

MV/LV TRANSFORMER

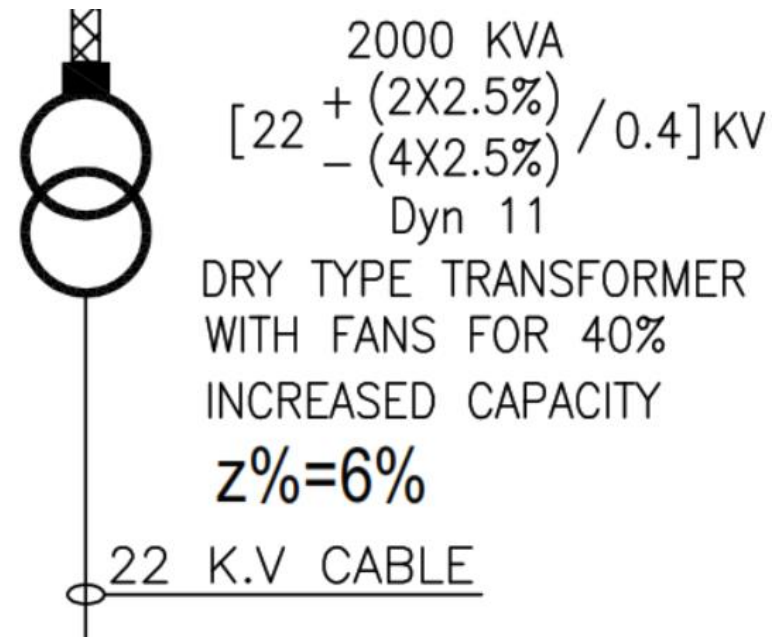


Outlines

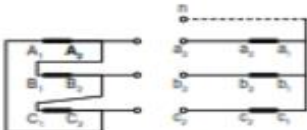
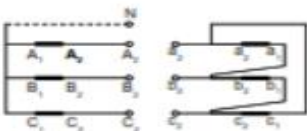
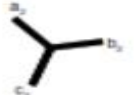
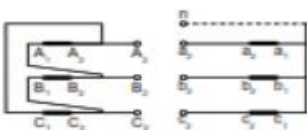
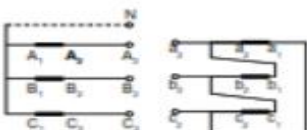
1. Characteristic parameters of a transformer
2. Technology and utilization of the transformers
3. Transformer sizing
4. Space allocation (space program)
5. Room Ventilation

1-Characteristic parameters of a transformer

1. Rated Power
2. Frequency
3. Rated primary voltage
4. Rated secondary voltage
5. Off-load tap-changer
6. Winding configurations



Transformer Vector Groups

Phasor symbols	Terminal markings and phase displacement diagram of induced voltages		Winding connections
	HV winding	LV winding	
Dy1			
Yd1			
Phase displacement = - 30° Clock-hour figure = 1			
Dy11			
Yd11			
Phase displacement = 30° Clock-hour figure = 11			

2-Technology and utilization of the transformers

- Liquid filled (oil-immersed) transformer.
- Dry type (cast resin encapsulated) transformer

Ambient Temperature

The rated power of the transformer is typically calculated for the following conditions:

- maximum ambient temperature of 40°C
- average daily ambient temperature of 30°C
- average annual ambient temperature of 20°C.

Oil Distribution Transformers



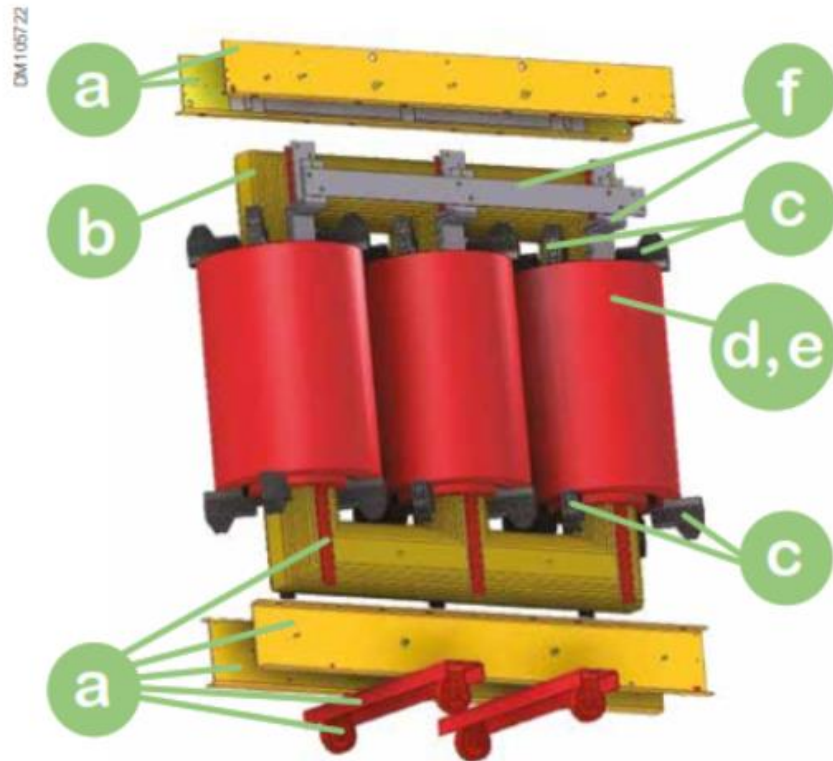
Minera

Technical Characteristics	
Rated power	3.15 MVA
Rated voltage	36 kV
Phases	Three-phase unit
Rated frequency	50 Hz or 60 Hz
Type of cooling	ONAN, ONAF (other on request)
Voltage regulation	Off-circuit tap changer (DETC) or on load tap changer (OLTC)
Other (optional)	Breathing or sealed type, standard or low noise levels, a wide variety of accessories

Oil ----
insulating
& cooling
material

Outdoor
applications

Cast Resin Transformers



Recommendation	Drawing Ref	Components	Weight (in kg)	Comment
Dismantling	a	Steel parts	100~5000	Clampings, rollers
	b	Core	300~25000	Magnetic steel
	c	Plastic parts	30~250	Support wedges
	d	Resin	100~3500	Coil insulation
	e	Conductors	30~5000	Aluminium or copper
	f	Bars	20~100	Aluminium or copper

In Trihal transformers, there is no component which may effect on human health or environmental pollution during dismantling process.

Cast Resin Transformers



Trihal with Enclosure



Technical Characteristics

Rated power	Up to 15 MVA
Rated voltage	Up to 36 kV
Rated frequency	50 Hz or 60 Hz
Type of cooling	AN, AF (other on request)
Other	Thermal protection system
On request	Enclosure, fans, anti-vibration pads, plug-in bushing, monobloc bushing, automatic voltage regulator panel, surge arrestors, etc.



Trihal Dry-Type Transformer

Safety and Reliability

To ensure total compliance with relevant national and international standards, Trihal transformers have been put through the most stringent series of tests. Trihal is one of few transformers having successfully passed these tests and is characterised by the following features:

- C3 – Climate Test – Operation and Storage to -50°C
- E3 – Environment Test – Nearly total condensation or heavy pollution or both
- Abnormal level of humidity up to 95% to IEC 60076-16
- F1 – Fire Behaviour – reduced flammability and self extinguishing
Excellent classification to IEC 60076-11 standard
- ≤ 5pC – Special test for Partial Discharge based on IEC 60076-11;
Tested at 1.3 Un with ≤ 5pC result.

Overloading

Overloading

The rated overloading of transformer depends on the transformer's previous load or the corresponding oil temperature at the beginning of the overloading. Examples of the permissible duration and the respective levels of the acceptable overloadings are shown below.

For example, if the transformer is loaded with 50% of its rated power continuously, then the transformer can be overloaded to 150% of its rated power for 15 minutes or to 120% of its rated power for 90 minutes.

Previous continuous loading	Oil temperature	Duration (min.) of overloading for specific levels of overloading (% of rated power)				
		10% min.	20% min.	30% min.	40% min.	50% min.
50	55	180	90	60	30	15
75	68	120	60	30	15	8
90	78	60	30	15	8	4

Permissible duration and level of acceptable overloading.

