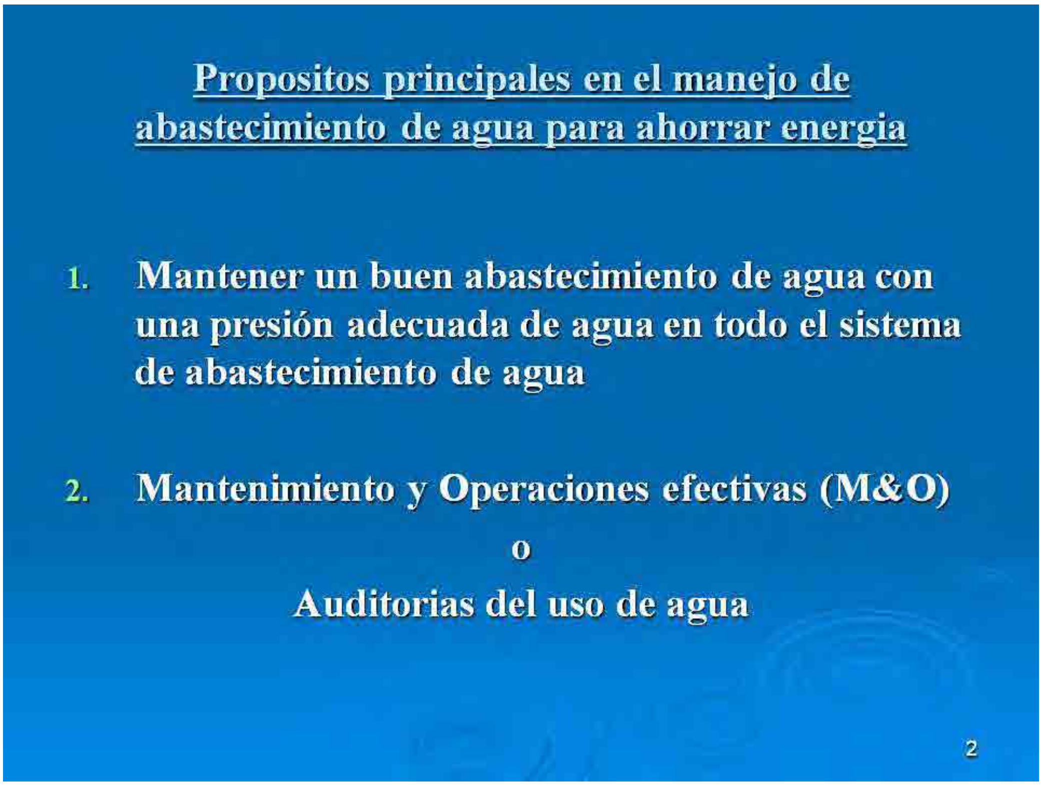
2009 年 **7** 月 **13** 日　水理解析について



Contenido

- Paso1: bases para el manejo de abastecimiento de agua
- Paso 2: Analisis hidraulico de la red

3

Paso 1: Base para el manejo de abastecimiento de agua

1. Entender el sistema completo de abastecimiento de agua (Diagrama esquematico es muy util)
2. Monitoreo del Flujo
   (Producción → Transmisión → Distribución)
   Exportar e Importar
3. Control y Monitoreo de la presion del agua

4

- 1. Entender el sistema completo de abastecimiento de agua

El primer paso en la red de distribución es aumentar el conocimiento existente de transmisión y sistemas de distribución.

Recolección de información del sistema y de otros recursos y luego combinarlos.

↓

Un esquema sistemático será muy útil para entender el sistema

5

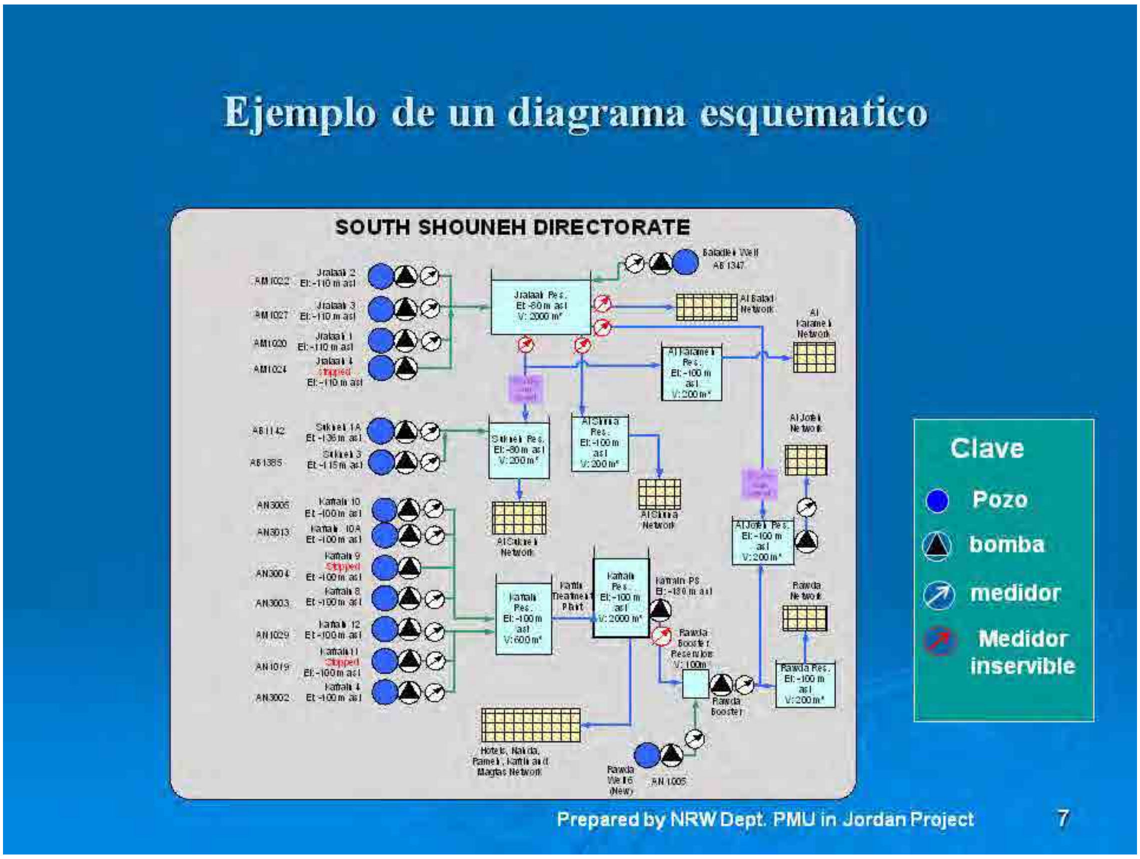
Preparacion de un diagrama esquematico

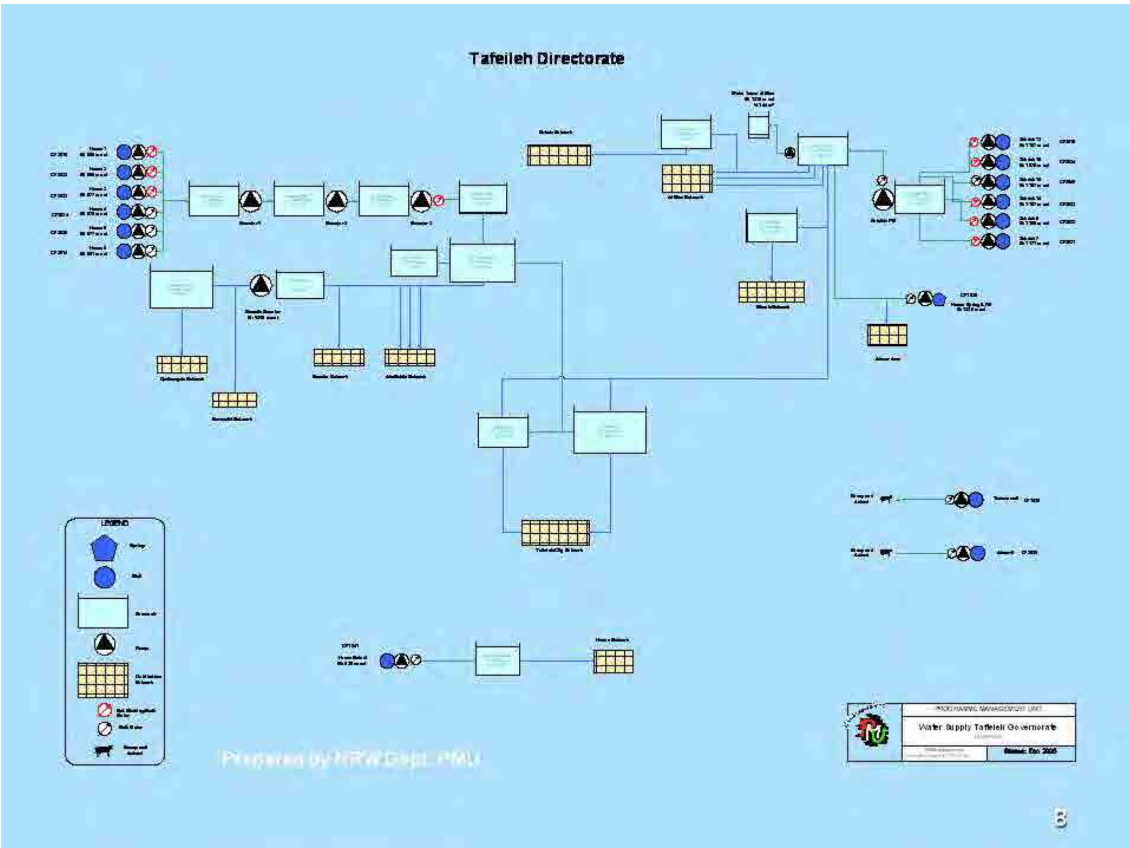
- Inventario de todas las instalaciones mayores,
- Usar un número de identificación estándar de las instalaciones,
- Aclarar las interrelaciones entre las instalaciones,
- Aclarar las areas de abastecimiento de cada reserva y de cada fuente de abastecimiento, y
- Integrar esta informacion esquematicamente en el diagrama.

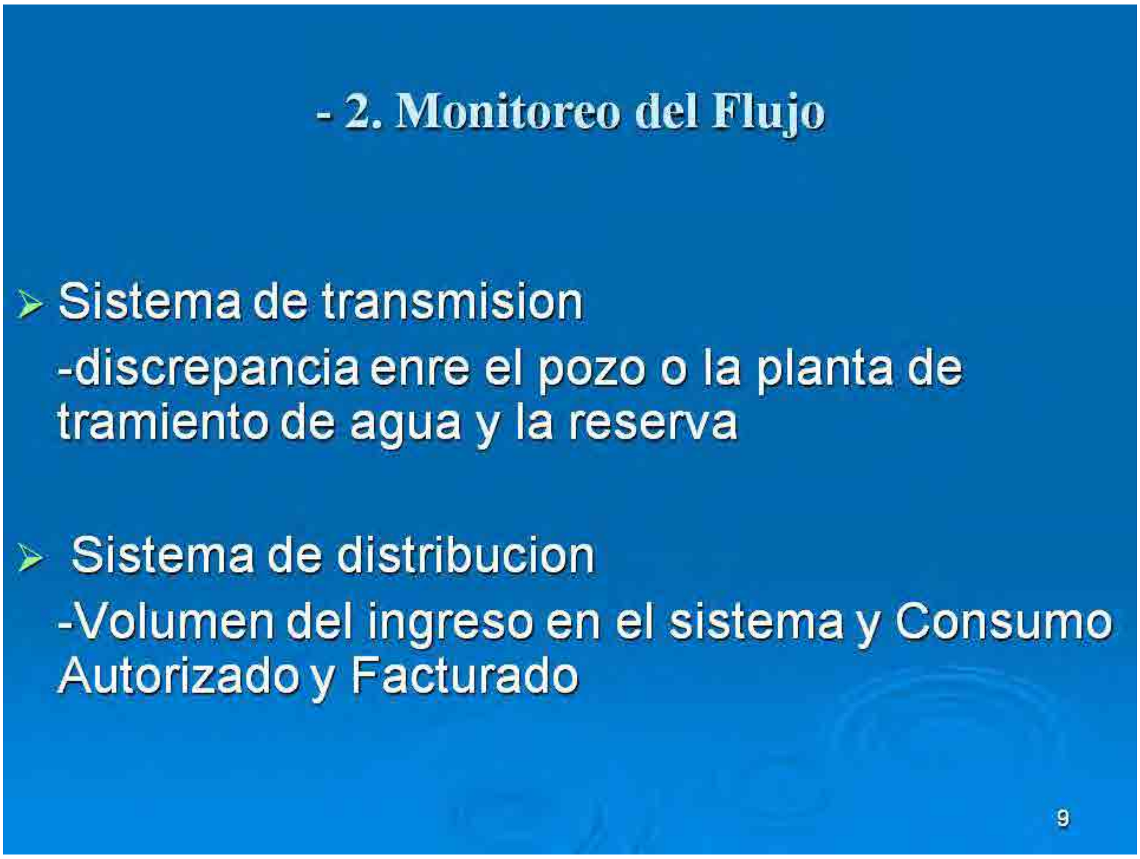
↓

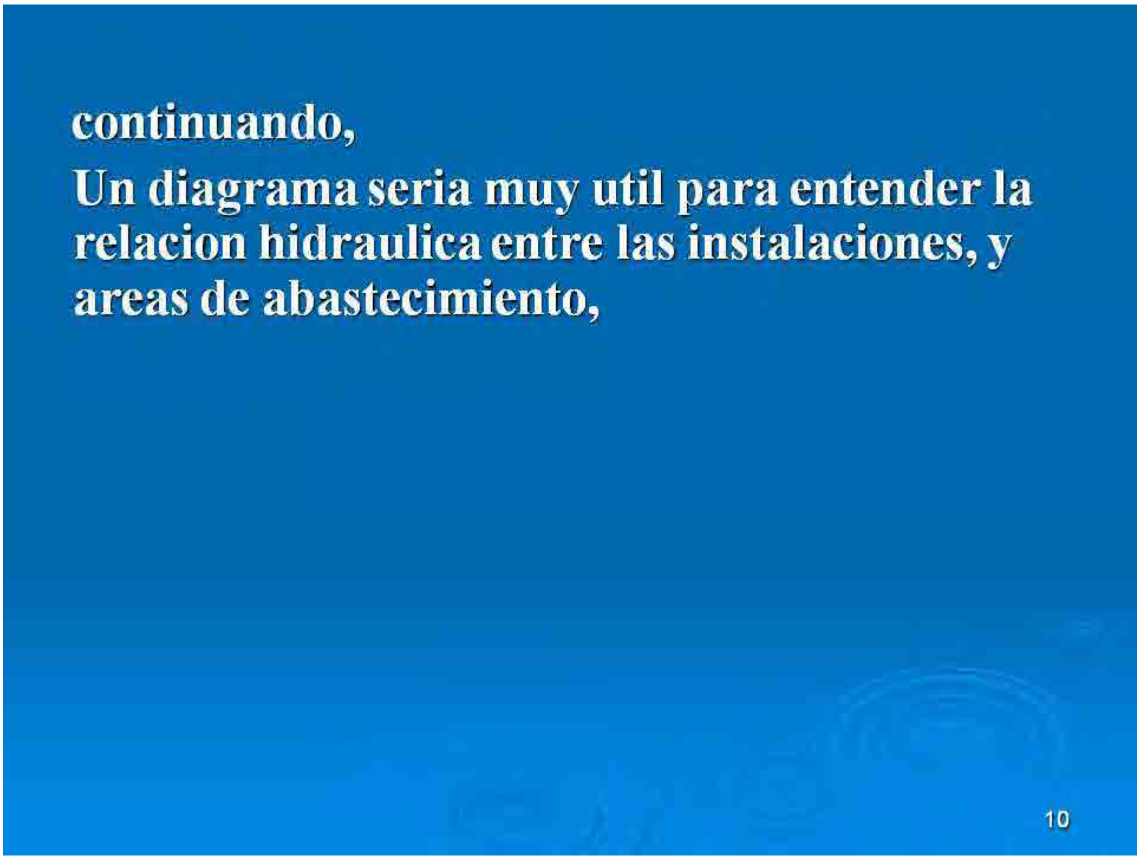
Ustedes tendran una idea mas clara de su sistema de agua!

