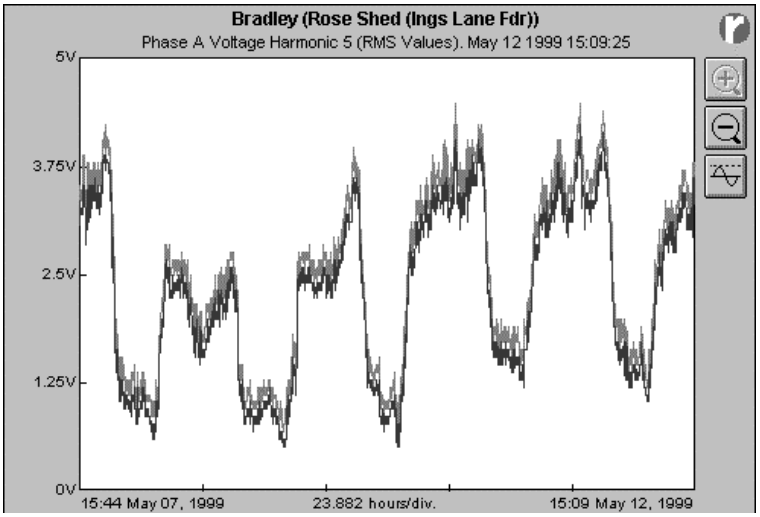
Stage 2

- This applies only to:
  - an lv connected load or aggregate load that doesn't meet Stage 1; i.e. IEC 61000-3-2 and 61000-3-6, or Table 7 current emissions
  - a load with the point of common coupling (PCC) greater than lv and less than 33kV i.e. at 6.6, 11 or 22kV
- Current emissions can be less than Table 12, or a simplified voltage assessment can be used based on the harmonic impedance just described

Measurement

- A new standard for measurement is being developed based on discrete Fourier transform rather than FFT. This will be a new edition of IEC 61000-4-7. In the mean time there are many commercially available instruments of a suitable specification
- Measurements are required over one week minimum
- What value to choose?
- Concept of 95% non-exceedance

Harmonic Measurements



The voltage assessment of the connection of new non-linear equipment under Stage 2:

(a) measure the levels of voltage distortion already existing on the system,

(b) assess the voltage distortion which will be caused by the new equipment, and

(c) predict the possible effect on harmonic voltage levels by an addition of the results of (a) and (b)

- If the results of (c) are less than the harmonic voltage planning levels for the 5th harmonic and the THD, connection of the equipment is acceptable

Formula to assess harmonic voltage emissions

$$v_{hc} = \frac{I_h \, k \, h \sqrt{3} \, V_s 100}{F 10^6} \ \%$$

- I_h = the harmonic current in amperes (RMS) drawn by the new load at the PCC
- V_s = the nominal system line voltage at the PCC in volts
- F = the system short-circuit level at the PCC in MVA.
- h = the harmonic order.
- v_{hc} = the calculated harmonic voltage distortion associated with the new load expressed as a percentage of the phase voltage at the PCC
- k = the harmonic impedance factor

Stage 3

- This only applies at 33kV and above
- It is expected that a computer based modelling package is used to carry out the calculation of harmonic emissions
- The rules for the addition of the background to the calculated values is the same as for Stage 2, but the assessment is slightly different

The voltage assessment of the connection of new non-linear equipment under Stage 3:

(a) measure the levels of disturbance already existing on the system,

(b) calculate the disturbance that will be caused by the new equipment, and

(c) predict the possible effect on the disturbance levels by an addition of the results of (a) and (b)

- If the results of (c) are less than the harmonic voltage planning levels for all individual harmonic orders and the THD, connection of the equipment is acceptable

Addition rules

- for harmonics up to the 5th and for all triplens, the measured and calculated values of voltage distortion are assumed to peak at the same time and to be in phase - linear addition is used - phase angles are the same
- for the other harmonics, an average phase difference of 90° is assumed at the time of maximum THD - rms addition is used
- The THD is then given by the rms sum of all harmonics up to the 50th

The Application Guide

- A number of different examples of the applications of the flow chart, the network impedance models, and the combinations rules are given in the Application Guide ETR 122
- ETR 122 is currently in the final stages of preparation since being circulated for comments to members of the Working Group and EA members
- Expected publication date late 2001