3-Transformer sizing

- Does my facility need a transformer ?!!!



elec company regulation (4) 2014.pdf



- As per elec. company: from 450k watts to above

3-Transformer sizing

الدليل الإرشادي لتطبيق الكود المصري لأسس تصميم وشروط تنفيذ
التوصيلات والتركيبات الكهربائية في المباني (المجلد الأول: أعمال التصميم)

يتم تحديد سعة محول التوزيع اللازم لتغذية المنشأة بناءً على أقصى طلب
كهربائي متوقع لهذه المنشأة وذلك طبقاً لما يلي:
سعة المحول = $1,25 \times$ أقصى طلب كهربائي (ك.ف.أ) (بمعنى أن المحول يحمل
فقط بـ ٨٠٪ من سعته)

4- Space allocation



Trihal - Cast Resin Transformer

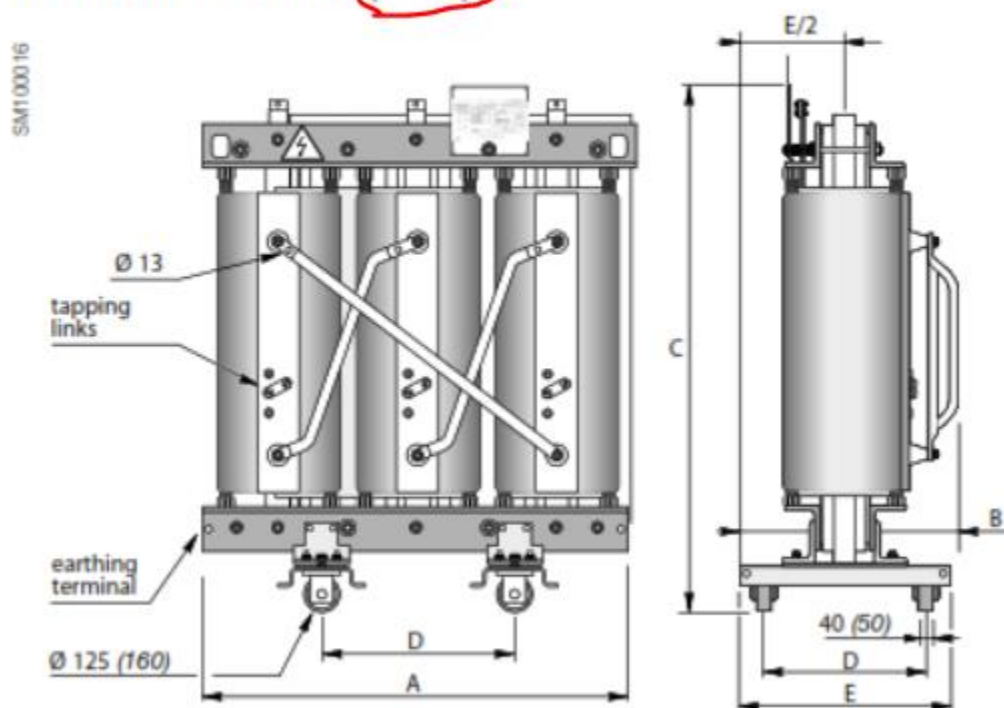
Up to 3150 kVA - 17.5 to 24 kV

Main electrical characteristics

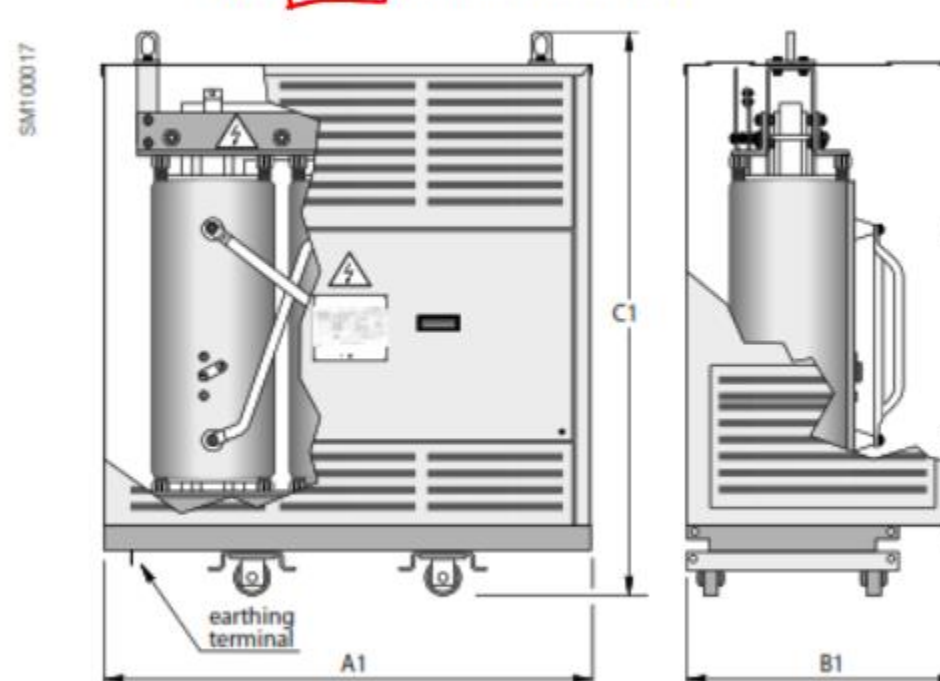
Power kVA	250	400	630	800	1000	1250	1600	2000	2500	3150
Primary voltage	28.5 to 34.5 kV									
Secondary voltage	400V between phases, 231V phase to neutral (at no load)									
HV insulation level	36kV									
HV tapping range	± 2.5 % and/or ± 5 %									
Vector group	Dyn 11, Dyn 5, Dyn 1 (other vector groups upon request)									
No-load losses (w)	1280	1650	2200	2700	3100	3600	4200	5000	5800	6700
Load losses at 75°C (w)	3500	5000	7000	8400	10000	12200	14800	18300	21800	26100
Load losses at 120°C (w)	4000	5700	8000	9600	11500	14000	17000	21000	25000	30000
Impedance voltage (%)	6	6	6	6	6	6	6	6	6	6
Acoustic Level dB(A):										
- power L_{WA}	67	69	71	72	73	75	76	78	81	83
- pressure L_{PA} (1m)	55	56	57	58	59	61	61	63	61	61

Dimensions* and weights

Without enclosure (IP00)



With IP31 metal enclosure



Rated power (kVA)		100	160	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
Without enclosure IP00															
Dimensions (mm)	-A	1290	1260	1330	1350	1410	1430	1500	1660	1660	1710	1790	1880	2070	2280
	-B	720	720	720	800	800	800	800	800	950	950	950	1200	1200	1200
	-C	1370	1370	1430	1580	1600	1620	1640	1810	1950	2100	2340	2420	2480	2660
	-D	520	520	520	670	670	670	670	670	820	820	820	1070	1070	1070
	-E	715	715	715	795	795	795	795	795	945	945	945	1195	1195	1195
Total weight (kg)		940	930	1200	1360	1580	1660	1920	2550	2790	3200	4000	4950	6160	8370
With IP31 metal enclosure															
Dimensions (mm)	-A1	1650	1650	1650	1700	1700	1800	1800	2000	2000	2150	2330	2330	2470	2680
	-B1	950	950	950	1020	1020	1020	1020	1170	1170	1170	1240	1270	1240	1310
	-C1	1750	1750	1750	1900	1900	2050	2050	2400	2400	2480	2650	2650	2880	3060
Weight enclosure (kg)		180	180	180	190	190	210	210	245	245	320	370	370	350	360
Total weight (kg)		1120	1110	1380	1550	1770	1870	2130	2795	3035	3520	4370	5320	6510	8730