6


Ejemplo de un diagrama esquematico
SOUTH SHOUNEH DIRECTORATE
Clave
Pozo
bomba
medidor
Medidor inservible
Prepared by NRW Dept. PMU in Jordan Project
7


Tafeileh Directorate
Water Supply Tafeileh Governorate
Prepared by NRW Dept. PMU
8


- 2. Monitoreo del Flujo
Sistema de transmision
-discrepancia enre el pozo o la planta de tramiento de agua y la reserva
Sistema de distribucion
-Volumen del ingreso en el sistema y Consumo Autorizado y Facturado
9


continuando,
Un diagrama seria muy util para entender la relacion hidraulica entre las instalaciones, y areas de abastecimiento,
10

- 3. Control y Monitoreo de la presion del agua

Entender el perfil hidraulico de un sistema

Un diagrama hidraulico seria muy util:

Para entender el sistema existente y facilitar la operacion y mantenimiento,

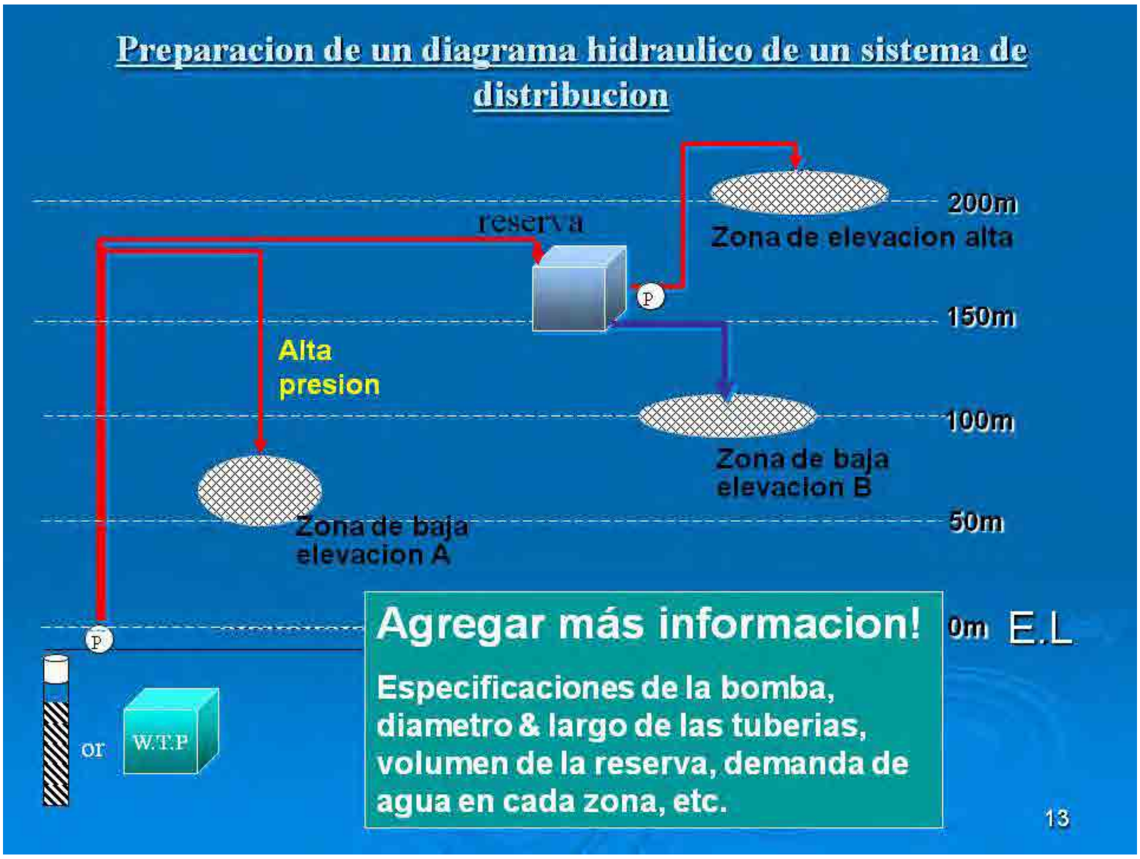
y

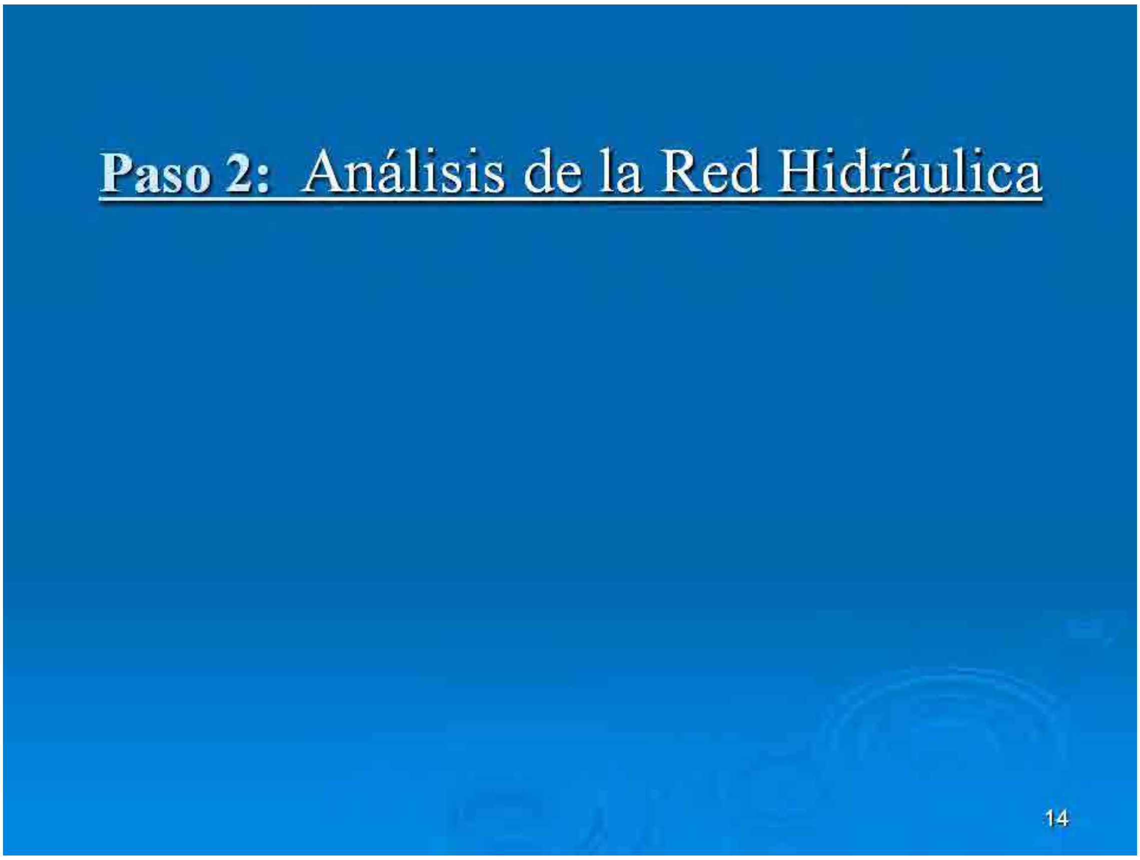
para disenar , planear, modificar o mejorar la operacion de abastecimeinto y distribucion de agua

11

Ilustracion de un sisema de abastecimiento de agua

12


Preparacion de un diagrama hidraulico de un sistema de distribucion
reserva
200m
Zona de elevacion alta
150m
Alta
presion
100m
Zona de baja
elevacion B
Zona de baja
elevacion A
50m
Agregar más informacion!
Especificaciones de la bomba, diametro & largo de las tuberias, volumen de la reserva, demanda de agua en cada zona, etc.
0m
E.L
P
P
or
W.T.P
13


Paso 2: Análisis de la Red Hidráulica
14

- El análisis de la red hidráulica posibilita:

  - Entender la condicion actual del suministro de agua

  - Elaborar un plan a futuro y rehabilitación de tuberias

15

Presentacion de problemas en el control de presion

- Hay areas en el sistema que presentan altas o bajas presiones de agua debido a la mala planificación o construcción de la red

- Hay malos sistemas de bombeo debido a la falta de analisis hidraulicos en la red

16

Informacion necesaria para el analisis hidraulico de la red

- ✓ Condicion Basica：servicio a la poblacion, area de servico, demanda de agua
- ✓ Configuracion：condicion de la distribucion de las intalaciones
- ✓ Informacion de las tuberias：diametros, Longitudes, profundidad o elevación.
- ✓ Instalaciones de Agua: Carga dinámica total (C.D.T), Capacidad de las instalaciones de agua.
- ✓ Arreglo de la base de datos：informacion de planos, registros de fugas

17

Confirmar los criterios de la informacion del diseno

- ➢ Factor de hora pico
- ➢ Presion estatica & presion efectiva
- ➢ otros(velocidad del caudal , hidrantes para incendios..)

18

Elevacion & Analisis

- Diametro adecuado de las tuberias
- Condicion de la presion del agua

19

Mayor control en metodos aplicables referentes al ahorro de energia

- Instalacion de tuberias paralelas (Double-ness)
- Conectar y entrelazar la red de tuberias
- Re-zonificar, colocación de valvulas, crear bloques utilizando válvulas de cortina, válvlas de reducción de presión (GV, PRV)
- Cambiar hacia una carga dinamica adecuada
- Otros

20


Gracias!
21

2009 年 7 月 13 日 パイロット施設の節電手法について 3

The Project for Capacity Development of ANDA for Operational Improvement
*** Power Saving Activity ***

SAMPLE FOR THE DEMONSTARION

*** Actual Situation Survey of ANDA Head Office Building***

[Actual Power Consumption Situation]

1. Annual Power Consumption --- Information from Invoice of CAESS
2. Monthly Power Consumption --- Information from Invoice of CAESS
3. Daily Power Consumption --- Information from Wattmeter of CAESS
4. Hourly Power Consumption --- Information from Wattmeter of CAESS
5. Conjectual Demand Curve --- Information from Wattmeter of CAESS
6. Power Consumption Analysis --- Information from Wattmeter of CAESS

7A. Actual Condition of Main Transformer

7B. Actual Condition of Connecting Cables of Main Transformer

8. Equipment List (blank form)
9. Power Consumption Survey Table (blank form)
10. Electrical Diagram (sample)

July 2009
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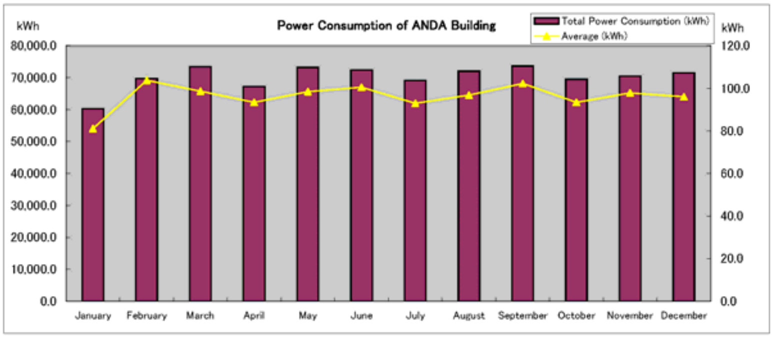
POWER CONSUMPTION OF ANDA HEAD OFFICE BUILDING 2008

Doc.1

	Total Power Consumption (kWh)	Average (kWh)	F.P.	Penalty %	Penalty ($)	Total Amount ($)	Remarks
January	60,302.4	81.1	0.754	14.0%	836.73	9,122.46	
February	69,729.6	103.8	0.753	14.0%	963.53	11,117.47	
March	73,377.6	98.6	0.745	15.0%	1,007.00	13,191.18	
April	67,224.0	93.4	0.754	14.0%	965.00	11,275.08	
May	73,200.0	98.4	0.754	14.0%	1,184.08	11,791.51	
June	72,355.2	100.5	0.755	14.0%	1,005.00	11,708.50	
July	69,158.4	93.0	0.755	14.0%	960.36	11,309.78	
August	72,000.0	96.8	0.755	14.0%	999.33	11,711.02	
September	73,632.0	102.3	0.755	14.0%	1,192.19	13,431.67	
October	69,489.6	93.4	0.751	14.0%	1,214.00	13,301.65	
November	70,425.6	97.8	0.750	15.0%	1,419.44	15,213.03	
December	71,457.6	96.0	0.763	13.0%	1,146.00	12,043.98	
	842,352.0	96.2	0.754		12,892.66	145,217.33	



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Doc.2

INVOICE OF ELECTRIC POWER COMPANY for ANDA HEAD OFFICE BUILDING

Electric Power Company

Potencia Contratada : 297.00 kW

Medidor	Multi.	Desde	Hasta	Lecture Actual	Lecture Anterior		Consumo		
74920	480	2008/12/4	2009/1/4	1,922.59	1,907.17	**15.42**	7,401.60	kWh	[PUNTA:5h/d]
74920	480	2008/12/4	2009/1/4	1,803.88	1,787.47	**16.41**	7,876.80	kWh	[VALLE:6h/d]
74920	480	2008/12/4	2009/1/4	7,039.94	6,943.27	**96.67**	46,401.60	kWh	[RESTO:13h/d]
74920	480	2008/12/4	2009/1/4	**0.66**	0.64		316.80	kw	[Max. Distribution Power]
74920	1	2008/12/4	2009/1/4	**74.20**	76.30		74.20	F.P.	[Average Power Factor]

Cargo de Comercializacion	$	9.570000		
Costo por tasa municipal por poste	$	0.140000		
Cargo por Energia Punta	$	907.860000	0.122657	[PUNTA : $/kWh]
Cargo por Energia Valle	$	774.720000	0.098354	[VALLE : $/kWh]
Cargo por Energia Resto	$	5,528.510000	0.119145	[RESTO : $/kWh]
Cargo por Distribucion Potencia	$	1,013.970000	3.200674	
Factor de Potencia	$	1,197.040000	15%	[Power Factor Penalty]
Subtotal	$	**9,431.810000**		
Impuesto de IVA	$	1,226.140000	13%	[Tax]
Compensacion por fallas	$	-0.190000		
Aseo	$	1,259.850000		
Alumbrado Publico	$	74.160000		
CONTRIBUCION ESPEC.-PARQUES	$	200.000000		
Total	$	**12,191.770000**		

July 2009
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Doc.3

DAILY POWER CONSUMPTION OF ANDA HEAD OFFICE BUILDING

Wattmeter	19-Feb		20-Feb		21-Feb		22-Feb		23-Feb		24-Feb		25-Feb		26-Feb		27-Feb		28-Feb		1-Mar		2-Mar	
	Thursday		Friday		Saturday		Sunday		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Monday	
1																								
2	7:37	15:47	7:34	16:01			11:05		7:46	15:58	7:46	16:05			7:39	15:56	7:33	16:03					7:42	16:04
3	1828.92	1828.92	1829.47	1829.47			1830.51		1831.06	1831.06	1831.59	1831.59			1832.62	1832.62	1833.13	1833.13					1834.77	
4	7219.11	7223.48	7224.25	7228.57			7230.84		7231.85	7236.22	7236.94	7241.23			7243.05	7247.3	7248	7252.37					7255.17	7259.33
5	1946.73	1946.73	1947.31	1947.31			1948.3		1948.78	1948.78	1949.28	1949.28			1950.24	1950.24	1950.74	1950.74					1952.23	
6	0.11	0.11	0.11	0.11			0.11		0.11	0.11	0.11	0.11			0.11	0.11	0.11	0.11					0.11	0.11
7	0.64	0.64	0.64	0.64			0.64		0.64	0.64	0.64	0.64			0.64	0.64	0.64	0.64					0.64	0.64
8	0.16	0.16	0.16	0.16			0.16		0.16	0.16	0.16	0.16			0.16	0.16	0.16	0.16					0.16	0.16
9	0.769	0.774	0.772	0.776			0.770		0.766	0.770	0.768	0.772			0.767	0.770	0.768	0.771					0.765	0.768
10	664	664	664	664			664		664	664	664	664			664								665	667
11	7367	7367	7367	7367			7367		7367	7367	7367	7367			7367								7369	7371

Total Power Consumption a day

punta (kWh)	-	0	264	0	0	0	499.2	0	264	0	254.4	0	0	0	494.4	0	244.8	0	0	0	0	0	787.2	
resto (kWh)	-	2097.6	369.6	2073.6	0	0	1089.6	0	484.8	2097.6	345.6	2059.2	0	0	873.6	2040	336	2097.6	0	0	0	0	1344	1996.8
valle (kWh)	-	0	278.4	0	0	0	475.2	0	230.4	0	240	0	0	0	460.8	0	240	0	0	0	0	0	715.2	

Average Power Consumption a day

Punta	Accum.Hour	-		5:00		10:00			5:00			5:00		10:00				5:00		15:00					
18-23h	Ave.kWh	-		52.8		49.9			52.8			50.9		49.4				49.0		52.5					
Resto	Accum.Hour	-	8:10	4:47	8:27	21:04			9:41		8:12	4:48	8:19	17:34			8:17	4:37	8:30	30:39					8:22
5-18h	Ave.kWh	-	256.8	77.3	245.4	51.7			50.1		255.8	72.0	247.6	49.7			246.3	72.8	246.8	43.8					238.7
Valle	Accum.Hour	-		6:00		12:00			6:00			6:00		12:00				6:00		18:00					
23-5h	Ave.kWh	-		46.4		39.6			38.4			40.0		38.4				40.0		39.7					

Instantaneous Maximum Power Consumption

punta (kW)		52.8		52.8		52.8		52.8		52.8		52.8		52.8		52.8		52.8		52.8		52.8		52.8
resto (kW)		307.2		307.2		307.2		307.2		307.2		307.2		307.2		307.2		307.2		307.2		307.2		307.2
valle (kW)		76.8		76.8		76.8		76.8		76.8		76.8		76.8		76.8		76.8		76.8		76.8		76.8