Summary of the main features of ER G5/4

- Compatibility and planning levels defined for all voltages from 400v to 400kV - fills gaps in Standards for >33kV
- Three stage procedure retained from G5/3 with flow chart to assist in its practical application
- IEC Standards used whenever possible at lower voltages. IEC Technical Reports used as the basis at higher voltages
- Aggregation of individual loads clarified

- Harmonic assessment up to 50th required
- Levels above 25th indicative until 2005
- When there is no standard for lv equipment, Stage 1 (or 2) emission assessment will apply
- Emissions limits for 5th harmonic reduced compared with G5/3; emissions limits for 11th and 13th increased, but lower levels for harmonic orders above this
- Burst harmonics and notching now included

What is BS EN 60150?

- This is a product quality standard for lv and mv
- In general, in the UK, the standard is exceeded
- It does, however, give some guidance on measurements which can be used to interpret the Electricity Supply Regulations
- Many DNOs will consider that if the quality meets this standard, then no remedial measures are required by the DNO if there has been a complaint
- As a quality standard, it is not surprising that the levels are very similar to the compatibility levels

Enforcement

- The enforcement of emission limits is via
  - Electricity Supply Regulations
  - Grid and Distribution Codes
  - connection agreements between NOCs and customers
- It is importance to ensure that the customer and the NOC have a shared understanding of the issues and any mitigation measures that may be required.
- Retro-fitting mitigation measures is likely to be expensive and cause disruption to production schedules and is not recommended

Future connection practice

- In the past we have allowed connection on the understanding that measurements are made and that mitigation measured will be put into place later
- This is not a good way to proceed in that it is difficult to make the conditions stick after energisation of the connection - disputes about measurement and delaying tactics have been experienced. We do not always make the necessary measurements and assessments

The preferred process for lv connections

- Assess application at very early stage for possible disturbing loads
- Request harmonic data for the equipment and carry out a very simple assessment (no data = hv connection?)
- If needed, carry out background measurements and a Stage 1 or Stage 2 assessment
- Determine any mitigation measures and ensure that they are enforceable - preferably installed before connection made live
- Complete project with measurements after connection

The preferred process for hv connections

- Assess application at very early stage for possible disturbing loads
- Request harmonic data for the equipment and carry out a very simple assessment (no data = no connection?)
- Carry out background measurements and the Stage 2 (or Stage 3 assessment for 33kV connection)
- Determine any mitigation measures and ensure that they are enforceable - preferably installed before connection made live
- Complete project with measurements after connection

Comparison with other Standards

CLP Power Supply Rules

Rated current "I" at 380/220V	Max. total odd harmonics Current emissions
I < 30A	20%
30A ≤ I < 300A	15%
300A ≤ I < 600A	12%
600A ≤ I < 1500A	8%
I ≥ 1500A	5%

Total even harmonic distortion: 25% of the odd harmonic limits

Different emphasis for other standards

- The differences in the standards relate to dividing the acceptable disturbance fairly between customers
  - on the basis of load as protection of fault level
  - on the basis of customer's load as proportion of total capacity at the PCC
  - divided between a small number of customers

Derivation of Tables 7 and 12 of G5/4

Emission Limits for LV systems kV				0.4		Emission Limits for systems kV				11.0
	rms calc based on 4 loads					rms calc based on adding load to 75% existing				
	Reference fault level of MVA			10.0			Reference fault level of MVA			100.0
Harmonic	Vpl %	k factor	I lin add	I rms add		Harmonic	Vpl %	k factor	I lin add	I rms add
2	1.6	1	28.9			2	1.5	2	4.9	
3	4	1	48.1			3	3	2	6.6	
4	1	1	9.0			4	1	2	1.6	
5	4	1	28.9			5	3	2	3.9	
6	0.5	1	3.0			6	0.5	2	0.5	
7	4	1		41.2		7	3	2		7.4
8	0.4	0.5		7.2		8	0.4	2		0.9
9	1.2	0.5	9.6			9	1.2	1	1.7	
10	0.4	0.5		5.8		10	0.4	1		1.4
11	3	0.5		39.4		11	2	1		6.3
12	0.2	0.5	1.2			12	0.2	1	0.2	
13	2.5	0.5		27.8		13	2	1		5.3