5-Room Ventilation

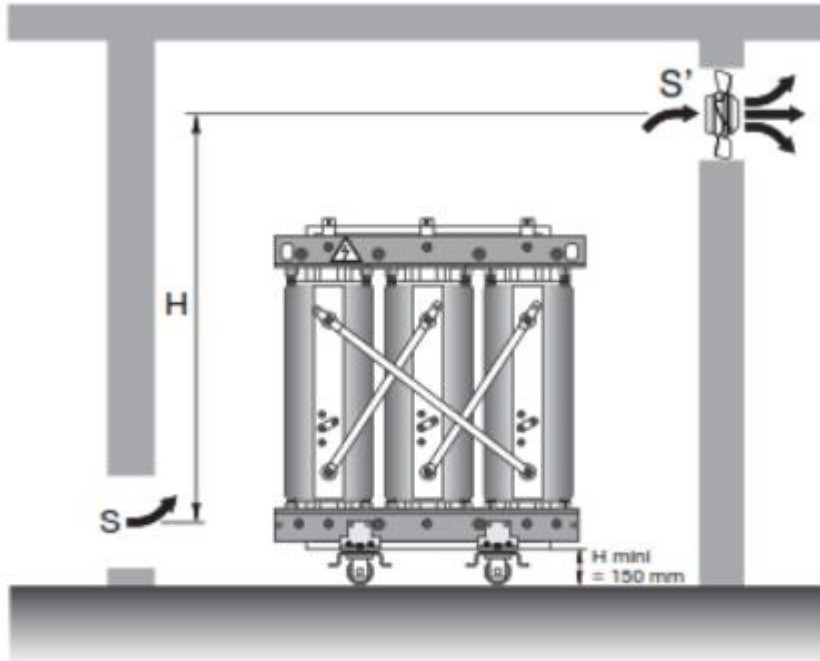
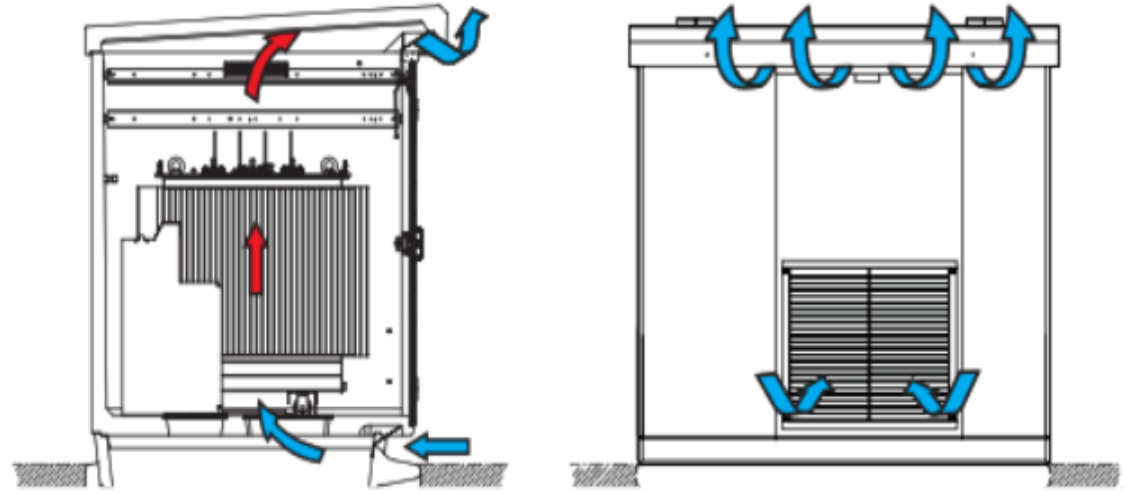


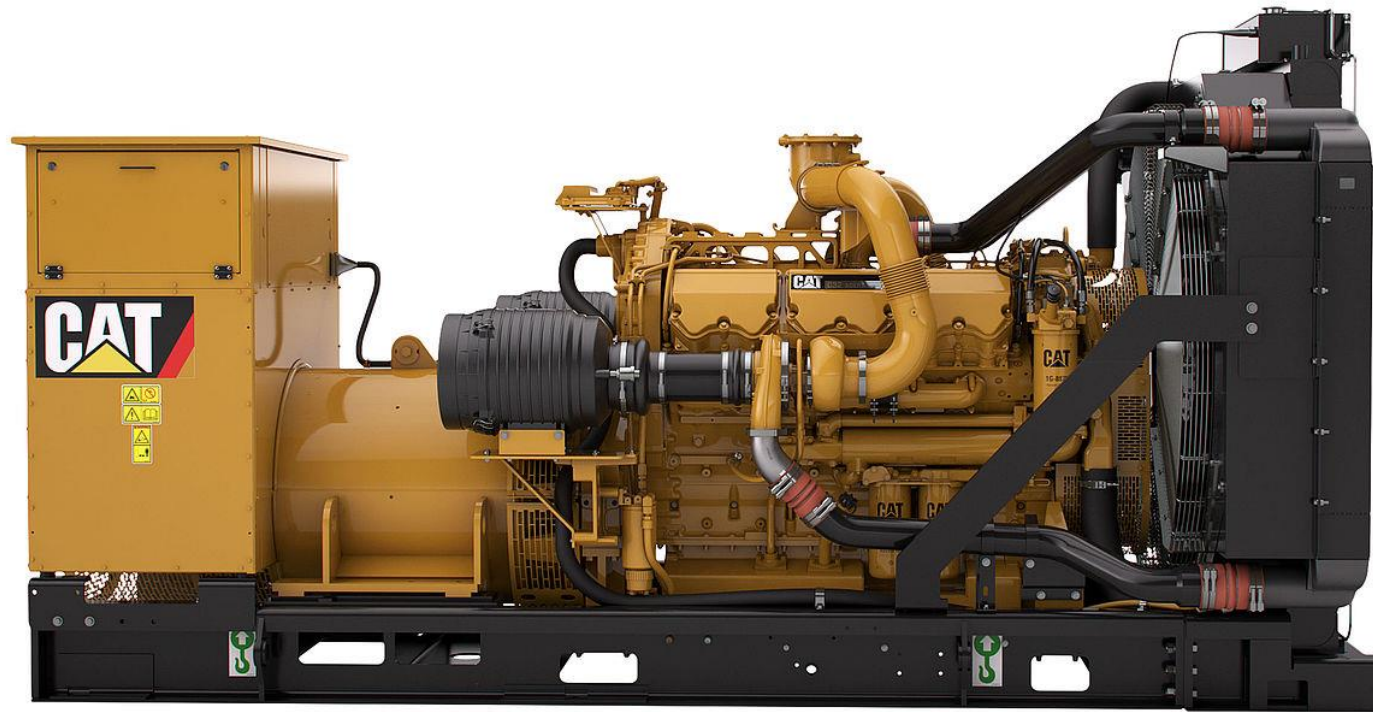
figure 2 - substation forced ventilation



الدليل الارشادي لتطبيق الكود المصري لأسس تصميم وشروط تنفيذ
التوصيلات والتركيبات الكهربائية في المباني (المجلد الثاني: تنفيذ الأعمال)

يراعى ان تكون فتحات دخول الهواء لغرفة المحول فى الحائط المقابل
مقابلة للجزء السفلى من المحول وأن تكون فتحات خروج الهواء فى
الحائط المجاور للمحول وفى مستوى أعلى من المحول.

Standby Diesel generator set



Shall the facility need a standby generator set?

المعايير التصميمية للمستشفيات والمنشآت الصحية

(الجزء الثاني)

الباب الرابع: متطلبات نظم البناء والشبكات الخدمية – المعايير الفنية

٢/٤ المعايير الفنية للتركيبات الكهربائية

١/٢/٤ التغذية الكهربائية

يجب أن تتم التغذية الكهربائية في المستشفيات من خلال مصدرين على الأقل، أحدهما مصدر التغذية الرئيسي لتغذية الأحمال غير الهامة Non-essential من خلال محولات التوزيع والآخر من مصدر احتياطي (مولدات الطوارئ) لتغذية الأحمال الهامة Essential .

ويجب أن يكون نظام التغذية الكهربائية في المواقع الطبية مصمماً ومركباً بحيث يسهل الانتقال التلقائي Automatic change- over من شبكة التوزيع الرئيسية Main distribution network إلى المصدر الاحتياطي والذي يعتمد على وحدة التوليد الاحتياطية لتغذية الأحمال الهامة والتي قد يطلق أيضاً عليها أحمال الطوارئ Emergency loads.