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Doc.4

HOURLY POWER CONSUMPTION OF ANDA HEAD OFFICE BUILDING

INSTRUCTION VALUE OF WATTMETER on February 19 2009

		19-Feb								Remarks
		8:00	9:10	10:00	11:30	12:30	14:00	15:00	16:00	
Date	0001	19.02.09	19.02.09	19.02.09	19.02.09	19.02.09	19.02.09	19.02.09	19.02.09	
Time	0002	7:37	8:52	9:50	11:10	12:11	13:38	14:37	15:47	
A	0003	1828.92	1828.92	1828.92	1828.92	1828.92	1828.92	1828.92	1828.92	
B	0004	7219.11	7219.68	7220.22	7220.99	7221.52	7222.29	7222.86	7223.48	
C	0005	1946.73	1946.73	1946.73	1946.73	1946.73	1946.73	1946.73	1946.73	
A	0006	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	
B	0007	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	
C	0008	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	
Cos Phi	0009	0.769	0.77	0.771	0.771	0.772	0.773	0.773	0.774	
	0010	664	664	664	664	664	664	664	664	
	0011	7367	7367	7367	7367	7367	7367	7367	7367	
	Er	0	0	0	0	0	0	0	0	
	F	0	0	0	0	0	0	0	0	

POWER CONSUMPTION EVERY HOUR

			8:10 - 9:10	9:10 - 10:00	10:00 - 11:30	11:30 - 12:30	12:30 - 14:00	14:00 - 15:00	15:00 - 16:00	Remarks
A : Punta	kWh	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
(18h-23h)	kVA	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Ave. kWh	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
B : Resto	kWh	-	273.6	259.2	369.6	254.4	369.6	273.6	297.6	
(5h-18h)	kVA	-	355.3	336.2	479.4	329.5	478.1	353.9	384.5	
	Ave. kWh	-	218.9	268.1	277.2	250.2	254.9	278.2	255.1	
C : Valle	kWh	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
(23h-5h)	kVA	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Ave. kWh	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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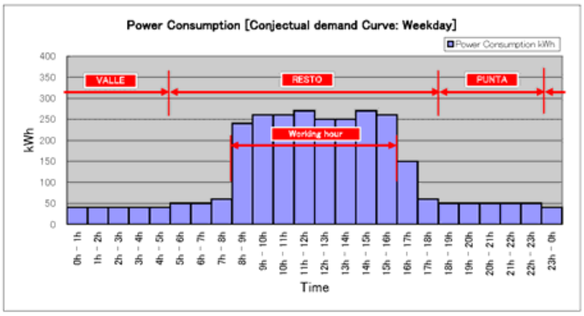
Doc.5

Conjectual Demand Curve - ANDA Head Office

[Weekday]

Time	Power Consumption kWh	Power Consumption kVA
0h - 1h	40	52
1h - 2h	40	52
2h - 3h	40	52
3h - 4h	40	52
4h - 5h	40	52
5h - 6h	50	65
6h - 7h	50	65
7h - 8h	60	78
8h - 9h	240	312
9h - 10h	260	338
10h - 11h	260	338
11h - 12h	270	351
12h - 13h	250	325
13h - 14h	250	325
14h - 15h	270	351
15h - 16h	260	338
16h - 17h	150	195
17h - 18h	60	78
18h - 19h	50	65
19h - 20h	50	65
20h - 21h	50	65
21h - 22h	50	65
22h - 23h	50	65
23h - 0h	40	52
TOTAL	2920	3792

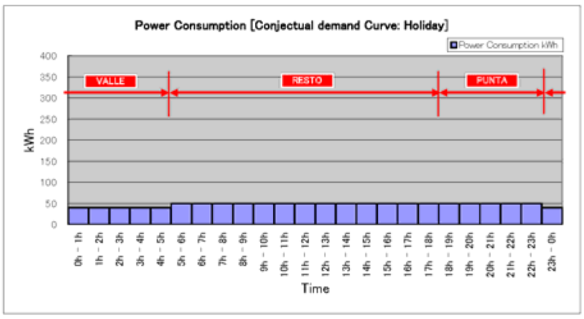
PF=0.77



[Holiday]

Time	Power Consumption kWh	Power Consumption kVA
0h - 1h	40	52
1h - 2h	40	52
2h - 3h	40	52
3h - 4h	40	52
4h - 5h	40	52
5h - 6h	50	65
6h - 7h	50	65
7h - 8h	50	65
8h - 9h	50	65
9h - 10h	50	65
10h - 11h	50	65
11h - 12h	50	65
12h - 13h	50	65
13h - 14h	50	65
14h - 15h	50	65
15h - 16h	50	65
16h - 17h	50	65
17h - 18h	50	65
18h - 19h	50	65
19h - 20h	50	65
20h - 21h	50	65
21h - 22h	50	65
22h - 23h	50	65
23h - 0h	40	52
TOTAL	1140	1481

PF=0.77



July 2009
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Doc.6

Power Consumption Analysis (from Wattmeter information)

1.Working Hour Analysis

Table1. Working hour per year

per year	Total hour	Working hour	Rest hour	Remarks
52 weeks	8,760.0	−	−	
365 days	8,760.0	−	−	
250 weekdays	6,000.0	2000.0	4000.0	
115 holidays	2,760.0	0.0	2760.0	
Total	8,760.0	2000.0	6760.0	
Ratio	100.0%	22.8%	77.2%	

2.Power consumption of Working Hour

Table2. Power consumption of Working hour per year

per year	Total (kWh)	Working hour (kWh)	Rest hour (kWh)	Remarks
250 weekdays	730,000.0	515,000.0	215,000.0	
115 holidays	131,100.0	0.0	131,100.0	
Total	861,100.0	515,000.0	346,100.0	
Ratio	100.0%	59.8%	40.2%	

Note : Analysis by conjectual data

3.Load Factor

Table3. Load Factor Table of ANDA Head Office

	Consumption (kWh)	Average (kWh)	Max. (kWh)	Load Factor	Remarks
Annual	842,352.0	96.2	316.8	**30.4%**	CAESS's Invoice
Monthly	70,196.0	97.5	316.8	**30.8%**	CAESS's Invoice
Daily (weekday)	2,900.0	120.8	307.2	**39.3%**	Wattmeter's data
Punta (weekday)	−	50.0	52.8	**94.7%**	Wattmeter's data
Retso (weekday)	−	250.0	307.2	**81.4%**	Wattmeter's data
Valle (weekday)	−	40.0	76.8	**52.1%**	Wattmeter's data
Daily (holiday)	1,100.0	45.8	76.8	**59.7%**	Wattmeter's data

July 2009
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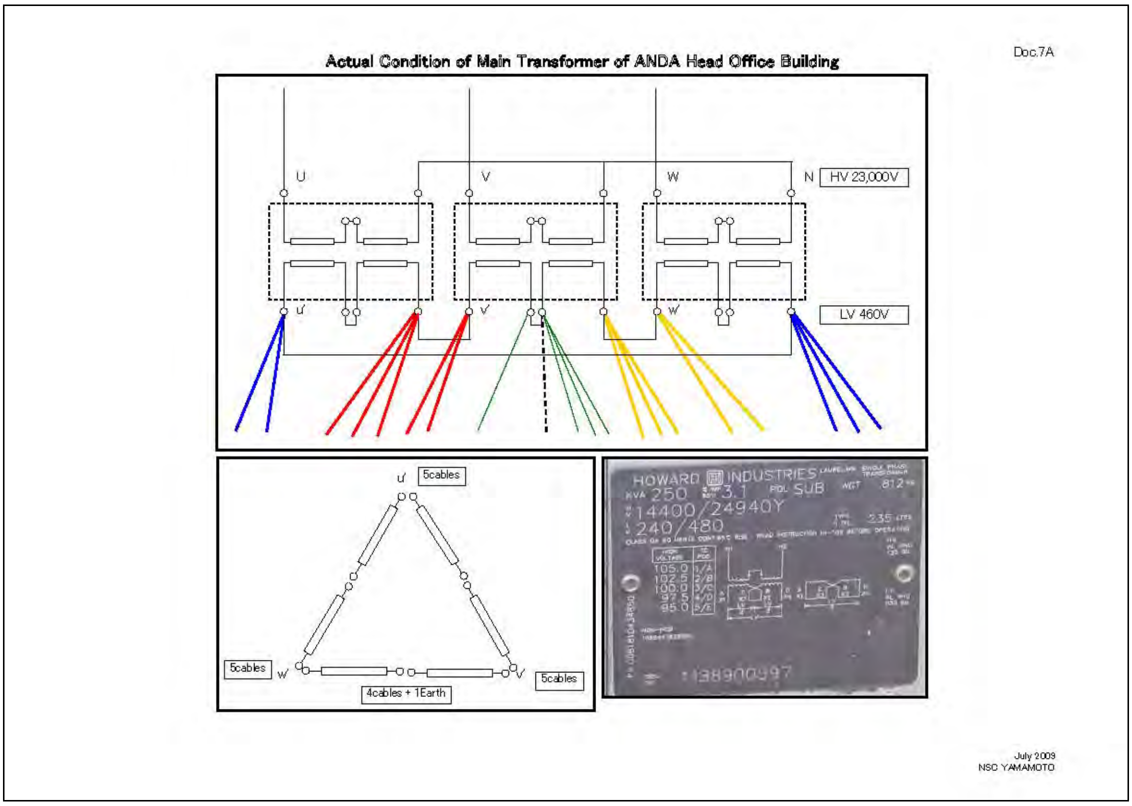
Doc.7A
Actual Condition of Main Transformer of ANDA Head Office Building
U
V
W
N
HV 23,000V
u'
v'
w'
LV 460V
u'
5cables
5cables
w'
v'
5cables
4cables + 1Earth
HOWARD INDUSTRIES
KVA 250
3.1
SUB
14400/24940Y
240/480
July 2009
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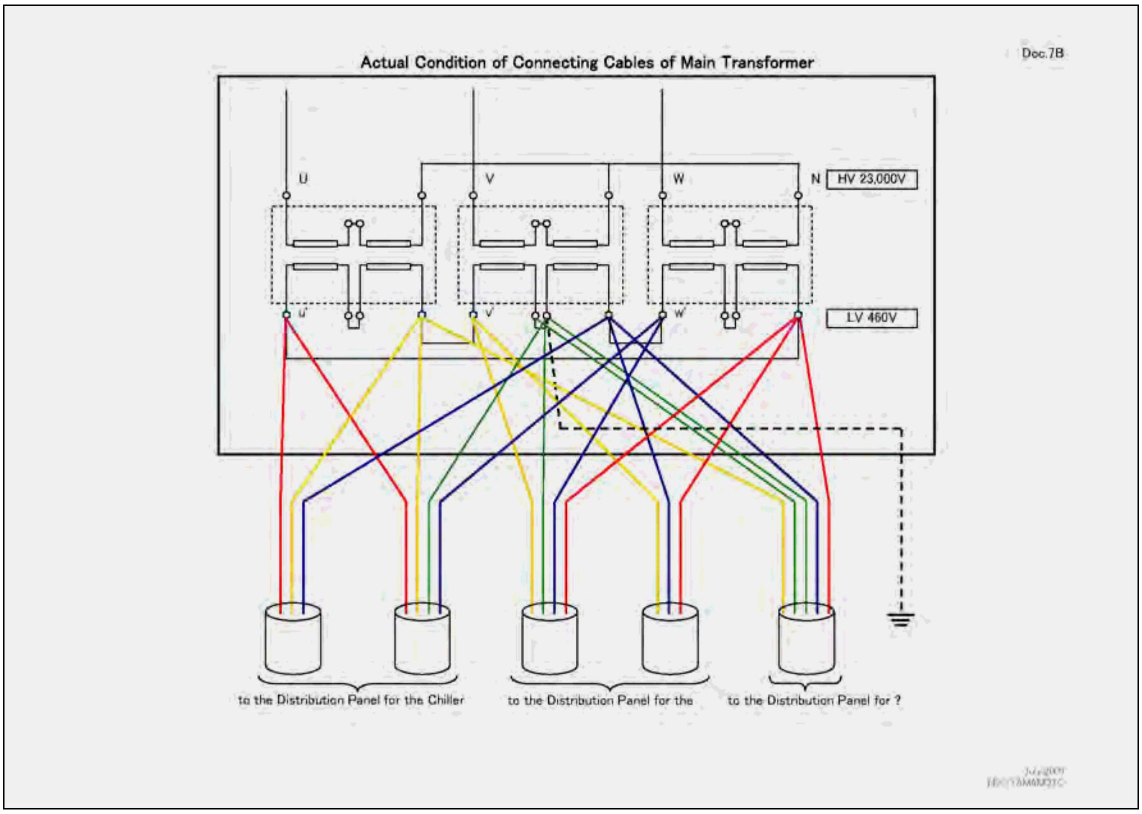
Doc.7B
Actual Condition of Connecting Cables of Main Transformer
U
V
W
N
HV 23,000V
u'
v'
w'
LV 460V
to the Distribution Panel for the Chiller
to the Distribution Panel for the
to the Distribution Panel for ?

Doc.8

Equipment List of ANDA headoffice

	Floor	Feeder	Equipment	Power Consumption (W)	Phantom Load (W)	Voltage	Ampere	Qnt'	Total Power Consumption	Total Phantom Load	Remarks
1									W	W	
2									W	W	
3									W	W	
4									W	W	
5									W	W	
6									W	W	
7									W	W	
8									W	W	
9									W	W	
10									W	W	
11									W	W	
12									W	W	
13									W	W	
14									W	W	
15									W	W	
16									W	W	
17									W	W	
18									W	W	
19									W	W	
20									W	W	
21									W	W	
22									W	W	
23									W	W	

July 2009
NSC YAMAMOTO

Doc.9

Page(__/__)

Power Consumption Table

DATE ____________

PANEL No. ____________ FEEDER No. ____________

		Voltage (V)				Current (A)				Power Factor				Active Power (kW)				Reactive Power (kVAR)				Power Consumption (kWh)				Remarks
		L1	L2	L3	3-L	L1	L2	L3	3-L	L1	L2	L3	3-L	L1	L2	L3	3-L	L1	L2	L3	3-L	L1	L2	L3	3-L	
0:00	1:00																									
1:00	2:00																									
2:00	3:00																									
3:00	4:00																									
4:00	5:00																									
5:00	6:00																									
6:00	7:00																									
7:00	8:00																									
8:00	9:00																									
9:00	10:00																									
10:00	11:00																									
11:00	12:00																									
12:00	13:00																									
13:00	14:00																									
14:00	15:00																									
15:00	16:00																									
16:00	17:00																									
17:00	18:00																									
18:00	19:00																									
19:00	20:00																									
20:00	21:00																									
21:00	22:00																									
22:00	23:00																									
23:00	0:00																									