G5/4 AND IEE 519 Voltage harmonic planning level comparison

Voltage Level	G5/4		IEE 519	
	Indiv 5& 7	THD	Indiv	THD
400v	4.0	5.0	3.0	5.0
6.6kV,11kV and 20kV	3.0	4.0	3.0	5.0
33kV to 69kV	2.0	3.0	3.0	5.0
69kV to 161kV	2.0	3.0	1.5	2.5
161kV and above	2/1.5	3.0	1.0	1.5

Summary

- I have described harmonics and why they need controlling
- Explained the Electromagnetic Compatibility concept
- Described the IEC 61000 series of standards
- Covered limitations of G5/3 and development of ER G5/4
- Described the main features of G5/4
- Looked in detail at the 3-stage assessment process
- Given an example and pointed to ETR122
- Briefly compared G5/4 with other standards
- Questions?

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Technical Workshop on Latest Development of IEE Wiring Regulations BS7671 and Harmonic Standard ER G5/4 (Session 2)

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Session 2 contents

- Latest Development of BS7671
- What's new in the 2001 issue
- New harmonised sections
- How does the changes affect the appendices
- Date when the 2001 edition comes into effect
- A brief look at some of the changes
- Where can we find useful information on BS7671:2001
- What's lie ahead of BS7671
- ????
- Questions Session

BS7671:2001

Requirements for Electrical Installations

IEE Wiring Regulations Sixteenth Edition

Background (1)

The Purpose of the BS7671 IEE Wiring Regulations is to be used as a UK National Code of Practice in the design, construction, testing and inspection of low voltage electrical systems in general. E.g.,

Buildings

Street located electrical equipment

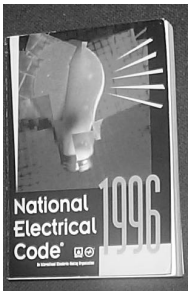
Marinas

Fish farms and etc

Slide 3

Background (2)

It is similar to the National Electrical Code (NEC) of America, COP of Electrical (Wiring) Regulations of Hong Kong SAR, Low Voltage Electrical Rules of France



Slide 4

Background (3)

It is non-statutory but compliance with the BS7671 (IEE Wiring Regulations) is deemed to satisfy the legislative requirements on the 'technical' aspects of the electrical system(s) – BS kite-marked products guarantee a good degree of safety

British Standards Institution (BSI)

Slide 5

Structure of COP of other countries

- The American's National Electrical Code (NEC) has a similar numbering sequence. E.g., Code 210-23 can be found in Chapter 2, Article 210 and it is code 23 of the Article. However, the NEC is more prescriptive than the BS7671
- The HKSAR COP uses a Code numbering system. E.g., Code 13A(3)(a)(v) gives the requirements for voltage drop of circuits