يجب عندما يكون إجمالي أحمال المستشفى أكبر من ٢٥٠ ك.ف.أ، تغذية المستشفى من خلال محولين بحيث يكون أي منهما قادراً على تغذية كامل حمل المستشفى، كما يجب تغذية الأحمال الحرجة بالأجهزة المستخدمة في غرف العمليات والإفاقة والرعاية المركزة والتي لا يسمح بانقطاع التغذية الكهربائية عنها مطلقاً، من خلال أنظمة التغذية بقدرة كهربائية غير قابلة للانقطاع. Uninterrupted Power Supply (UPS) system.

يجب الأخذ في الاعتبار إمكانية زيادة الأحمال مستقبلاً بنسبة ٢٠%.

ويوضح الشكل (١-٤) مخططاً للتغذية الكهربائية بالمستشفيات

Outlines

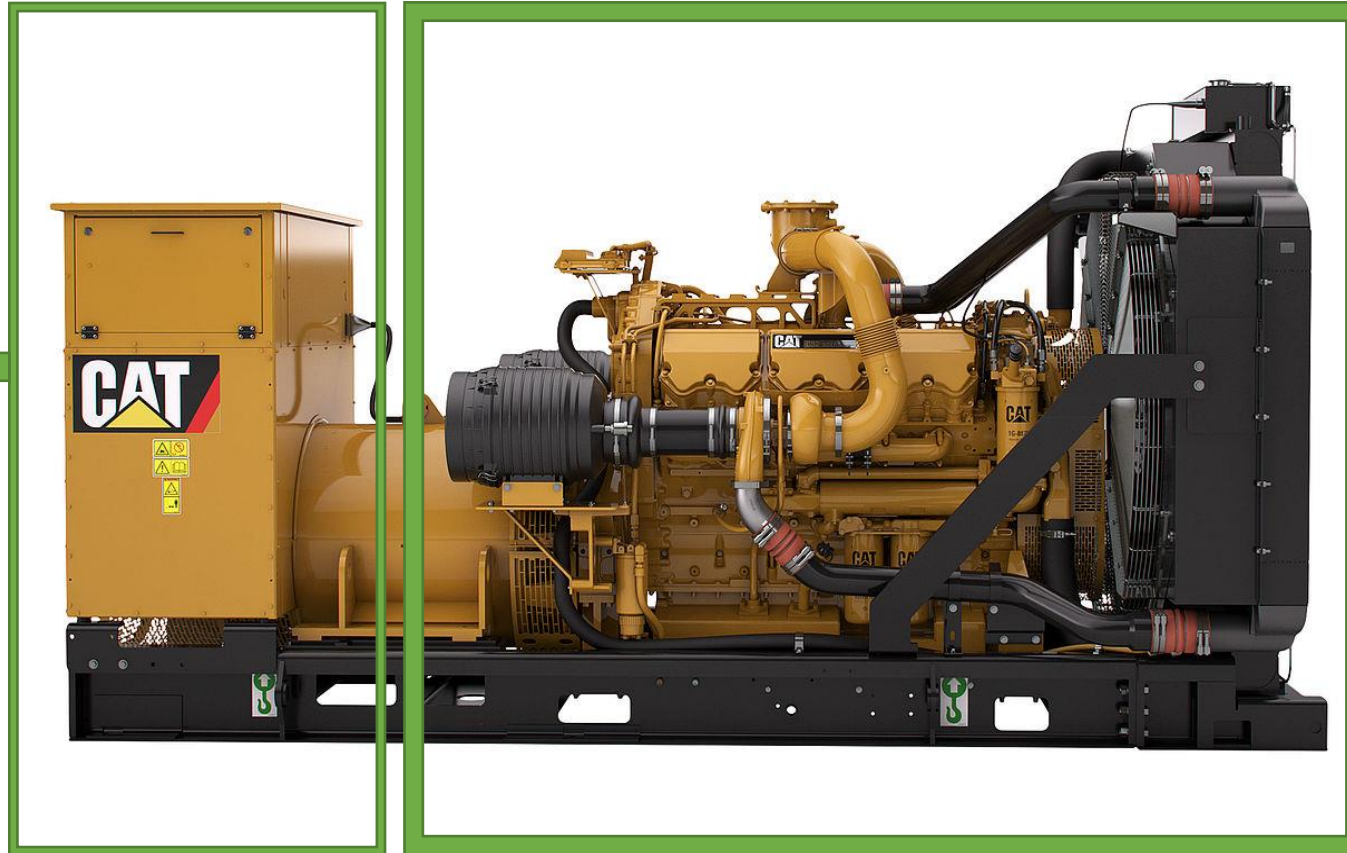
1. Components
2. Mechanical systems
3. Specifications
4. Generator Power ratings
5. Performance classes
6. Space allocation