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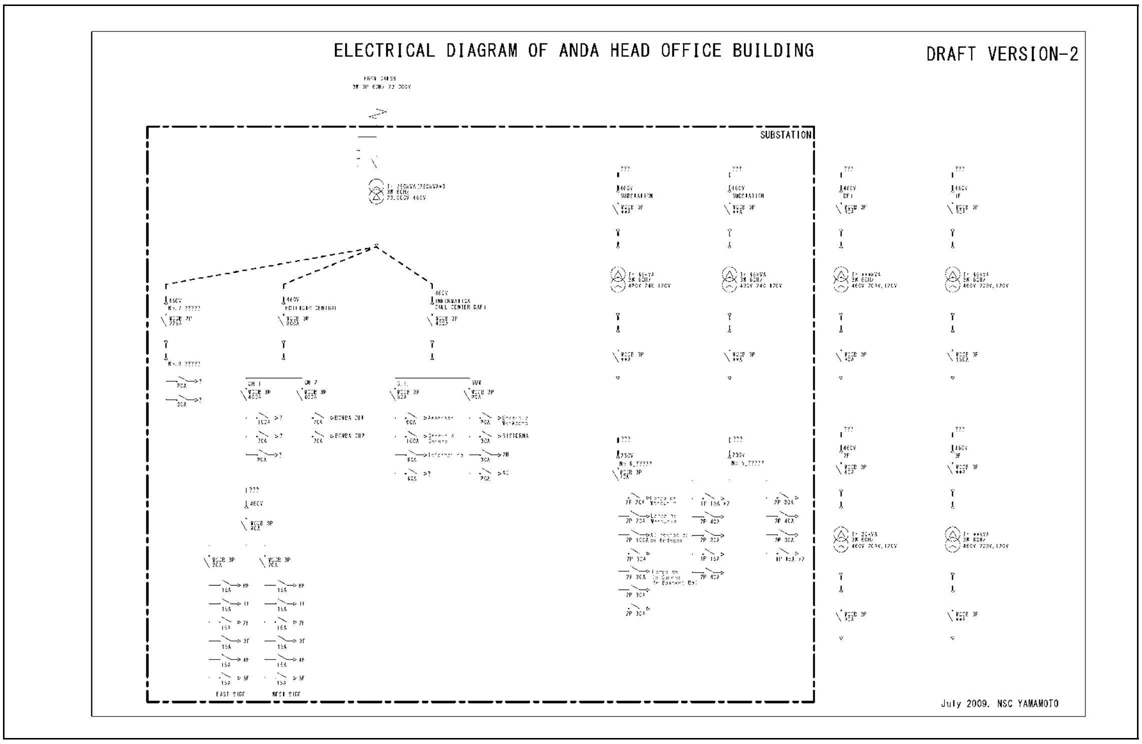
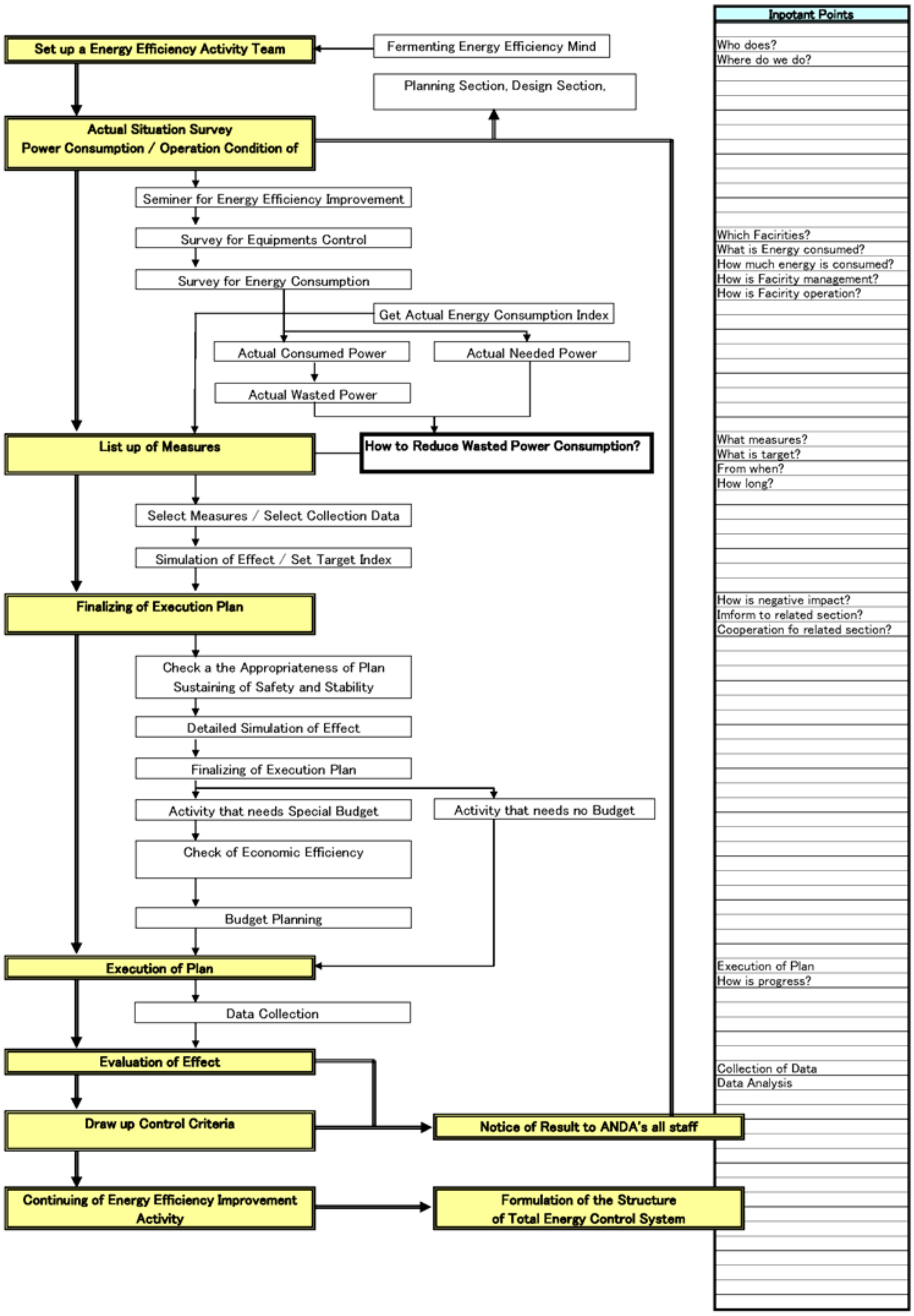

ELECTRICAL DIAGRAM OF ANDA HEAD OFFICE BUILDING
DRAFT VERSION-2
SUBSTATION
EAST SIDE
WEST SIDE
July 2009, NSC YAMAMOTO

2009 年 7 月 20 日 研修計画策定ワークショップ

The Project for Capacity Development of ANDA for Operational Improvement

ENERGY EFFICIENCY INPROVEMENT FLOWSHEET



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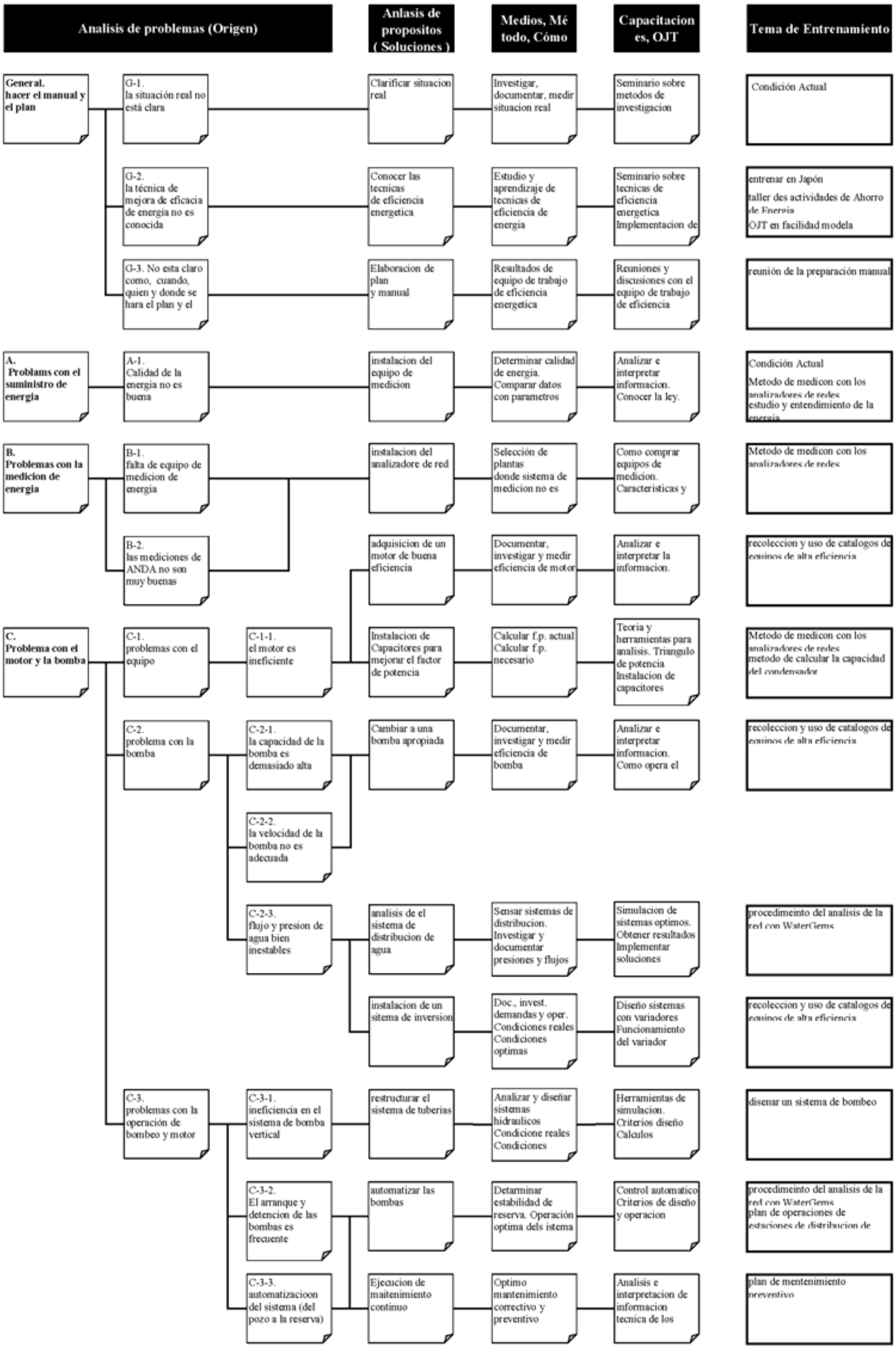
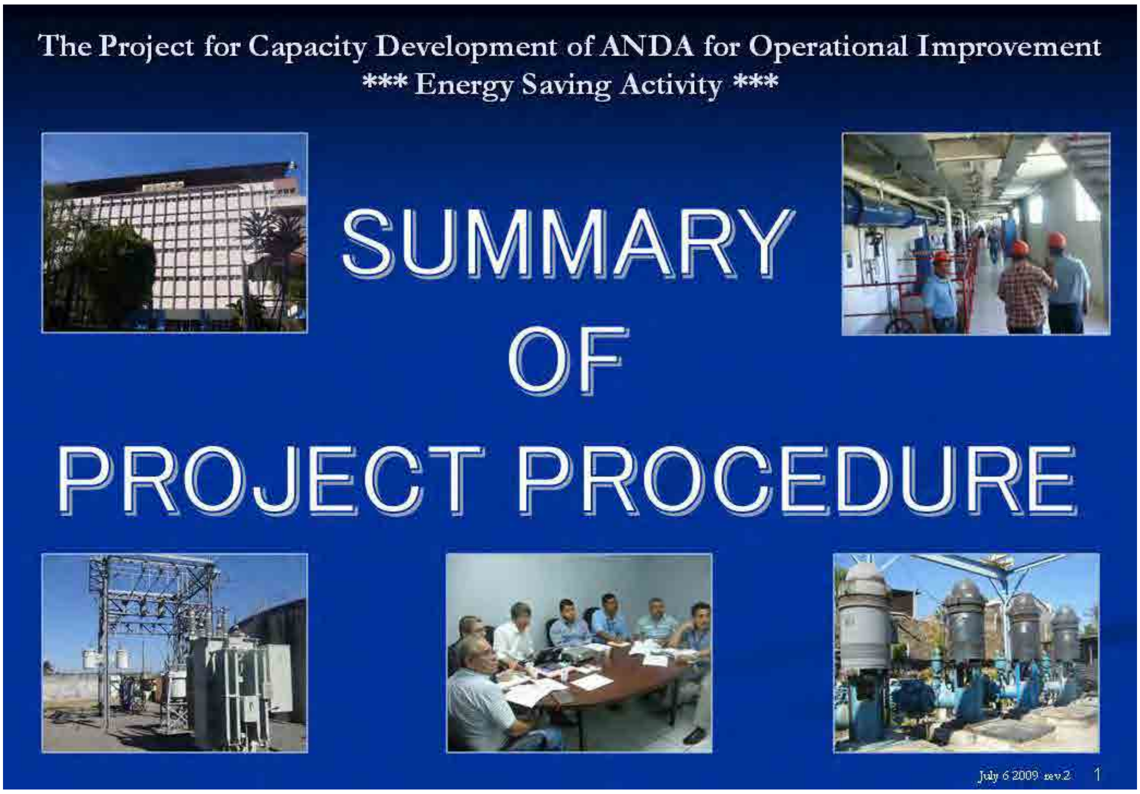
200907A



July 2009
NSC YAMAMOTO

2009 年 10 月 26 日 パイロット施設の節電手法について 4



The Project for Capacity Development of ANDA for Operational Improvement
*** Energy Saving Activity ***

- Steps of Briefings for Project Members
  - 1. Outline
  - 2. Project Schedule
  - 3. What is Energy Efficiency
  - 4. Roles of Members for Actual Situation Survey
  - 5. Procedure of Field Tests
  - 6. Selection of Pilot Facilities (Inefficiency Facilities in AMSS)
  - 7. Energy Efficiency Measures Technique
  - 8. Simulation of Effect of Measures
  - 9. Execution of Measures
  - 10. Assessment of Effect of Measures

2

The Project for Capacity Development of ANDA for Operational Improvement
*** Energy Saving Activity ***

Steps of Briefings for Project Members

- 11. Roles of Members for Making Energy Efficiency Manual
- 12. Roles of Members for Making Energy Efficiency Plan for All Facilities of ANDA
- 13. Analysis of Water Transmission Line
- 14. Analysis of Distribution Pipe Network
- 15. Simulation of Efficiency Improvement for Water Transmission line and Distribution pipe network
- 16. Roles of Members for Making Water Transmission and Distribution Improvement Plan

3

The Project for Capacity Development of ANDA for Operational Improvement
*** Energy Saving Activity ***

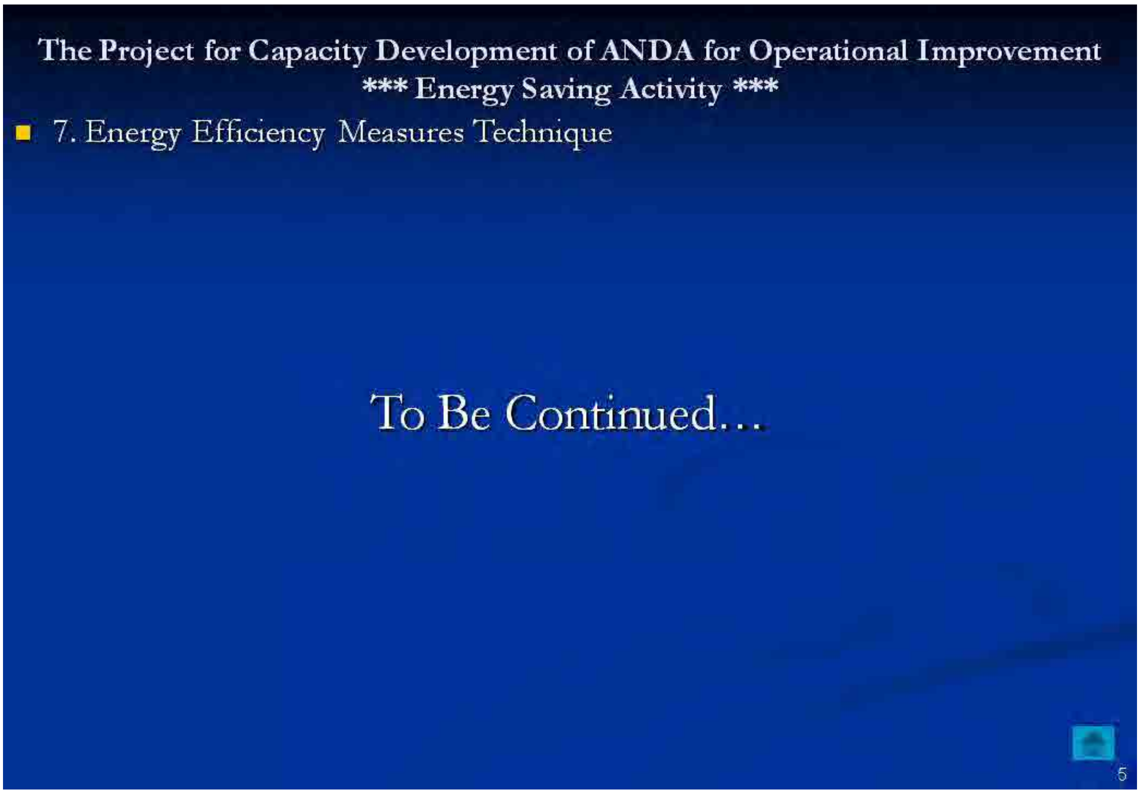
Steps of Briefings for Project Members

- 1. Outline
- 2. Project Schedule
- 3. What is Energy Efficiency
- 4. Roles of Members for Actual Situation Survey
- 5. Procedure of Field Tests

Today's Briefing

- 6. Selection of Pilot Facilities (Inefficiency Facilities in AMSS)
- 7. Energy Efficiency Measures Technique
- 8. Simulation of Effect of Measures
- 9. Execution of Measures
- 10. Assessment of Effect of Measures