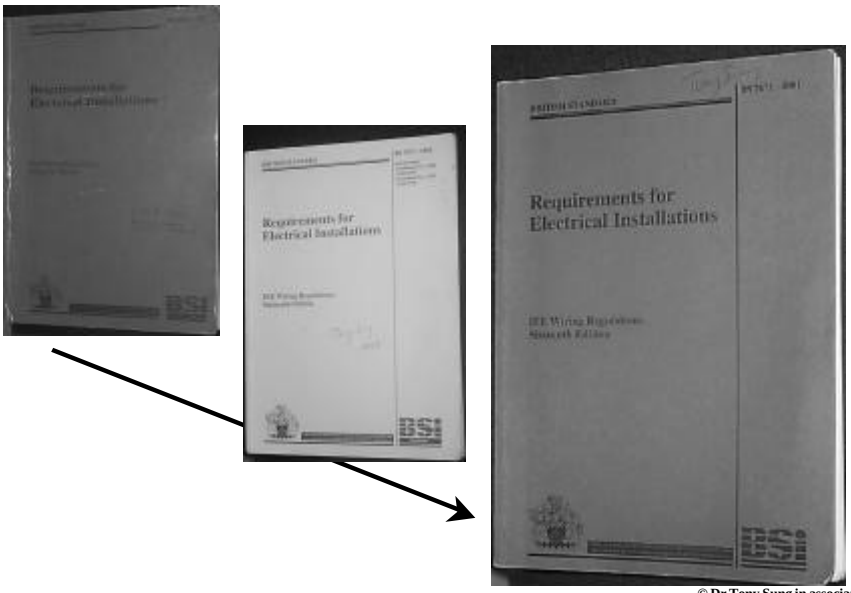
Slide 6

IEE Wiring Regulations

1. 14th Edition – issued 1966
2. 15th Edition – issued 1981
3. 15th Edition of IEE Wiring Regulations took account of technical substance of agreements reached in CENELEC so that the technical intent of relevant CENELEC Harmonization Documents were included (6 amendments - 1988)
4. 16th Edition – issued 1991
5. BS7671:1992 – issued in October 1992 (3 amendments April 2000)
6. BS7671:2001 – issued in June 2001, next amendment due in December 2001

Slide 7

BS7671 Versions



Slide 8

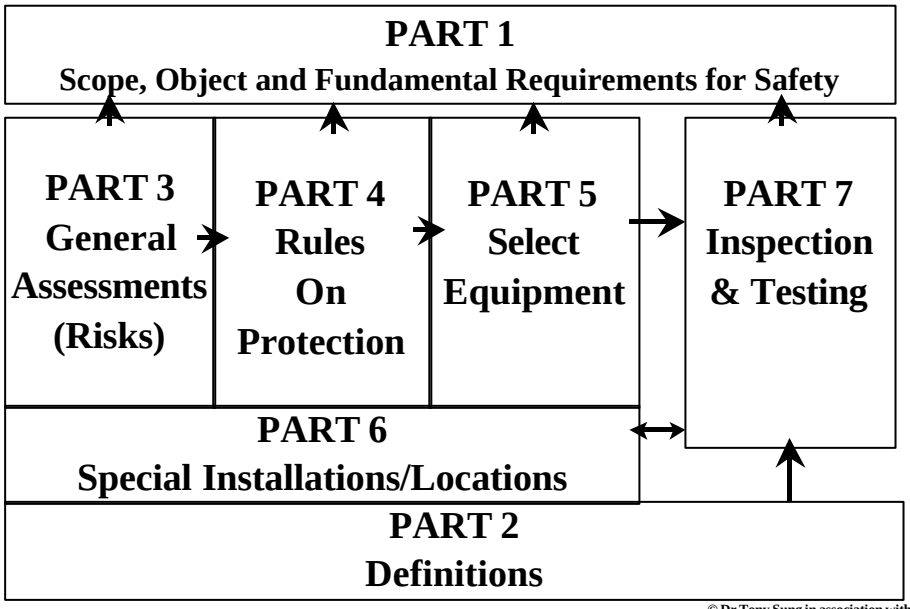
Purpose of BS7671

1. It is intended to be used by professional engineers and technician engineers who are able to apply the COP correctly and in competence (CPD course in BS7671)
2. It is not intended to be used as a design specification nor an instruction manual for untrained persons
3. It comprises of 7 parts and 6 appendices

It is being used by many countries as an additional 'Good Practice Guide' to designing, installing and maintaining safe electrical installations

Slide 9

How to use BS7671



Slide 10

Structure of BS7671

It is based on the plan agreed internationally (European Community) for the arrangement of safety rules for electrical installations

- The sequence of activities should following the plan
- The numbering system is Part-Chapter-Section-group-number. E.g., 460-01-02 is the regulation requiring all installation to have a means of isolating the incoming supply at the origin (intake point) of the installation.
- The regulation can be found in Part 4, Chapter 46, section 460, group 460-01 and it is the second regulation in the group.