ISO 8528

1- Components

■ Electrical
system

Alternator



■ Mechanical
system

Engine

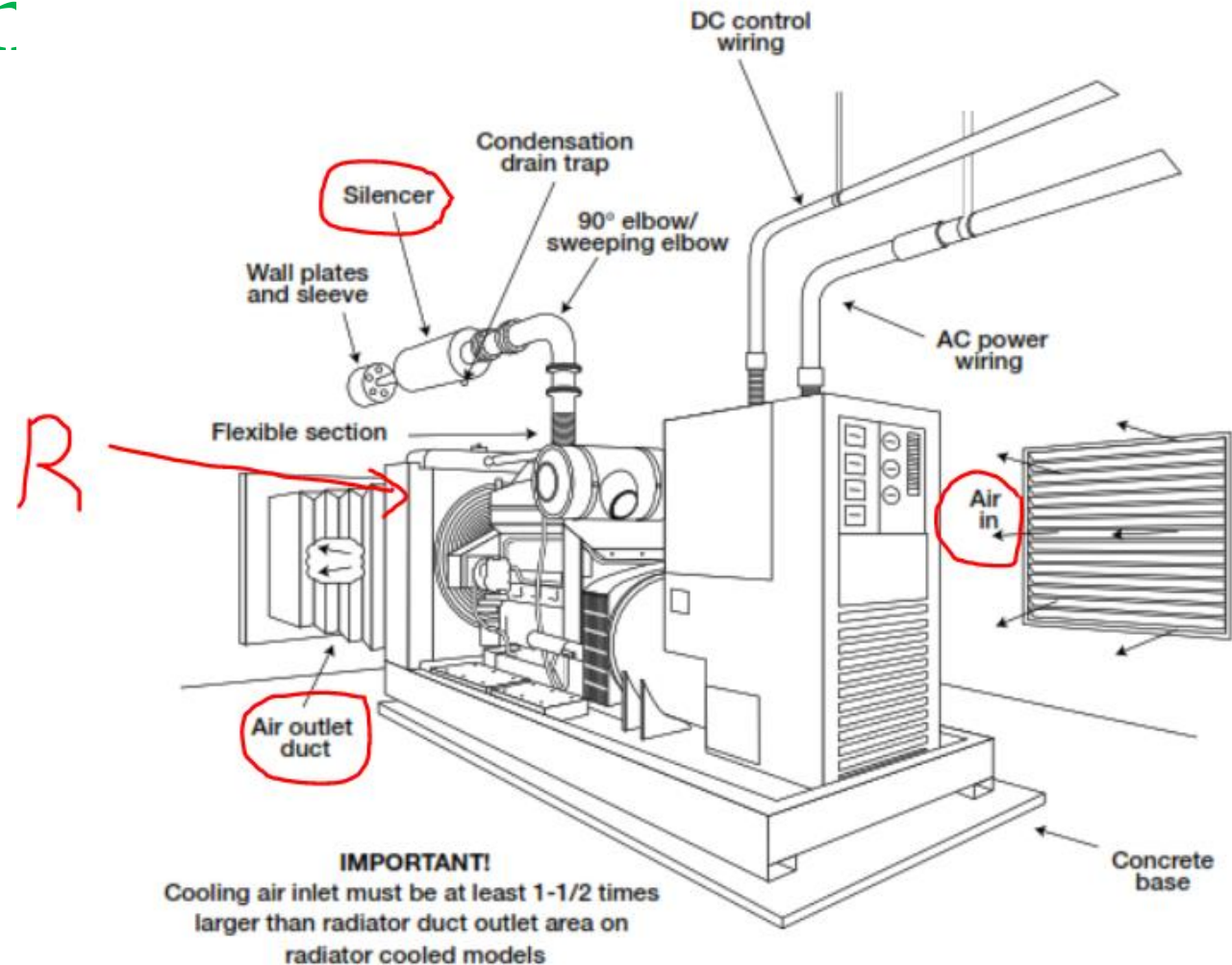
2- Mechanical system

Fuel systems

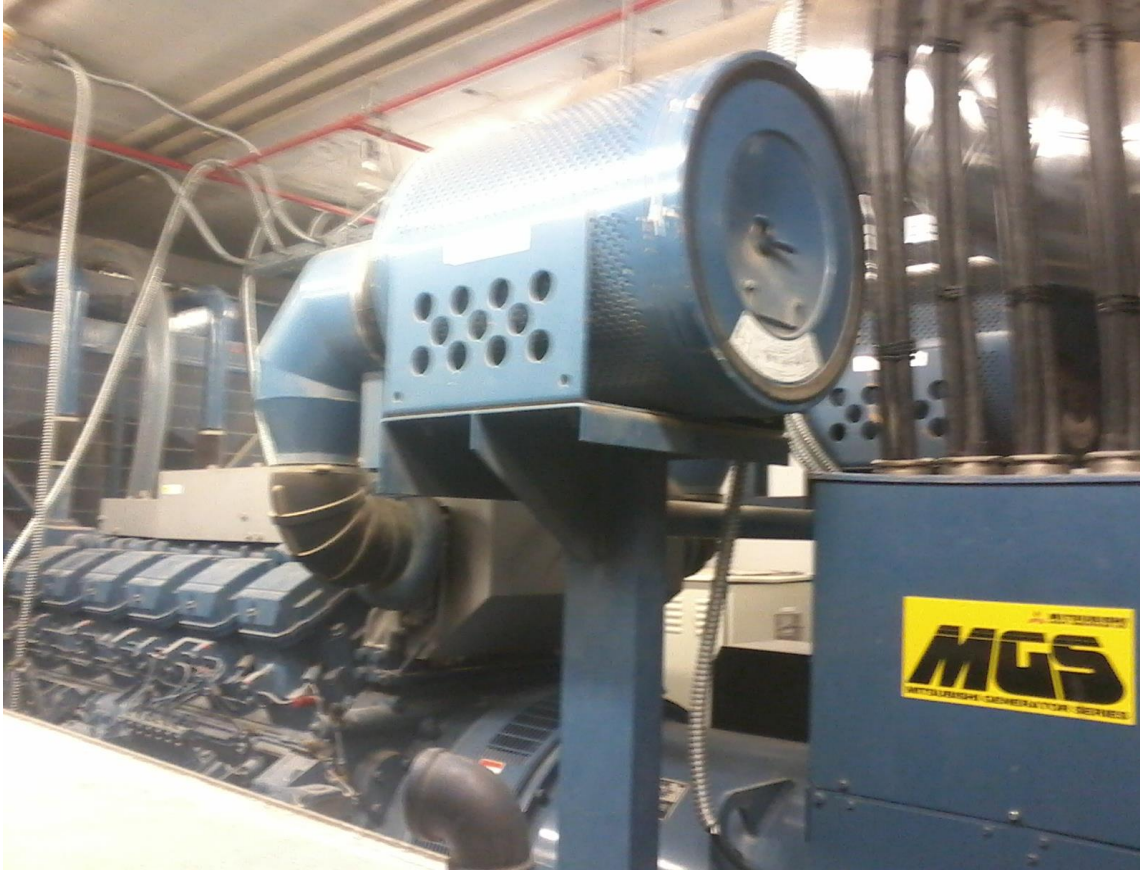
Exhaust systems

Cooling systems

Starting systems



Site Photos



3- Specifications

TECHNICAL DATA

748 kW - 906 kW 50 Hz KTA38 Series Engines



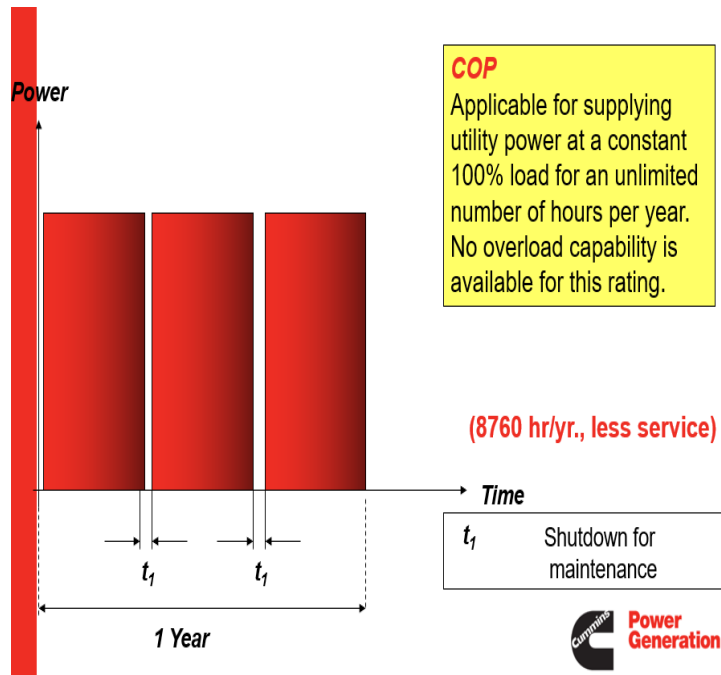
Section G

Generating Sets – 50 Hz

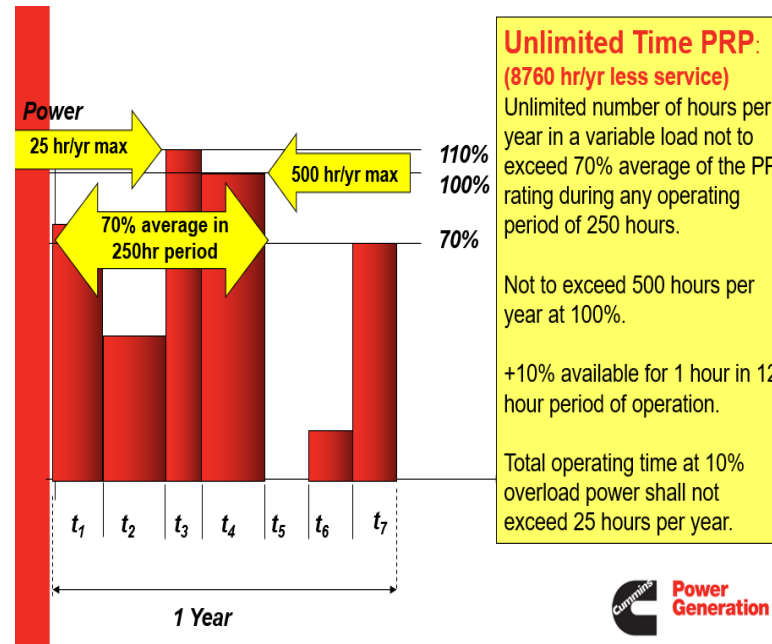
Set output	380-415 V 50 Hz	380-415 V 50 Hz
Prime at 40°C ambient	748 kWe 936 kVA	815 kWe 1019 kVA
1999 Set Model (Prime)	CP900-5	CP1000-5
New Model (Prime)	748 DFJC	815 DFJD
Standby at 40°C ambient	832 kWe 1040 kVA	906 kWe 1132 kVA
1999 Set Model (Standby)	CS1000-5	CS1100-5
New Model (Standby)	832 DFJC	906 DFJD
Engine Make	Cummins	Cummins
Model	KTA38G3	KTA38G5
Cylinders	Twelve	Twelve
Engine build	Vee	Vee
Governor / Class	Electronic / A1	Electronic / A1
Aspiration and cooling	Turbo Aftercooled	Turbo Aftercooled
Bore and stroke	159 mm x 159 mm	159 mm x 159 mm
Compression ratio	13.9:1	13.9:1
Cubic capacity	37.8 Litres	37.8 Litres
Starting / Min °C	Unaided	Unaided / 7°C
Battery capacity	254 A/hr	254 A/hr
Nett Engine output – Prime	786 kWm	860 kWm
Nett at flywheel – Standby	875 kWm	950 kWm
Maximum load acceptance single step (cold)	500 kWe	451 kWe
Speed	1500 rpm	1500 rpm
Alternator voltage regulation	±0.5%	±0.5%
Alternator insulation class	H	H
Single load step to NFPA110 para 5.13.2.6	100%	100%