4

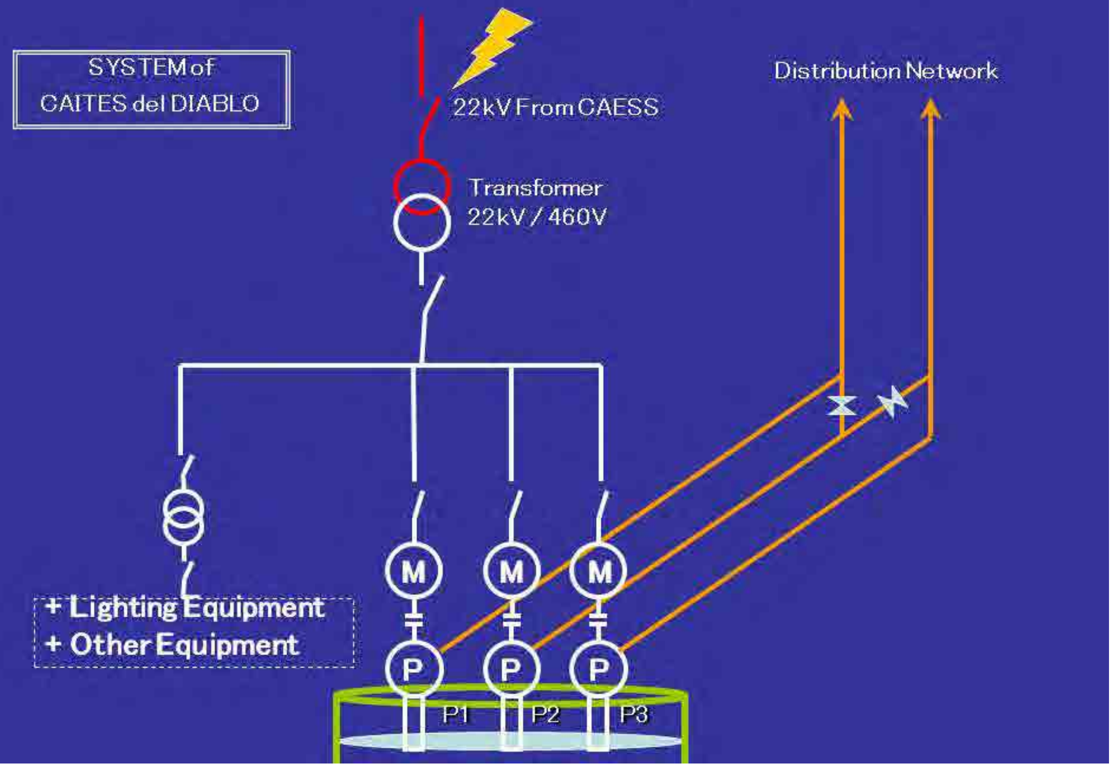

The Project for Capacity Development of ANDA for Operational Improvement
*** Energy Saving Activity ***
7. Energy Efficiency Measures Technique
To Be Continued…
5

THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT

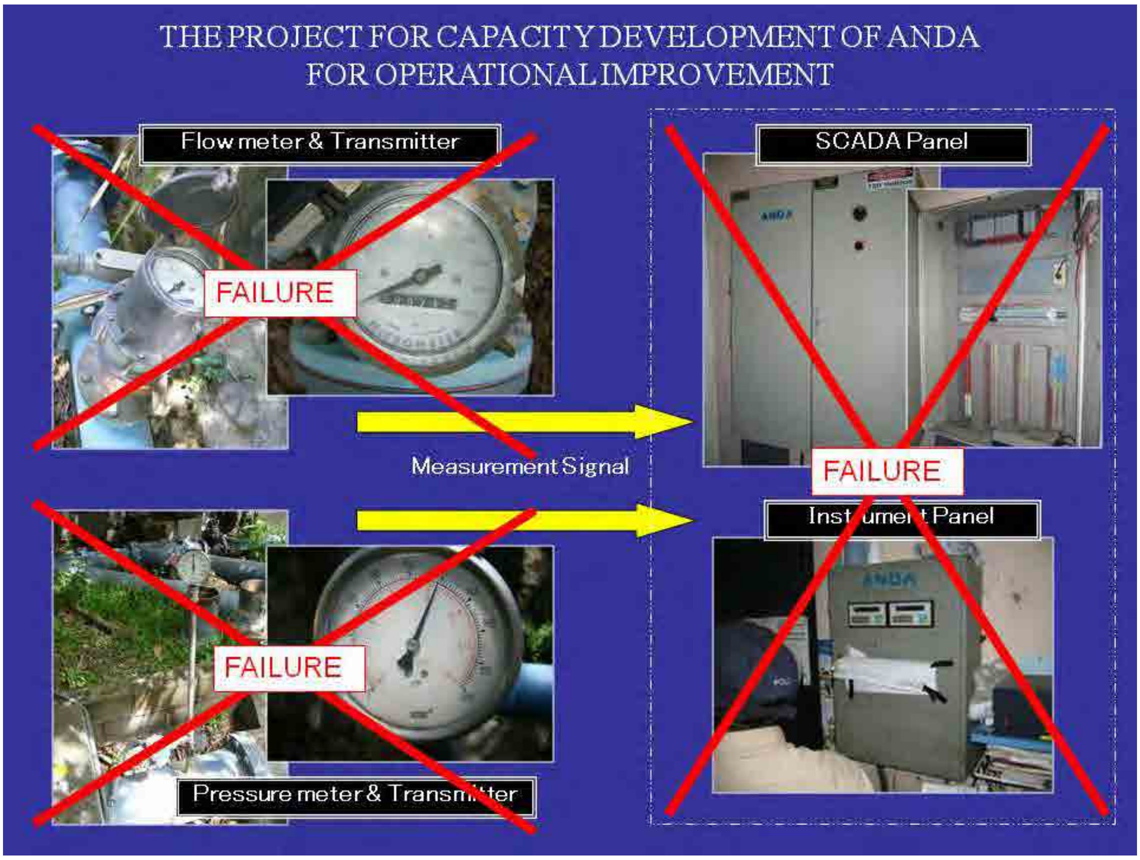
Analysis Case #1

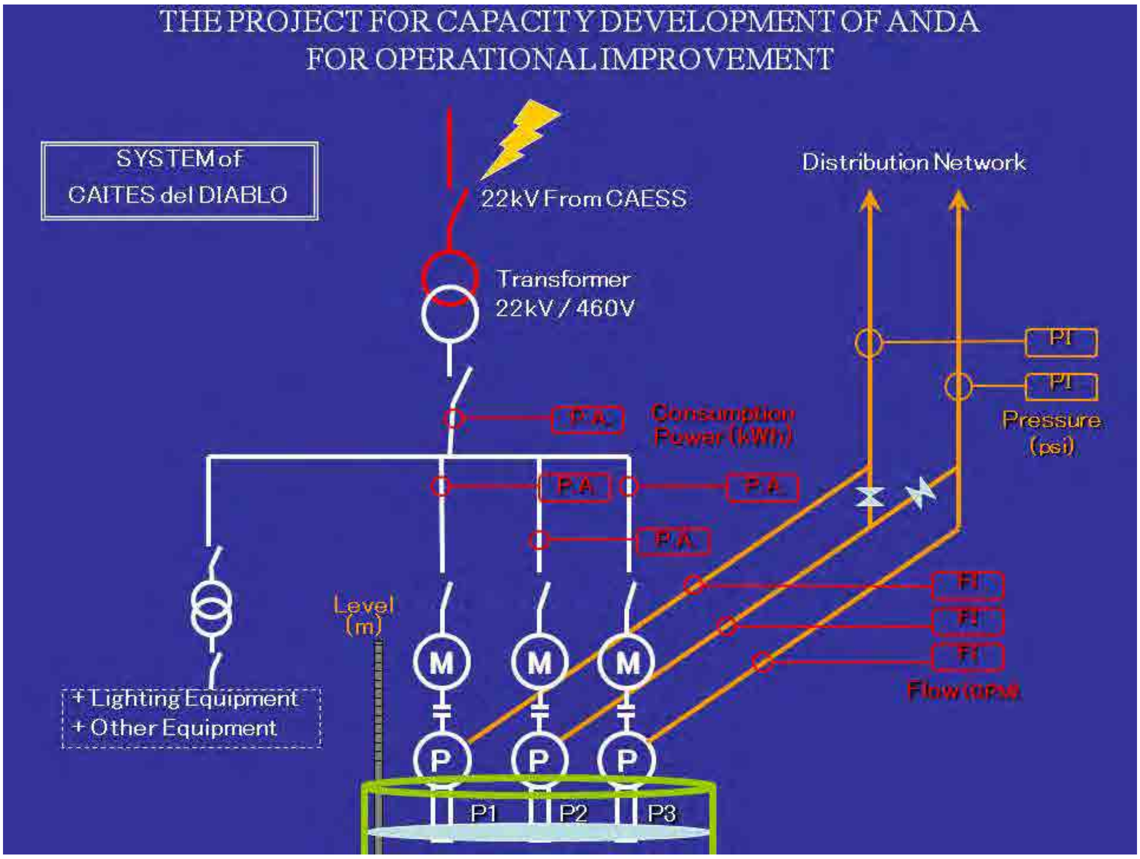
Facility	Pumping Station " Caites del Diablo"
Equipments	Transformer 3P x 1 (750kVA , 22kV / 460V) Pump x 3 (1737GPM , 290 FT) Motor x 3 (200HP / 140kW , 460V) Pump x 2 (237GPM , 237FT) Motor x 2 (25HP / 18kW , 460V)
(Consumption Power) Bill of CAESS (2009.Sep.3 - Oct.3)	Max power : 264kW Consumption Power : 174,672 kWh / Month Power Factor : 0.951 Amount Billed : $ / Month
Remarks	2 small pumps (Motor 25HP) are out of service. Outdoor lighting has been installed. Chlorine injection equipment is a pressure injection type.

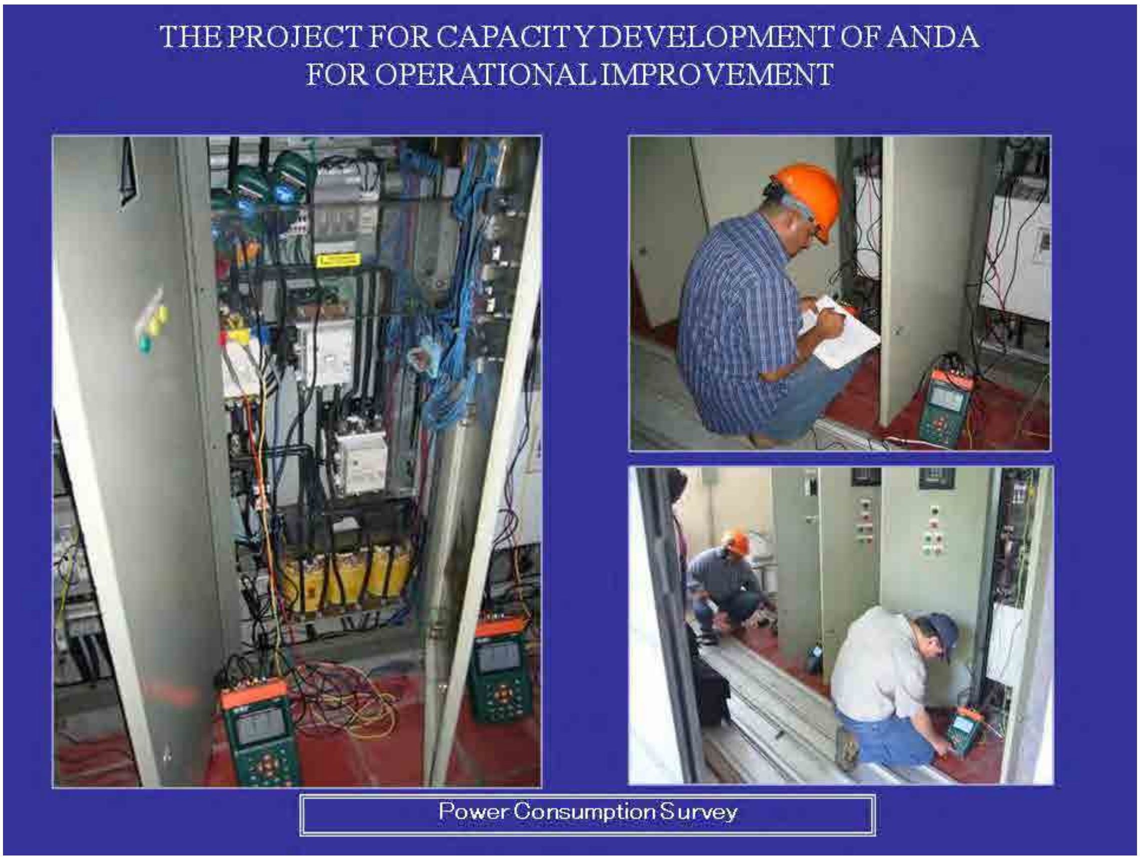
THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT




THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
Transformer
750kVA x 1
Pump Control Panel
3P 3W22kV
From CAESS
3P
3W
460V
Pump x 3 (1737GPM, 290FT)
Motor x 3 (200HP, 460V)
3P
3W
460V
Distribution
Network


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
Flow meter & Transmitter
FAILURE
SCADA Panel
Measurement Signal
FAILURE
Instrument Panel
FAILURE
Pressure meter & Transmitter


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
SYSTEM of
CAITES del DIABLO
22kV From CAESS
Transformer
22kV / 460V
Distribution Network
PI
PI
Pressure
(psi)
P.A.
Consumption
Power (kWh)
P.A.
P.A.
P.A.
FI
FI
FI
Level
(m)
M
M
M
P
P
P
+ Lighting Equipment
+ Other Equipment
P1
P2
P3


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
Power Consumption Survey

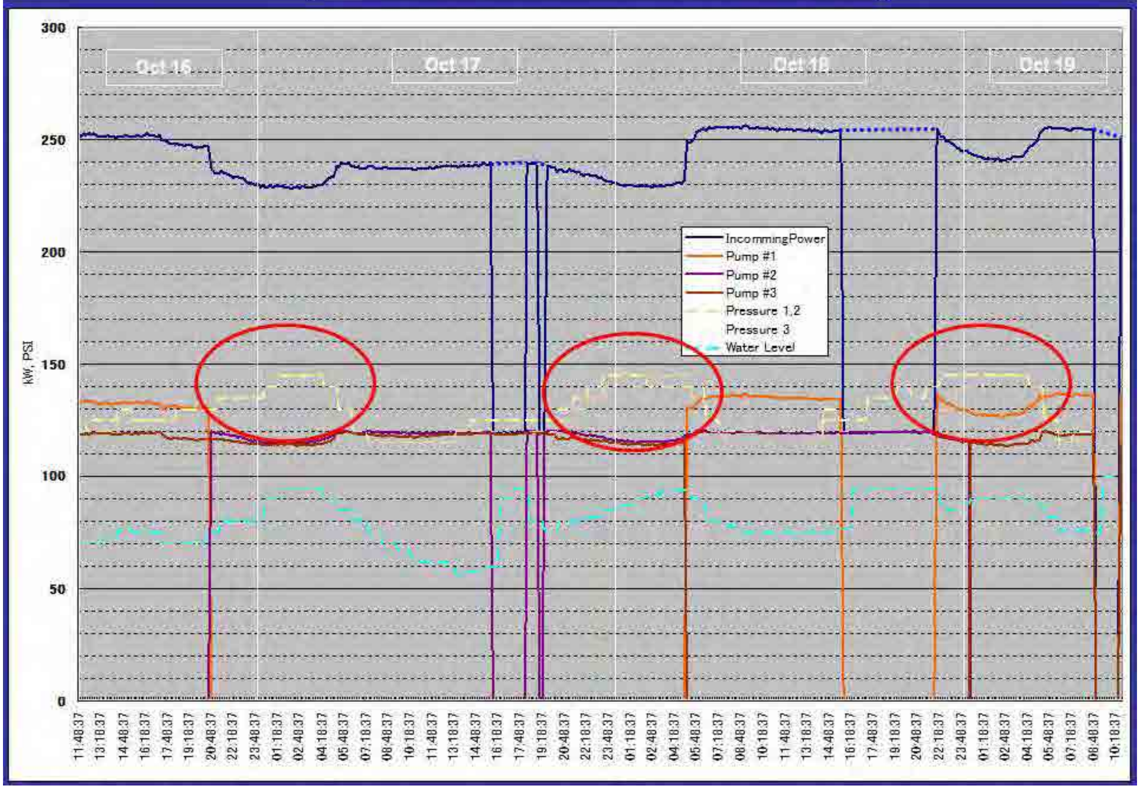
THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA FOR OPERATIONAL IMPROVEMENT

Survey Result

(Survey period : 2009 July 31 – Aug 27, Oct 16 – 19)

Daily Consumption Power	4,800kWh ~ 5,520kWh / day (Transformer's loss is not included)	
Max. Consumption Power	256.6kW / 267.4kVA (Transformer's loss is not included)	
Power Consumption Motor #1	Max. 137.1kW Max. 139.2kVA P.F. 0.99	Original Max. 137.1kW Max. *******kVA P.F. *******
Power Consumption Motor #2	Max. 120.5kW Max. 131.9kVA P.F. 0.92	Original Max. 120.5kW Max. 142.7kVA P.F. 0.84
Power Consumption Motor #3	Max. 120.1kW Max. 123.6kVA P.F. 0.97	Original Max. 120.1kW Max. 141.4kVA P.F. 0.85