Introduction to 2001 Issue

Changes necessary to maintain technical alignment with CENELEC Harmonisation Documents, including:

- An expanded Part 1
- Section 443 added
- Section 482 added
- Amendments to Chapter 43, Chapter 46, Section 604 and Section 611
- (Changes of a national origin) a revision of Section 607

New Harmonised Sections

HD 384.1	**Scope, Object & Fundamental Principles**	**Part 1**
HD 384.2	**Definitions**	**Part 2**
HD 384.4.43	**Protection against Overcurrent**	**Part 4, Chapter 43**
HD 384.4.443	**Protection against Overvoltages of Atmospheric origin or due to switching**	**Part 4, Section 443**
HD 384.4.46	**Isolation & Switching**	**Part 4, Chapter 46**
HD 384.4.482	**Protection against Fire where particular risks or danger exists**	**Part 4, Section 482**
HD 384.5.52	**Wiring Systems**	**Part 5, Chapter 52 & Appendix 4**
HD 384.5.537	**Switchgear & Controlgear, devices for Isolation & Switching**	**Part 5, Section 537**
HD 384.7.704	**Construction & Demolition Site Installations**	**Part 6, Section 604**
HD 384.7.714	**Outdoor Lighting Installations**	**Part 6, Section 611**

Appendices

Changes necessary to maintain technical alignment with latest update, including:

- Appendix 1 – Standards (BS EN & IEC)
- Appendix 2 – Legislations (national)
- Appendix 3 – Time/Current Characteristics of Overcurrent Protective Devices (national)
- Appendix 4 – Preface & current rating tables, etc. (national)
- Appendix 5 – ‘AM’ code (IEC 60364-3: Amd No: 2 1995)
- Appendix 6 – Forms (national)

Effective date(s)

- Following a full review, the 2001 issue replaces the 1992 as amended issue.
- The 2001 issue is published on 1st June 2001 and comes into effect on 1st January 2002.
- Installations designed after 1st of January 2002 should comply with the 2001 edition.
- However, designers and installers may work to this issue prior to 1st January 2002

Slide 15

Part 1, Part 2 & Part 3

- 30 Regulations replaced by 52 Regulations (alignment with CENELEC).
- 162 Definitions in 1992 edition and 165 definitions in the 2001 edition.
- Regulation 331-01-01 revised to include the requirements for carrying out assessments for new sections

Slide 16

Definitions

- "Consumer Unit" amended with the word 'miniature' removed from 'miniature circuit breakers'
- "Earth Leakage Current" deleted but with a new definition "Leakage Current" being added
- "Fuse" amended with the word 'fusing' replaced with 'melting'
- "Hazardous-live-part" deleted
- "Mobile & offshore installations" added
- "Protective Conductor Current" added
- "Residual current" revised

Part 4

- Tables 41B2 and 41C deleted the Z_S and Z_{cpc} values of Type 1, 2 & 3 mcbs (no longer available in the EC)
- Regulation 434-04 on requirements for protection of conductors in parallel against overcurrents deleted (moved to 473-01 and 473-02)
- Chapter 44 Protection against overvoltage and Chapter 48 Choice of Protective Measures as a function of External Influences have been added

EC = European Community

Part 5 and Part 6

- Several regulations within Chapter 52 Selection and Erection of Wiring Systems and Section 537 Isolation and Switching Devices amended
- Section 607 Earthing Requirements for the installation of equipment having high protective conductor currents and Section 611 Installation of Highway Power Supplies, Street Furniture and Street Located Equipment revised extensively

Part 7

- Chapter 73 Periodic Inspection & Testing revised
- Chapter 74 Certification and Reporting revised extensively

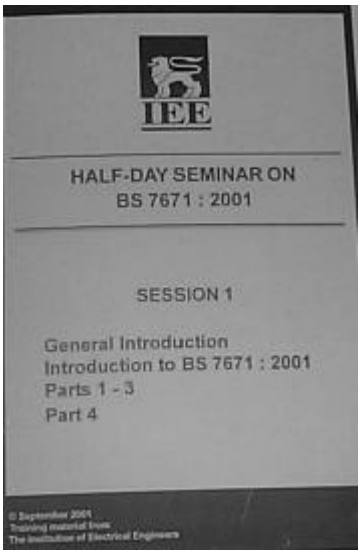
Appendices

- Appendix 3 – Type 1, 2 and 3 mcbs time-current characteristics deleted
- Table 4A2 Schedule of appropriate current rating tables added
- The BSI is revising the cable standards, pvc insulated cables will be called thermoplastic insulated cables and EPR, CSP or XLPE will now be classified as thermosetting insulation.
- Current rating tables stop referring to a particular BS