4- Generator Power Ratings

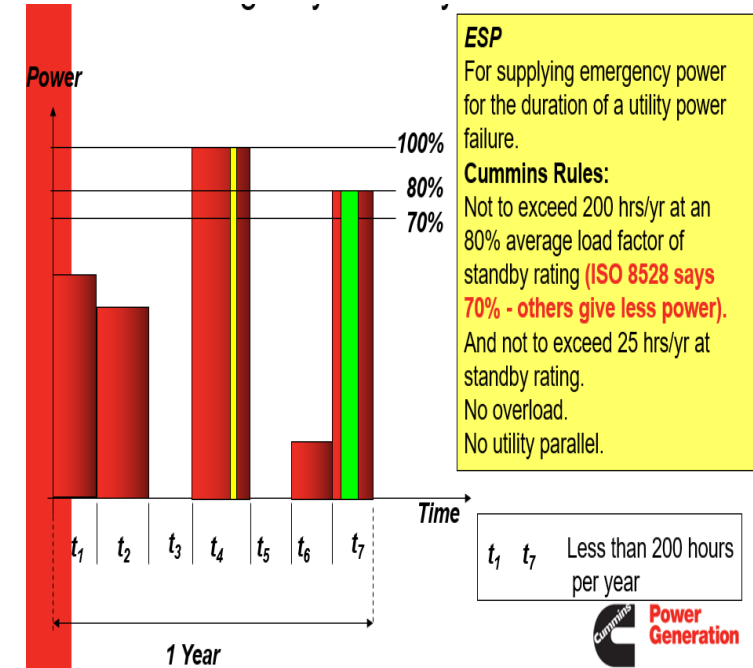
Continuous operating power



Prime Power



Emergency standby power



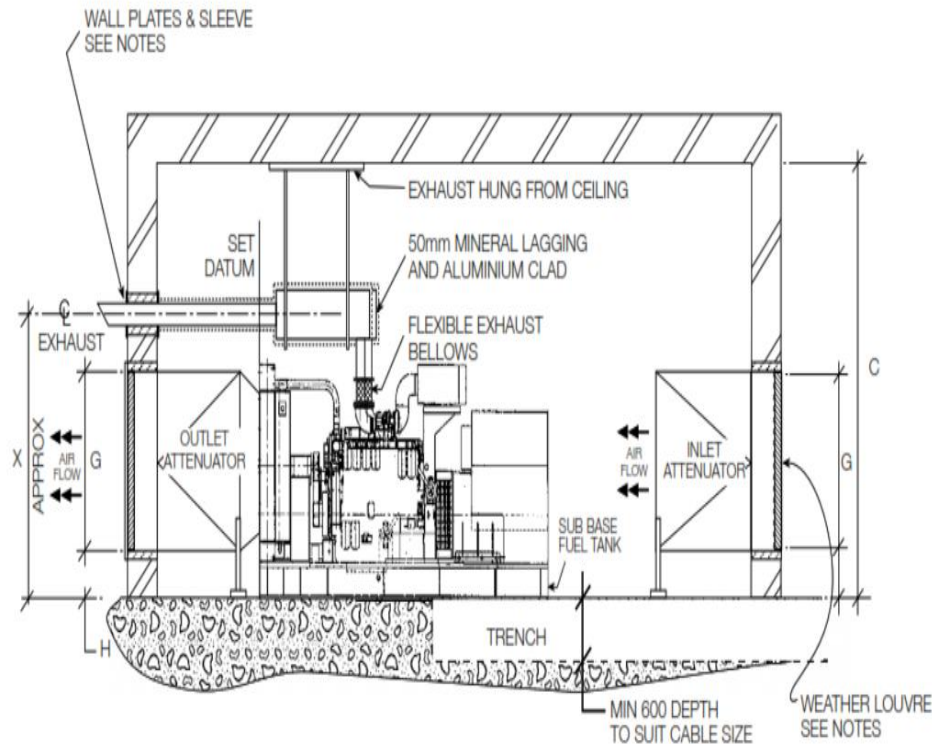
5- Performance classes

IS/ISO 8528-5 : 2005

Table 4 — Performance class operating limit values

Parameter		Symbol	Unit	Operating limit values			
				Performance class			
				G1	G2	G3	G4
Frequency droop		δf_{st}	%	≤ 8	≤ 5	$\leq 3^r$	AMC ^a
Steady-state frequency band		β_f	%	$\leq 2,5$	$\leq 1,5^b$	$\leq 0,5$	AMC
Related range of downward frequency setting		$\delta f_{s,do}$	%	$> (2,5 + \delta f_{st})$			AMC
Related range of upward frequency setting		$\delta f_{s,up}$	%	$> + 2,5^c$			AMC
Rate of change of frequency setting		v_f	%/s	0,2 to 1			AMC
Voltage unbalance		$\delta U_{2,0}$	%	1 ⁱ	1 ⁱ	1 ⁱ	1 ⁱ
Related range of voltage setting		δU_s	%	$\leq \pm 5$			AMC
Rate of change of voltage setting		v_U	% s ⁻¹	0,2 to 1			AMC
Transient voltage deviation	100 % sudden power decrease	δU_{dyn}^+	%	$\leq + 35$	$\leq + 25$	$\leq + 20$	AMC
	sudden power increase ^{d,e}	δU_{dyn}^-		$\leq - 25^d$	$\leq - 20^d$	$\leq - 15^d$	
Voltage recovery time ^j (see Figure 5)		$t_{U,in}$	s	≤ 10	≤ 6	≤ 4	AMC
		$t_{U,de}$		$\leq 10^d$	$\leq 6^d$	$\leq 4^d$	
Voltage modulation ^{k,l} (see Figure 11)		$\hat{U}_{mod,s}$	%	AMC	0,3 ^{m,n}	0,3 ⁿ	AMC