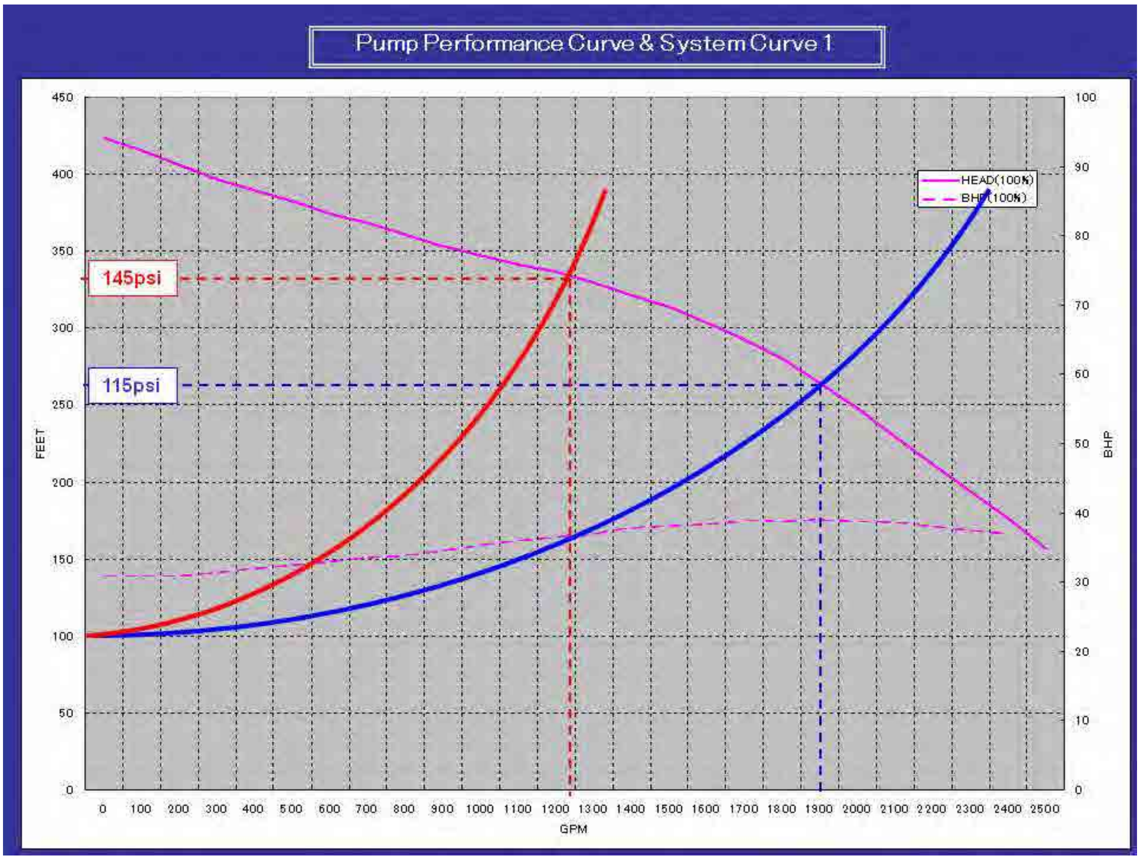
Measurement Data (2009,Oct 16 – 19)

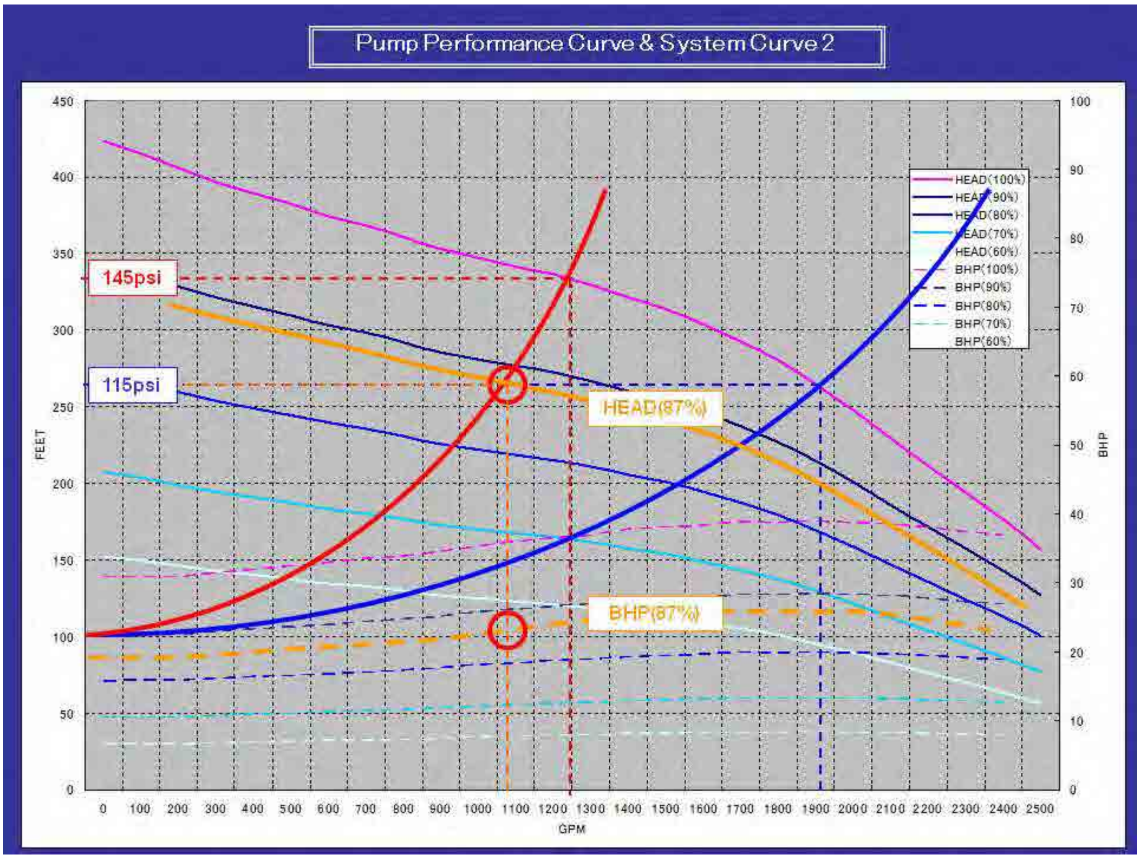


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT

- Energy Loss Issue
  → High Pressure / Water Head at nighttime

- Proposed Measures
  → Pump Speed Control Method
  Control Pump Speed by Flow and Pressure





THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT

Relation amang
Speed Control, Discharge Volume, Water Head
and Pump Input Power

Discharge Volume : $Q_2 = Q_1 \times (N_2 / N_1)$

Water Head : $H_2 = H_1 \times (N_2 / N_1)^2$

Pump Input Power : $P_2 = P_1 \times (N_2 / N_1)^3$

N_1 = Nominal Speed
N_2 = Controlled Speed

THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT

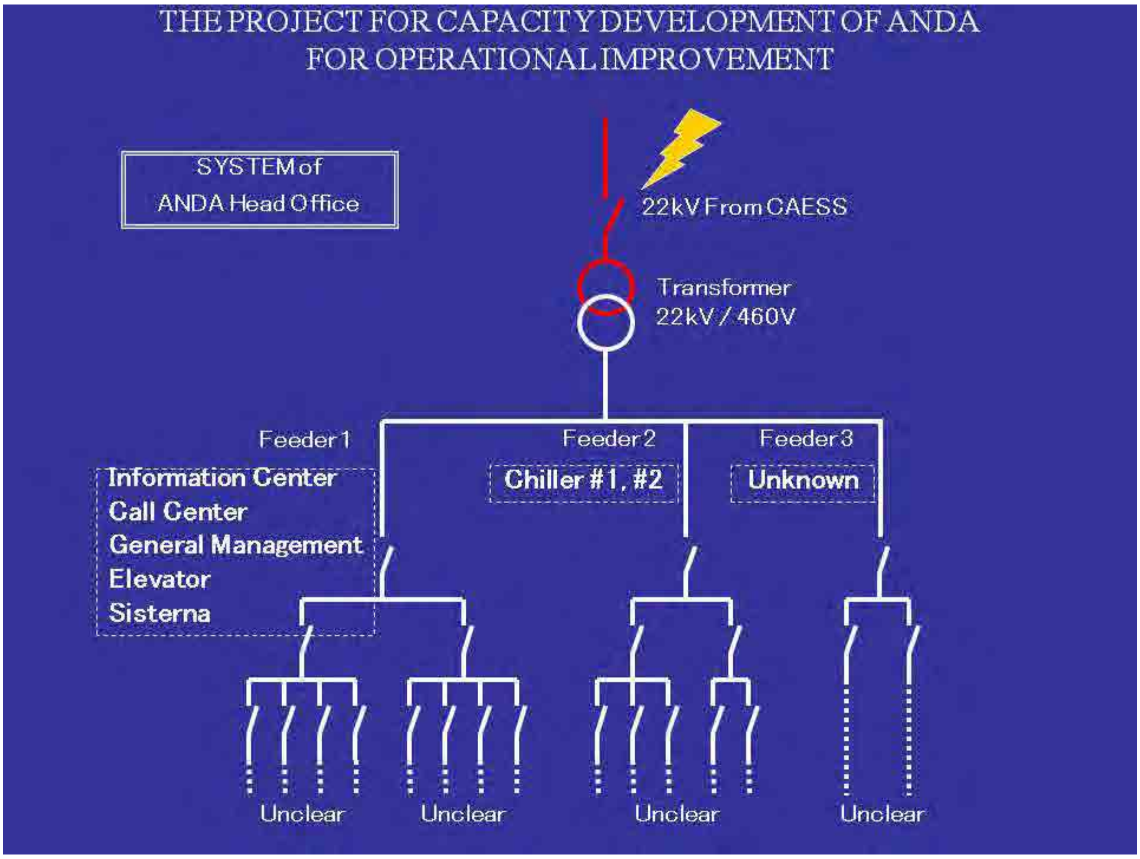
Merit of Pump Speed Control Method

Controlled Speed	Discharge Volume	Water Head	Pump Input Power
100%	100%	100%	100%
90%	90%	81%	73%
80%	80%	64%	51%
70%	70%	49%	34%
60%	60%	36%	21%

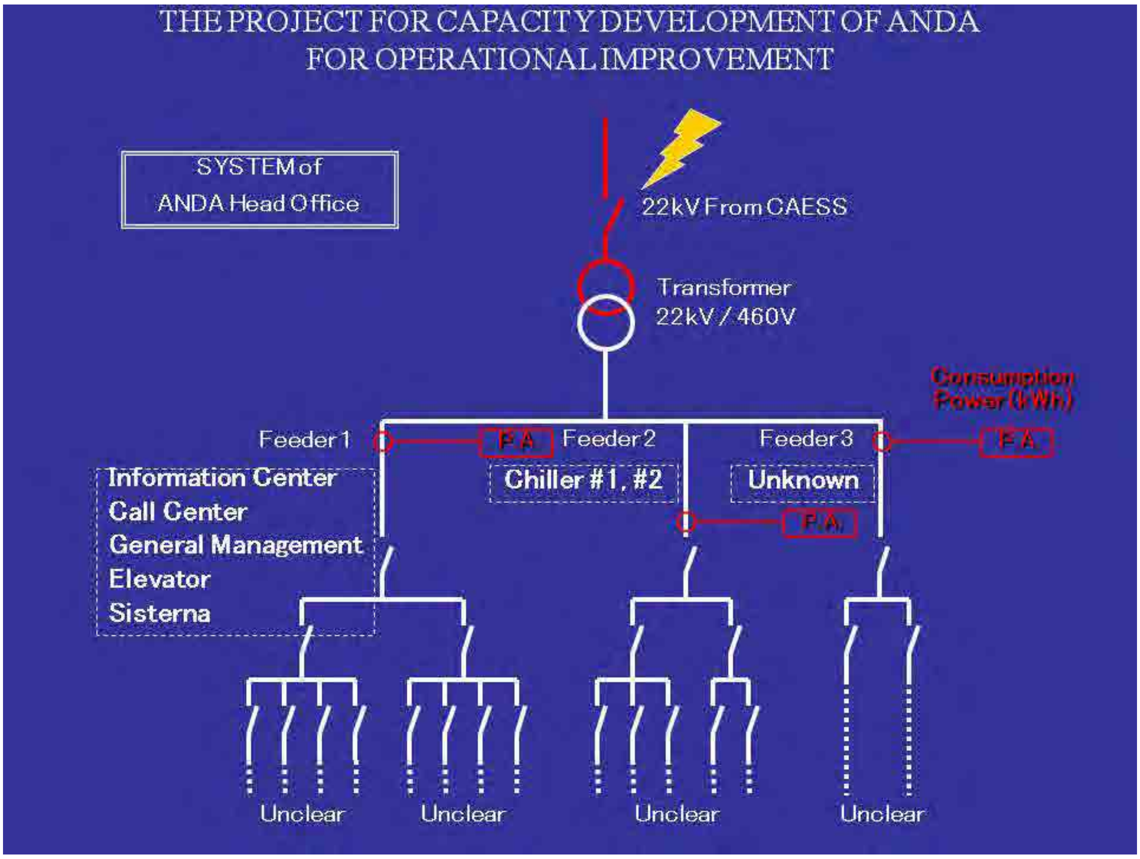
THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT

Analysis Case #2

Facility	Office Building " ANDA Head Office"
Equipments	Main Transformer 1P x 3 (250 x 3 =750kVA , 22kV / 460V) Auxiliary Transformer 3P x more than 6 (30 ~ 45kVA , 460V / 205 / 110 V)
(Consumption Power) Bill of CAESS (2009.Sep.3 - Oct.3)	Max power : 340.8kW Consumption Power : 73,348.8 kWh / Month Power Factor : 0.782 Amount Billed : $ / Month
Remarks	Detail information of connected load is unclear, because wiring diagram is not kept.


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
SYSTEM of
ANDA Head Office
22kV From CAESS
Transformer
22kV / 460V
Feeder 1
Feeder 2
Feeder 3
Information Center
Call Center
General Management
Elevator
Sisterna
Chiller #1, #2
Unknown
Unclear
Unclear
Unclear
Unclear


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
Transformer
250kVA x 3
3P 3W 22kV
From CAESS
Distribution Panels
Office Building
3P 3W 460V
1P 3W 230V
Feeder 3
Feeder 2
Feeder 1


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
SYSTEM of
ANDA Head Office
22kV From CAESS
Transformer
22kV / 460V
Consumption
Power (kWh)
Feeder 1
P.A
Feeder 2
Feeder 3
P.A
Information Center
Call Center
General Management
Elevator
Sisterna
Chiller #1, #2
Unknown
P.A
Unclear
Unclear
Unclear
Unclear