Information on BS7671:2001

- IEE web Site – http://www.iee.org.uk (login to Building Electrical Technology Professional Network - BETNET)
- CIBSE Electrical Services Group web site – http://www.cibse.org or http://www.geocities.com/sung_tony
- HKIE web site – link to BS and Special Power Divisions where appropriate
- Short courses run by IEE HK or CIBSE HK
- Short courses run by your local universities or a UK university such as UMIST

IEE Short Courses on BS7671:2001



Slide 23

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- ***Assessments***
- ***Maximum Demand & Diversity***
- ***Earthing & Bonding***
- Overvoltages due to lightning and switching
- Harmonic distortion imposed onto the supply network as well as its harmful effect within the installation – corrective action(s) may be needed
- High Protective conductor current may necessitate a duplicate high integrity circuit-protective-conductor
- Mandatory supplementary bonding in particular locations

Slide 24

Local supplementary bonding(1)

Regulations 413-02-04, 413-02-07, 08, 471-08-01, 547-03:

- **Purpose of bonding is to eliminate the presence of touch voltages among simultaneous-accessible-parts**
- **For the appearance of any touch voltage as a result of a fault – designers/installers should coordinate the use of the circuit-protective-device and Z_{cpc} to facilitate rapid disconnection and safe touch voltage value – consider local supplementary bonding between exposed-conductive-parts and extraneous-conductive-parts/exposed-conductive-parts only where specified in Part 6 and when automatic disconnection to protect against electric shock for the assessed equipment/location/body resistance cannot be met.**

Local supplementary bonding(2)

It shall be the responsibility of Designers and/or installers to ensure that local supplementary bonding does not create other risks such as:

(i) Flash-over due to indiscriminate local supplementary bonding

(ii) high touch voltage due to flash-over

(iii) the damaging of IT/data equipment due to lightning current entering the local supplementary bonding conductors

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- ***Cable sizing (harmonic contents must be considered where appropriate)***
- ***Protection against overcurrents***
- Reduced neutrals are ruled out normally (Regulations 524-02)
- Cables are needed to be sized basing on the neutral current rather than the line current (Regulations 473-03-04 & 05)

?

- ***Protection against electric shock, overvoltage, undervoltage, thermal effect, Isolation & Switching***
- Equipment to have impulse withstand ability for protection against overvoltage and/or surge protection devices to be considered
- Type 1, 2 and 3 mcbs are obsolete – maintenance issues
- Tables 41B2, 41C and 41D include RCBO as standard devices
- Cable standards are being revised
- For TN-S and TNC-S systems, except for household and domestic installations, neutral need not be broken at the main switch

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- ***Selection & erection of equipment***
- ***Special installations & Particular locations***
- Cables standards are being revised
- BS7671 recognises Band I and Band II circuits, Cat I, II and III circuits are no longer included
- IT equipment has special requirements
- The product of 'residual current x Z_{cpc}' remains to be no greater than 50V or 25V where applicable, but as long as the total residual current does not cause nuisance tripping, the 25% limit has been removed

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- ***Inspection & Testing***
- New inspection & testing schedules, certification have been given

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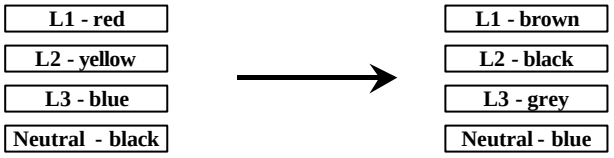
Change of Cable colour codes – it will have significant implications on many problems to be faced by facilities managers/engineers:

New built design, Alteration and additions

Maintenance, Spares, Electrical Safety for ordinary and technical persons



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With only a BS number – ***remain as a UK National Code***

With a BS EN number – ***becomes a European Code but care must be exercised in applying the rules taking into considerations of national differences of supply voltage and frequency etc***

Will there be a 17th Edition IEE Wiring Regulations ? – ***remains a possibility but not within the near future***

Thank you for your attention.

We invite you to continue our discussions using the Internet Forum Pages provided by HKIE BS Division and IEE BETNET where appropriate.

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Questions Session