5- Space Allocation



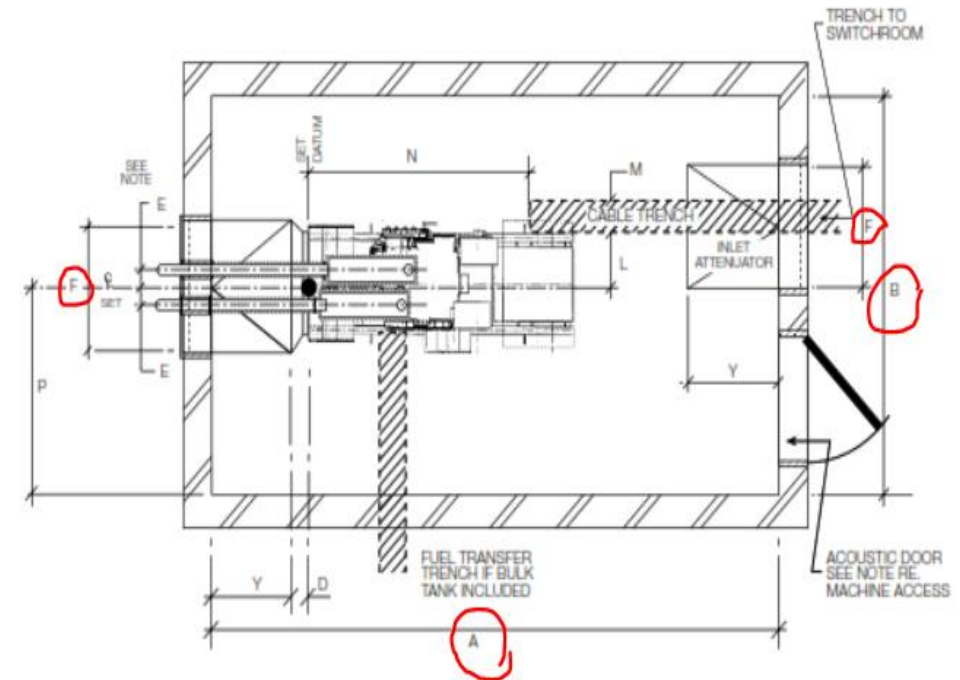
Section in the room

RECOMMENDED ROOM SIZES

Section B/60

Cummins Generator Sets 681 - 2500 kVA – 60 Hz

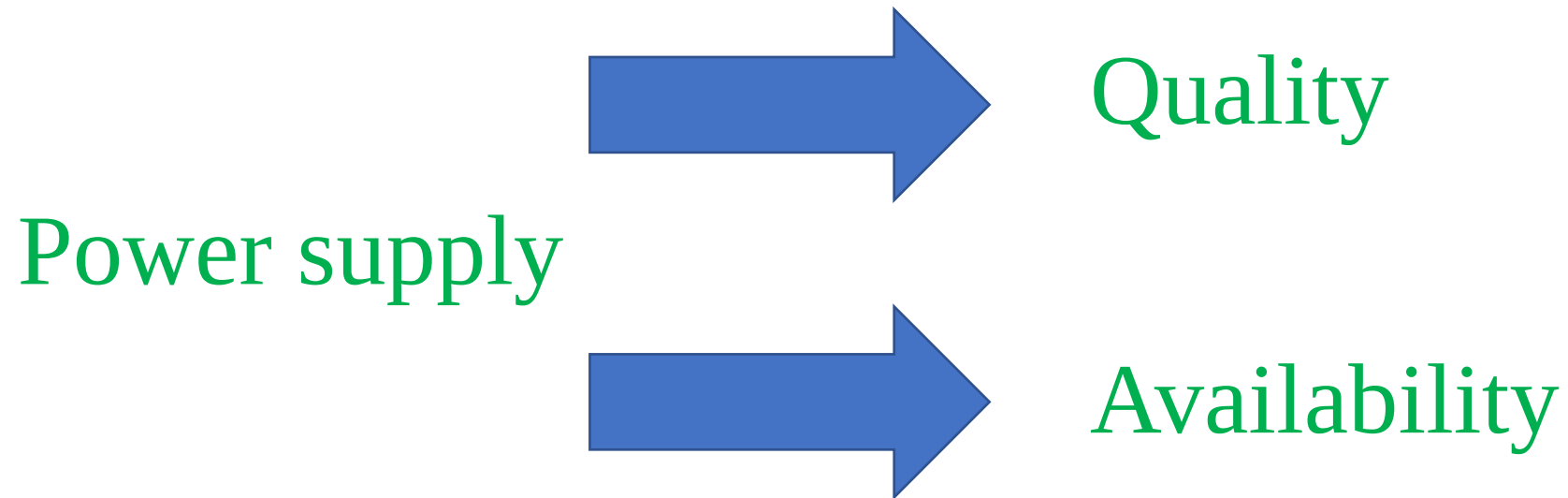
Generator room layout with Acoustic Treatment to Achieve 85dBA @ 1 metre



Room plan

Uninterruptible Power Supply (UPS)

Shall the facility need the UPS?



Shall the facility need the UPS?

Ministry Of Health and Population
General Administration for
Engineering Services Researches And
Medical Equipment



وزارة الصحة والسكان
قطاع شئون مكتب الوزير
الإدارة العامة لبحوث الخدمات الهندسية
والتجهيزات الصحية

معايير عامة للأعمال الكهربائية في المستشفيات

- تغذية جميع الاعمال الكهربائية بغرف العمليات من لوحات وحدات عدم انقطاع التيار (UPS-Panel)
- تغذية بومة الغازات من خلال مخرج 4×3 مم 2 (دائرة خاصة بها) بمفتاح فصل مناسب (DCS).
- تغذية كشاف العمليات من خلال مخرج 4×3 مم 2 (دائرة خاصة بها) بمفتاح فصل مناسب (DCS) .
- يتم توزيع مجموعات البرايز بغرفة العمليات طبقا للفرش الطبي المقدم (مجموعة برايز بكل جانب) بحيث تكون مجموعة البرايز
- الواحدة كافية لتشغيل كافة المعدات الطبية التي تعمل بنفس الوقت بغرف العمليات (في المعتاد عدد 4 برايز دابل كس بكل جانب ما عدا جانب الباب بريزة واحدة فقط).
- يتم مراعاة تنفيذ أنظمة الأرضي اللازمة لأرضيات الانتى ستاتيكية بالعمليات و العناية.
- نقل جميع لوحات التوزيع لتكون داخل غرف كهرباء خاصة .
- تغذية جميع أعمال القوى لسراير غرف العناية المركزة من لوحات وحدات عدم انقطاع التيار UPS-Panels .
- جميع اعمال القوى داخل غرف المناظير يتم تغذيتها من خلال لوحات UPS .
- تغذية ملحقات جهاز قسطرة القلب من لوحات وحدات عدم انقطاع التيار UPS
- تغذية بعض أعمال القوى بالكونترات من لوحات UPS.

Outlines

1. Technology and Types
2. Characteristic parameters of a UPS
3. Space allocation (space program)
4. Battery

1-Technology and Types of the UPS system

- Diesel Rotary UPS



- Static UPS



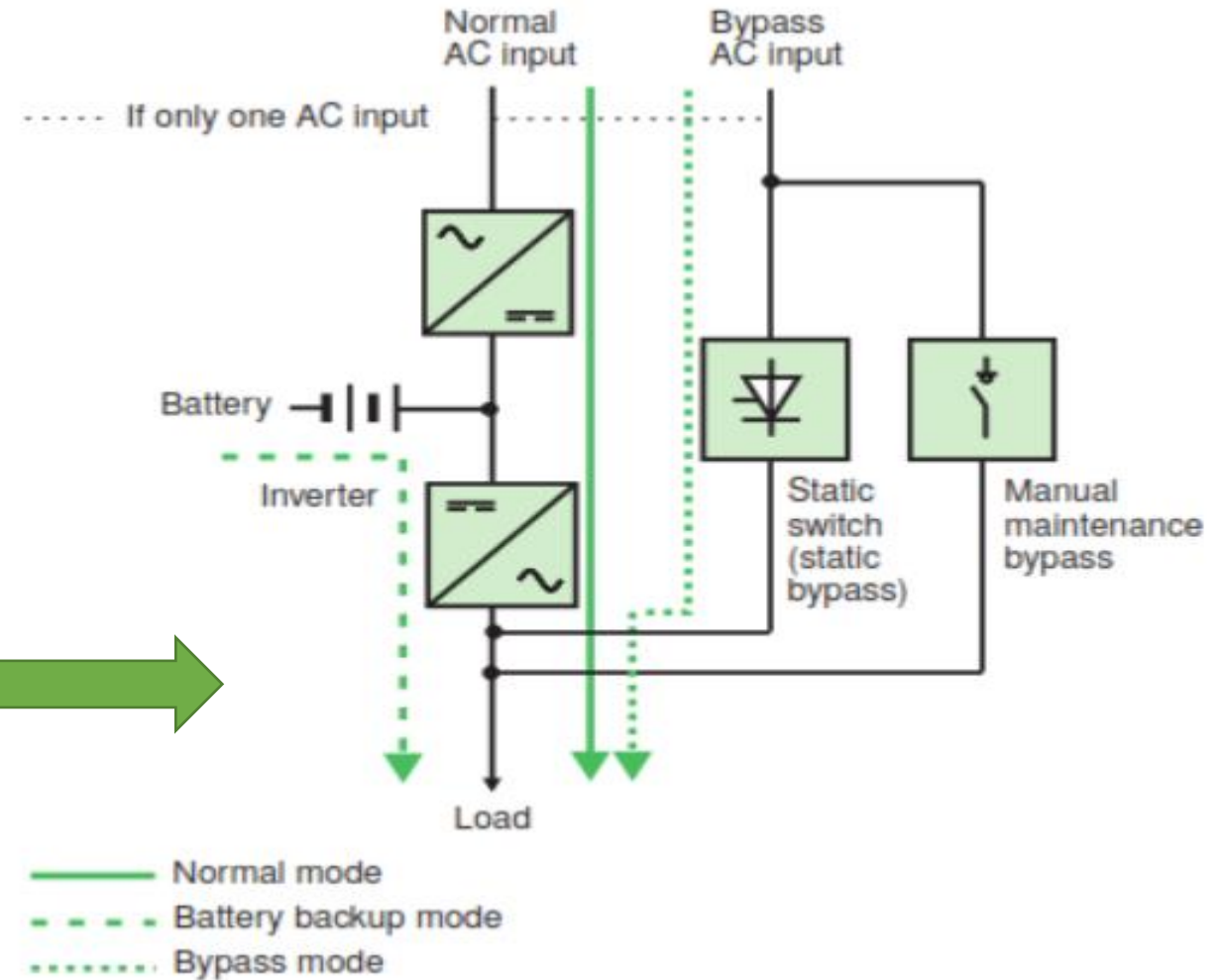
Static UPS components

A UPS comprises the following main components:

- **Rectifier/charger**, which produces DC power to charge a battery and supply an inverter
- **Inverter**, which produces quality electrical power, i.e.
 - Free of all utility-power disturbances, notably micro-outages
 - Within tolerances compatible with the requirements of sensitive electronic devices (e.g. for Galaxy, tolerances in amplitude $\pm 0.5\%$ and frequency $\pm 1\%$, compared to $\pm 10\%$ and $\pm 5\%$ in utility power systems, which correspond to improvement factors of 20 and 5, respectively)
- **Battery**, which provides sufficient backup time (8 minutes to 1 hour or more) to ensure the safety of life and property by replacing the utility as required
- **Static switch**, a semi-conductor based device which transfers the load from the inverter to the utility and back, without any interruption in the supply of power

Types of static UPSs

- Passive standby (also called off-line)
- Line interactive
- Double conversion (also called on-line)



2-Characteristic parameters of a UPS

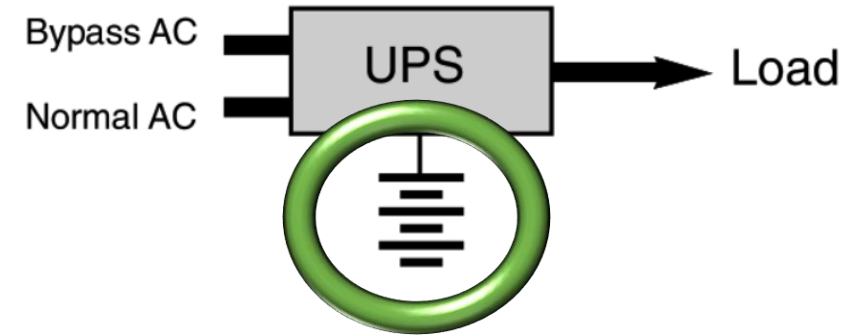
Rated power (kVA/kW)	160/144	200/180
Normal AC supply input		
Input voltage (V)	250 – 600 V ¹	
Normal and bypass AC inputs	Single input or dual input as standard	
Frequency (Hz)	40 – 70 Hz	
Input power factor	0.99	
THDI	< 3% full load	
Bypass AC input		
Input voltage range	342 – 457 V	
Frequency	50 Hz or 60 Hz	
Output		
Phase-to-phase output voltage (V)	380/400/415 V	
Load power factor	0.9 (0.7 leading to 0.5 lagging without de-rating)	
Output frequency	50/60 Hz +/- 0.1% (free-running)	
Overload capacity utility operation at 40 °C	150% for 1 minute and 125% for 10 minutes	
Output voltage regulation	+/- 1%	
Total harmonic distortion (THDU)	< 2% at 100% linear load; < 3% at 100% non-linear load	
Output voltage tolerance	Symmetric load (0 – 100%): +/- 1% static; asymmetric load: +/- 3% static	
Overall efficiency		
Efficiency at full load (AC-AC) at 100% load	Up to <u>96.5%</u>	
ECONversion mode (meets EN62040-3 Class 1)	Up to 99% (meets EN62040-3 Class 1)	
Standard ECO mode	Up to <u>99%</u>	

3-Space Allocation

Dimensions and weights		
UPS (H x W x D)	1,970 x 1,003 x 854 mm	
Weight in kg. (UPS) (total -power cabinet plus I/O cabinet)	699 kg	724 kg
Modular battery Cabinet - Narrow (H x W x D), weight without batteries	1,970 x 370 x 854 mm 139 kg	
Modular battery Cabinet - Wide (H x W x D), weight without batteries	1,970 x 700 x 854 mm 210 kg	

4-BATTERY

- Nickel-cadmium
- Valve regulated Lead-acid



Type	Part number	Nom. voltage V	Power 15 min 1.60 Vpc 25 °C W/block	Nominal capacity C ₁₀ 1.80 Vpc 25 °C Ah	Length (l) max. mm	Width (b/w) max. mm	Height (h1) max. mm	Height incl. connectors (h2) max. mm	Weight approx. kg	Internal resistance mOhm	Short circuit current A	Terminal
XP6V2800	NAXP062800HP0FA	6	2270	195	309	172	223	241	32.6	1.60	3900	F-M6
XP12V1800	NAXP121800HP0FA	12	1370	56.4	220	172	219	235	22.5	8.60	1521	* F-M6
XP12V2500	NAXP122500HP0FA	12	1870	69.5	262	172	223	239	27.7	6.20	2030	F-M6
XP12V3000	NAXP123000HP0FA	12	2350	92.8	309	172	223	239	32.8	5.20	2400	F-M6

Battery



1.95 Vpc – Discharge in A at 25 °C													
Type	Part number	5 min	10 min	15 min	30 min	45 min	1 h	2 h	3 h	5 h	8 h	10 h	20 h
XP6V2800	NAXP062800HP0FA	137	137	137	137	108	92.1	60.7	44.1	28.4	18.4	15.0	7.99
XP12V1800	NAXP121800HP0FA	109	87.8	72.6	46.0	33.8	28.5	15.8	10.9	7.56	5.07	4.31	2.17
XP12V2500	NAXP122500HP0FA	120	102	92.6	60.8	46.7	36.1	19.8	13.3	8.66	5.96	4.99	2.54
XP12V3000	NAXP123000HP0FA	108	108	108	71.9	56.5	47.6	30.9	21.9	13.5	8.64	6.99	3.61

1.90 Vpc – Discharge in A at 25 °C													
Type	Part number	5 min	10 min	15 min	30 min	45 min	1 h	2 h	3 h	5 h	8 h	10 h	20 h
XP6V2800	NAXP062800HP0FA	238	238	238	160	127	107	71.1	48.8	32.8	21.4	17.4	9.26
XP12V1800	NAXP121800HP0FA	152	113	89.5	54.3	39.8	33.5	19.2	13.8	9.39	5.95	5.08	2.61
XP12V2500	NAXP122500HP0FA	173	134	115	73.0	54.6	43.4	23.7	15.8	10.7	7.18	6.04	3.15
XP12V3000	NAXP123000HP0FA	195	195	176	94.2	70.0	56.7	33.5	24.8	15.7	10.1	8.21	4.29

1.85 Vpc – Discharge in A at 25 °C													
Type	Part number	5 min	10 min	15 min	30 min	45 min	1 h	2 h	3 h	5 h	8 h	10 h	20 h
XP6V2800	NAXP062800HP0FA	473	399	361	201	151	123	73.9	55.4	35.6	23.1	18.8	10.0
XP12V1800	NAXP121800HP0FA	189	134	104	61.4	44.5	37.3	21.7	15.5	10.2	6.39	5.42	2.82
XP12V2500	NAXP122500HP0FA	218	158	134	82.1	60.8	47.9	25.8	17.3	11.5	7.73	6.67	3.53
XP12V3000	NAXP123000HP0FA	209	209	180	107	78.8	63.1	36.3	26.6	16.9	11.0	8.94	4.71