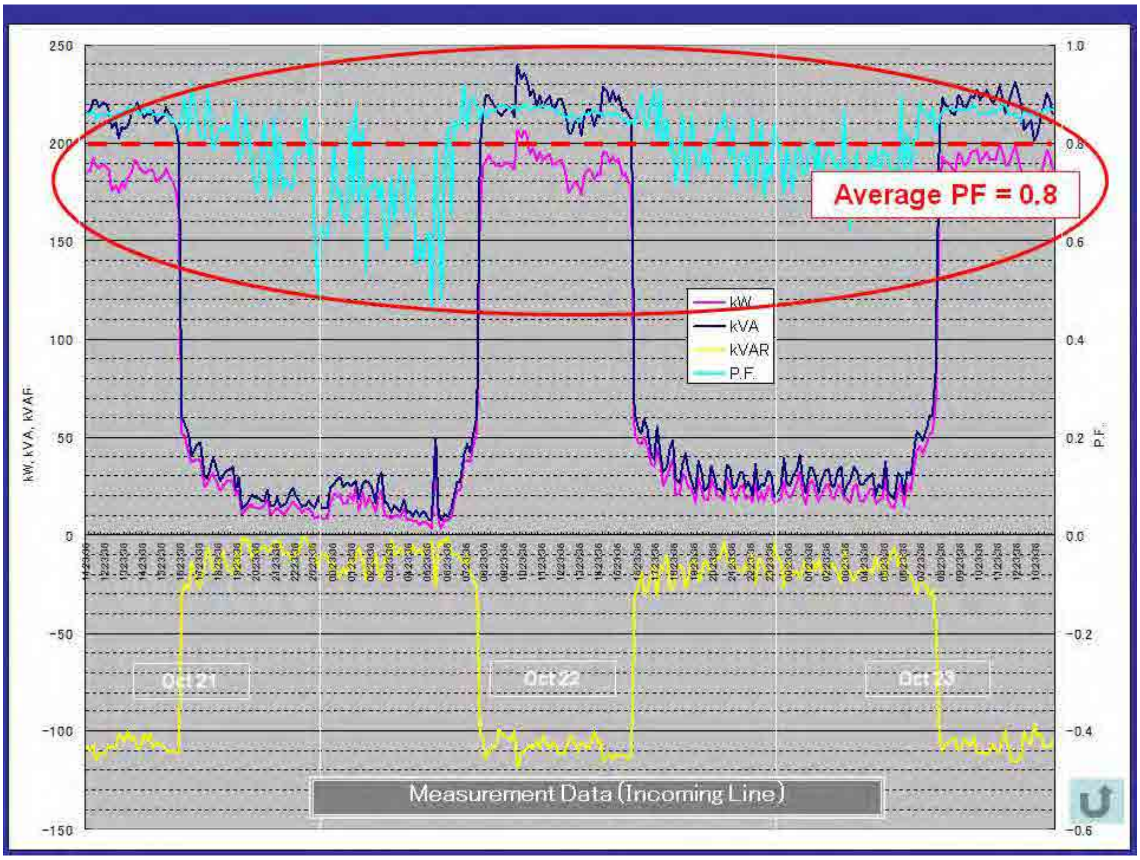

THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
Power Consumption Survey

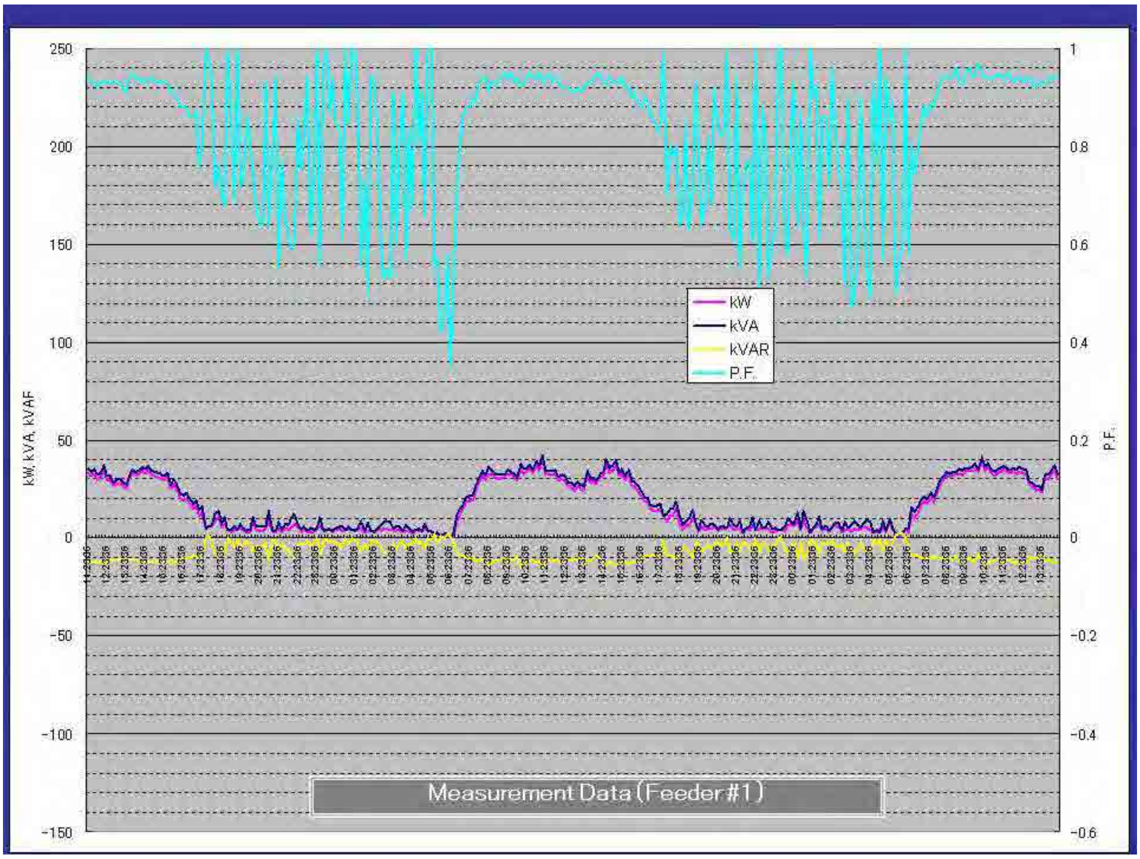
THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA FOR OPERATIONAL IMPROVEMENT

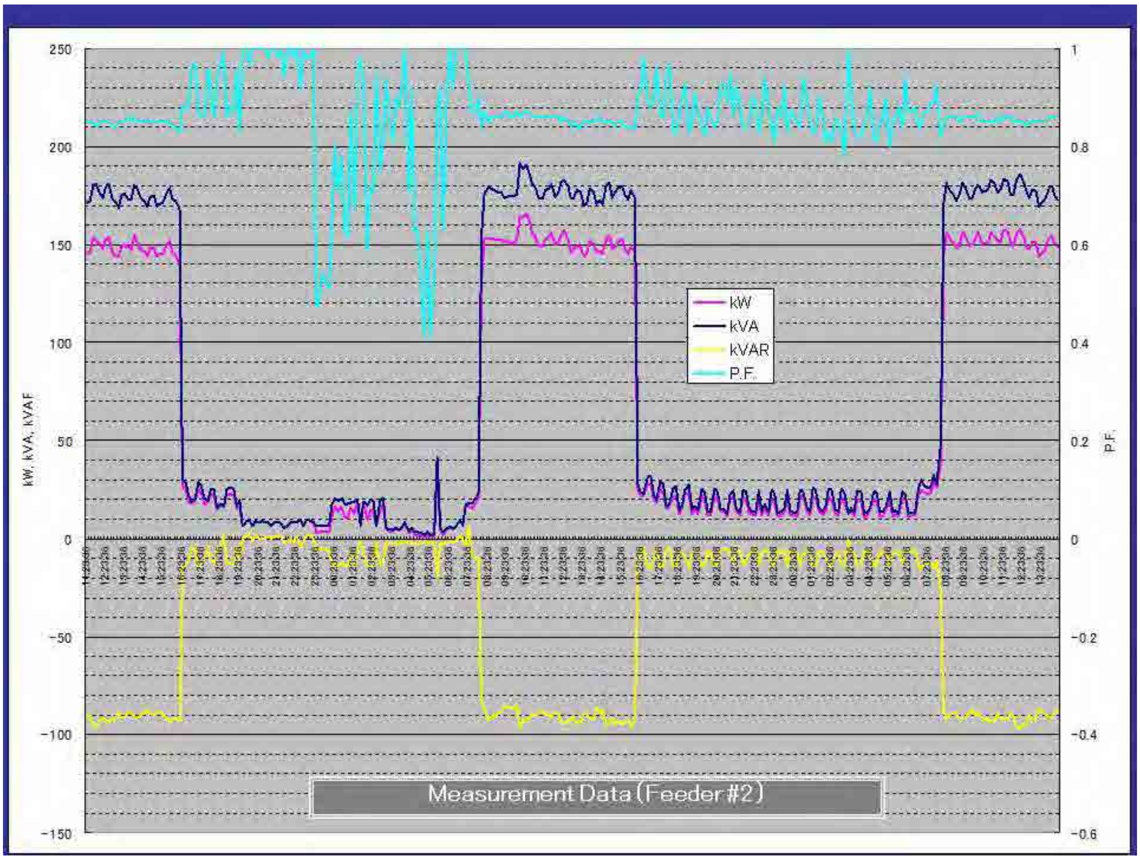
Survey Result

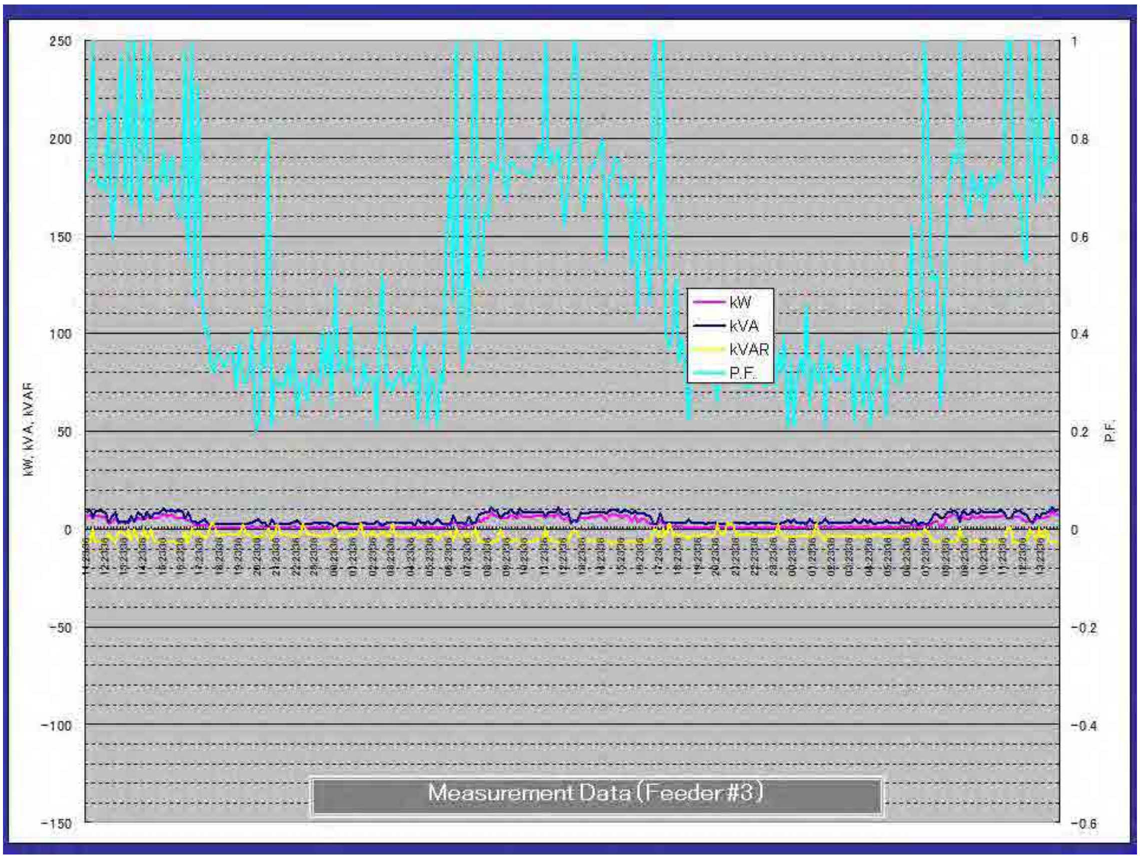
(Survey period : 2009 July 18 – July 20, Oct 21 – 23)

Daily Consumption Power	1,200kWh ~ 3,000kWh / day (Transformer's loss is not included)	
Max. Consumption Power	240kW / 289kVA (Transformer's loss is not included)	
Power Consumption Feeder #1	Max. 40.0kW Min. 0.5kW P.F. 1.0 ~ 0.35	Original Max. *******kW Max. *******kVA P.F. *******
Power Consumption Feeder #2	Max. 190.0kW Min. 0.7kW P.F. 1.0 ~ 0.41	Original Max. *******kW Max. *******kVA P.F. *******
Power Consumption Feeder #3	Max. 10.0kW Min. 0.5kW P.F. 1.0 ~ 0.2	Original Max. *******kW Max. *******kVA P.F. *******




kW
kVA
kVAR
P.F.
kW, kVA, kVAF
P.F.
Measurement Data (Feeder #1)


kW
kVA
kVAR
P.F.
kW, kVA, kVAF
P.F.
Measurement Data (Feeder #2)



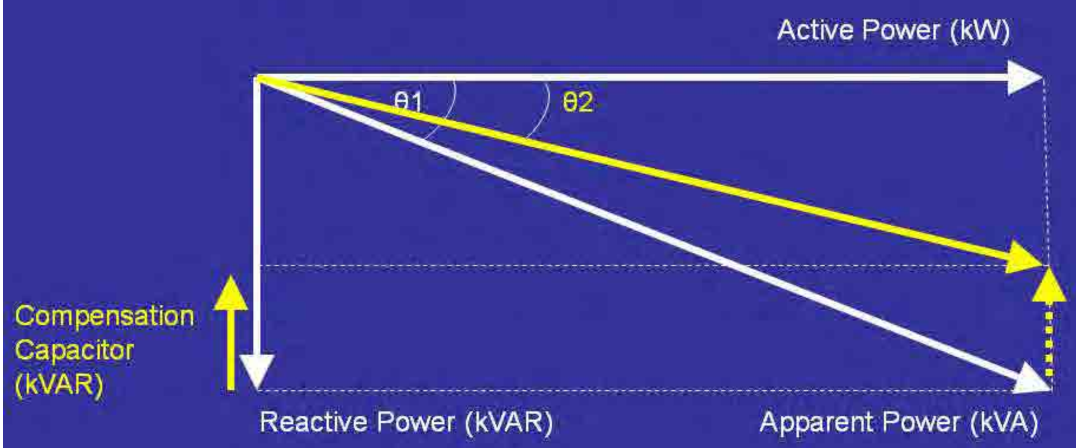
THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT

- Energy Loss Issue
  → Low Power Factor

- Proposed Measures
  → Power Factor Correction
  by Capacitor Bank and APFC

THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT

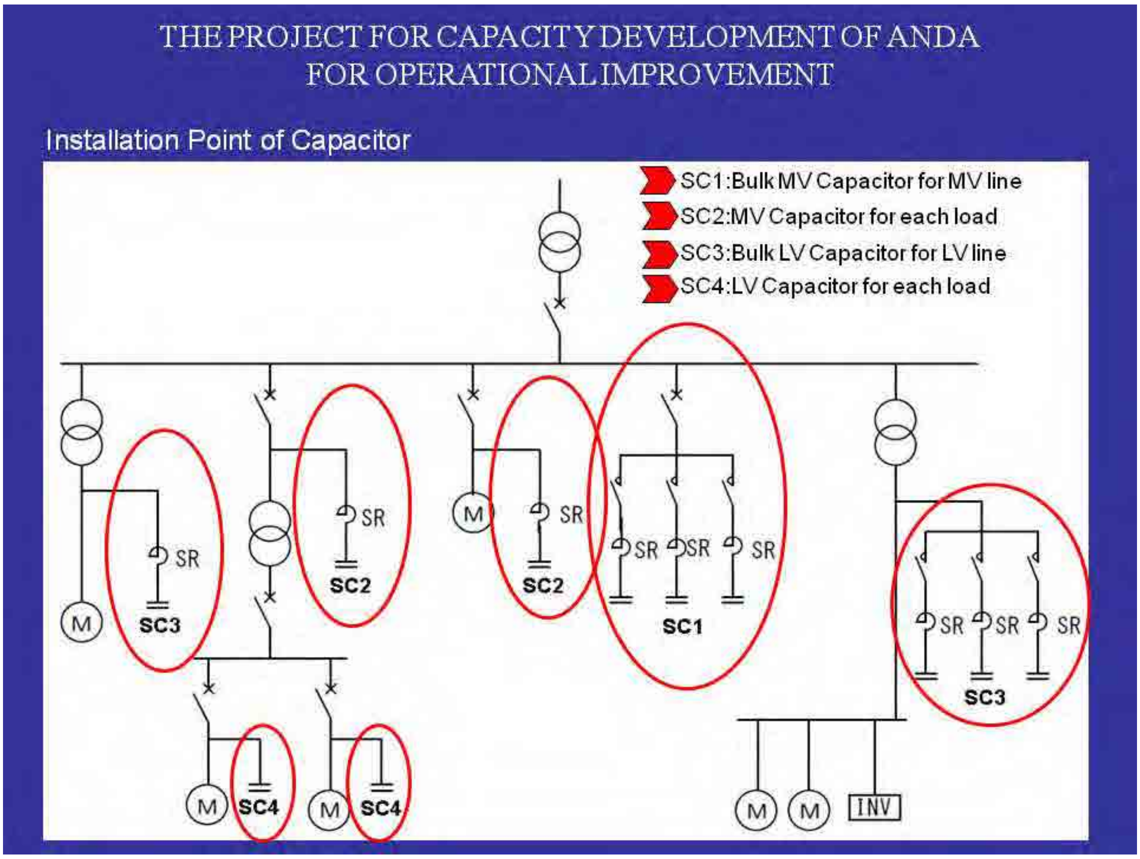
Diagram showing the principle of compensation

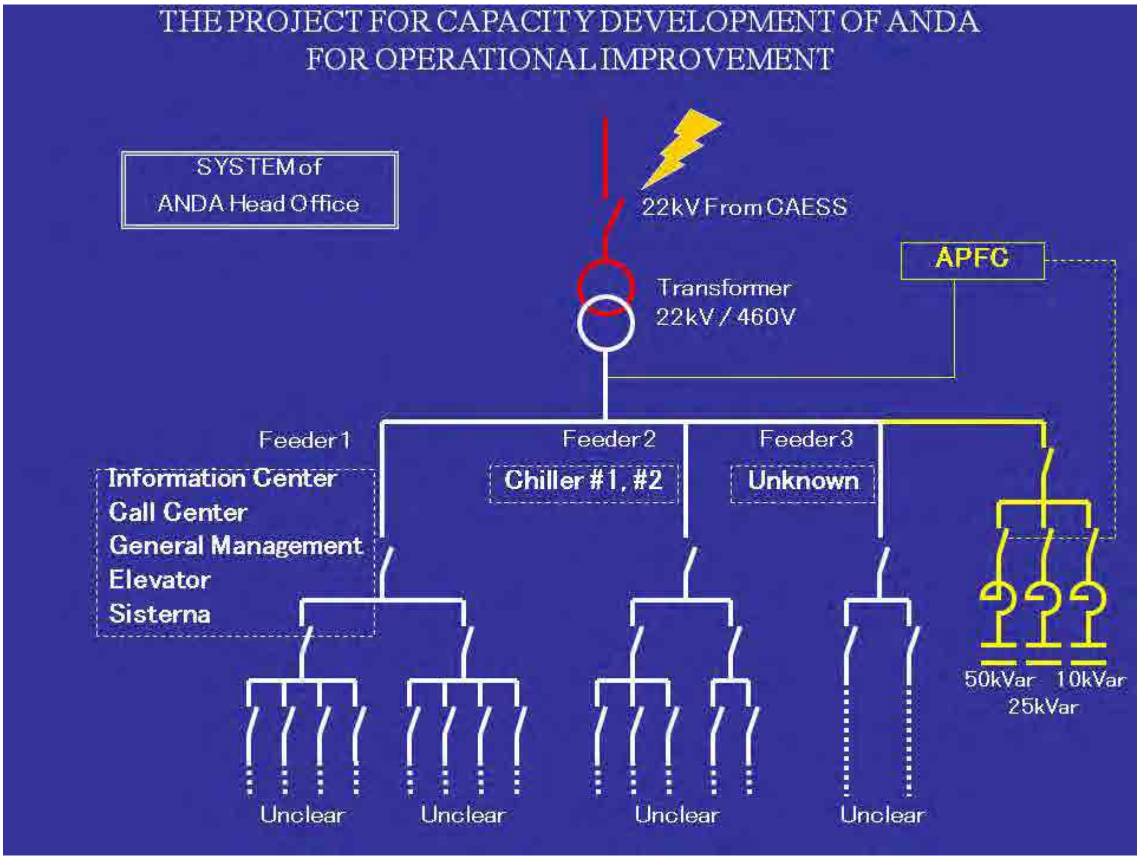


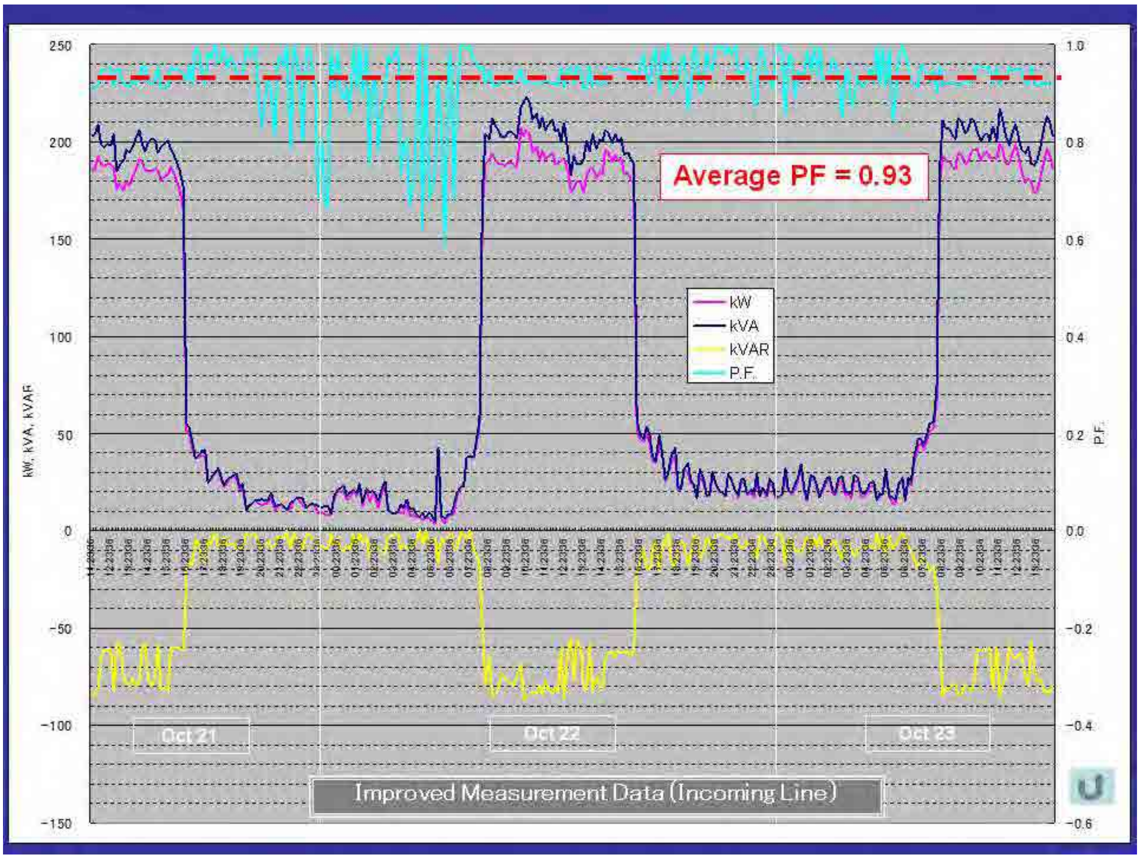
THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT

Merit of Power Factor Correction by Capacitor

- Reduction of Loss in Transformer
- Reduction of Loss (P, kW) in Cables
- Reduction of Cable Size
- Reduction of Voltage Drop
- Increase in Available Power
- Reduction in the Cost of Electricity


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
Installation Point of Capacitor
SC1:Bulk MV Capacitor for MV line
SC2:MV Capacitor for each load
SC3:Bulk LV Capacitor for LV line
SC4:LV Capacitor for each load
SR
SC1
SC2
SC3
SC4
M
INV


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
SYSTEM of
ANDA Head Office
22kV From CAESS
APFC
Transformer
22kV / 460V
Feeder 1
Feeder 2
Feeder 3
Information Center
Call Center
General Management
Elevator
Sisterna
Chiller #1, #2
Unknown
50kVar
10kVar
25kVar
Unclear
Unclear
Unclear
Unclear



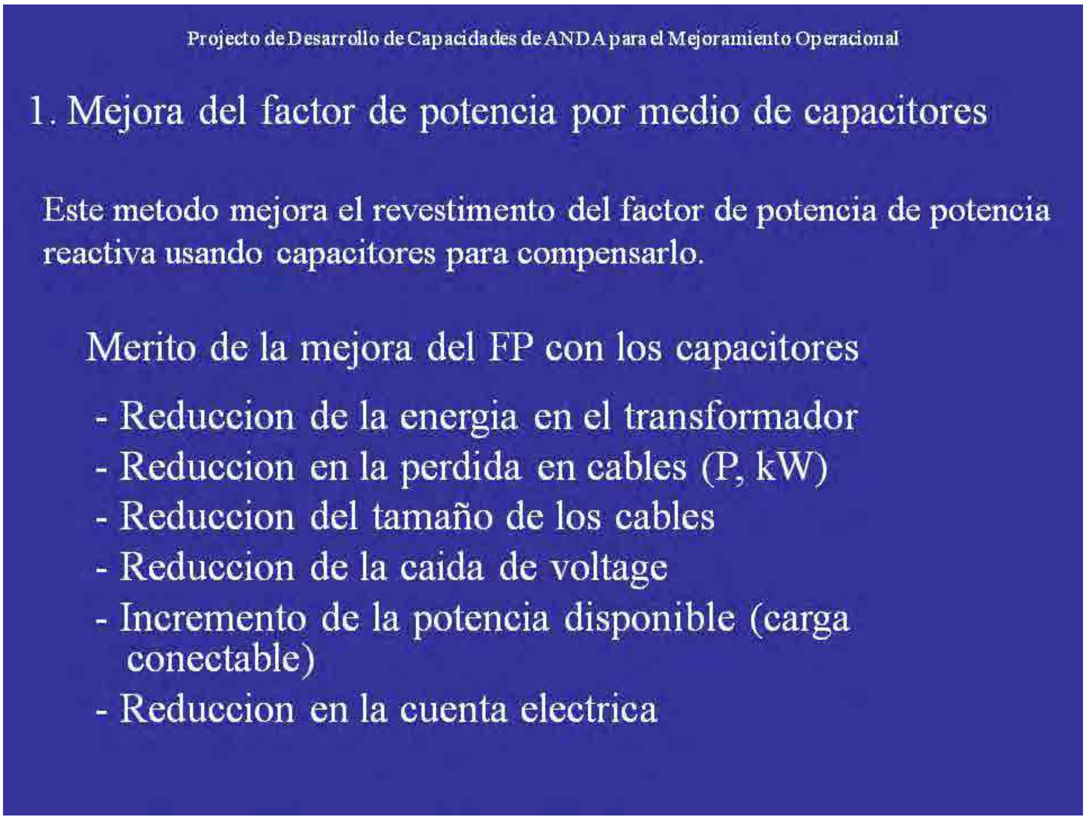
THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT

Needs to be Improved for Energy Saving

- Preventive maintenance has not been executed
  → Impossible to use Equipment highly effective
- Most measurement equipment is out of order
  → Operation status of facility is ungraspable
- No efficient use of Operation data
  → Operation data should be reflected to the appropriate operation
- Neither design drawing nor the maintenance record are kept
  → Plan for the improvement work of facility can not be settled on


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
TO BE CONTINUED ...
YAMAMOTO, NSC JAPAN

2009 年 11 月 19 日 パイロット施設の節電手法について 5



Projecto de Desarrollo de Capacidades de ANDA para el Mejoramiento Operacional

2. Capacidad de los capacitores compensatorios

Como se selecciona el capacitor?

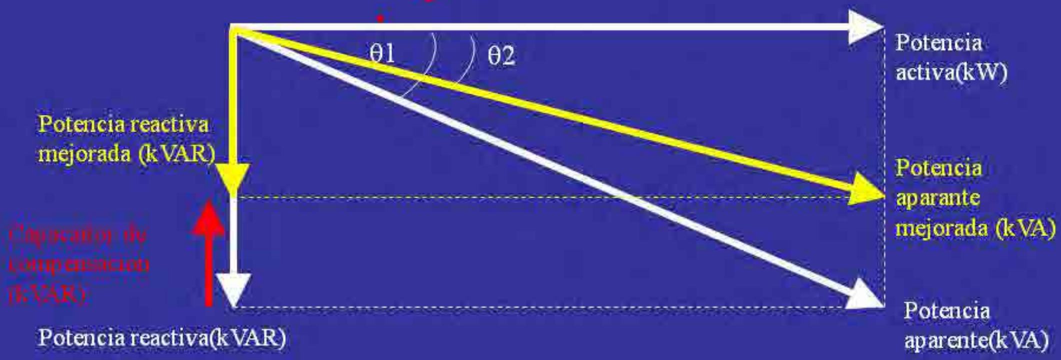


Fig. : Diagrame q muestra la compensacion general

Projecto de Desarrollo de Capacidades de ANDA para el Mejoramiento Operacional

2. Capacidad de los capacitores compensatorios

Formula del capacitor compensatorio…

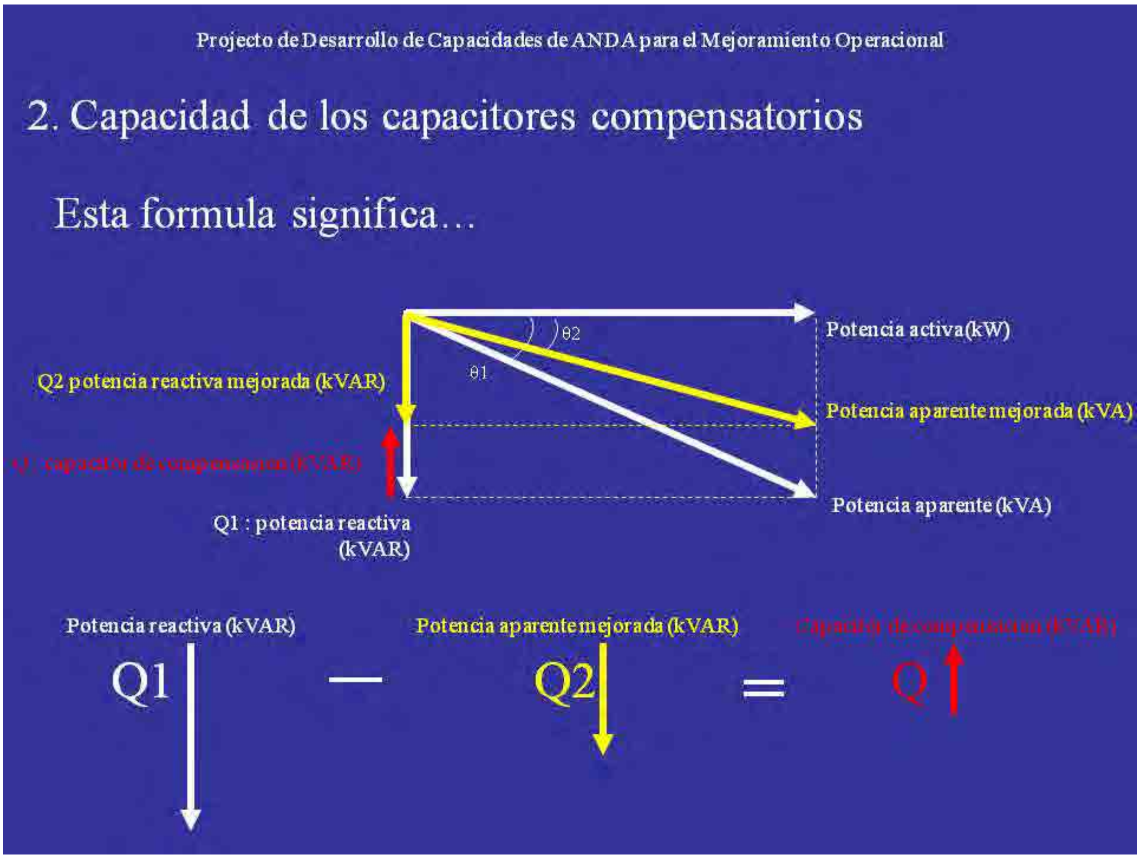
$$Q = P \times \left[\sqrt{\frac{1}{\cos^2\theta_1} - 1} - \sqrt{\frac{1}{\cos^2\theta_2} - 1} \right]$$

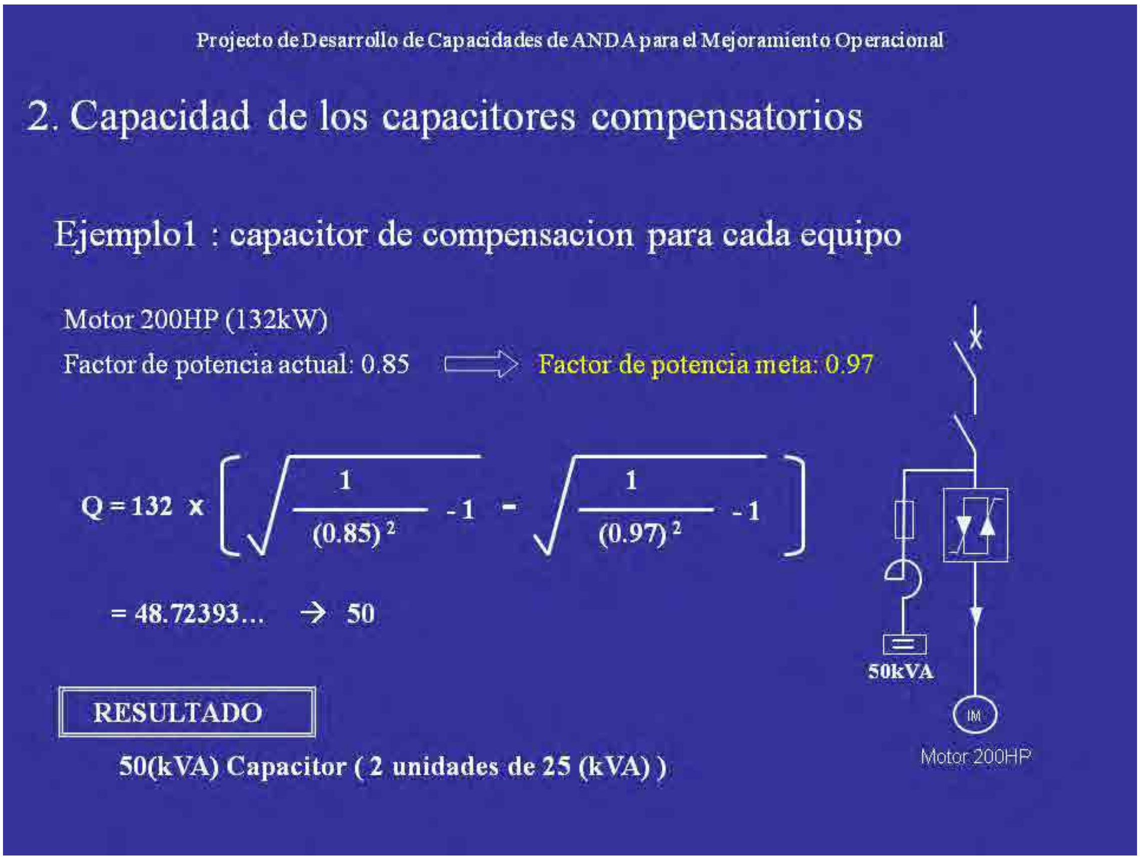
Q : capacitor compensatorio (kVA)

P : potencia activa (kW)

$\cos\theta_1$: Factor de potencia actual

$\cos\theta_2$: Factor de potencia meta

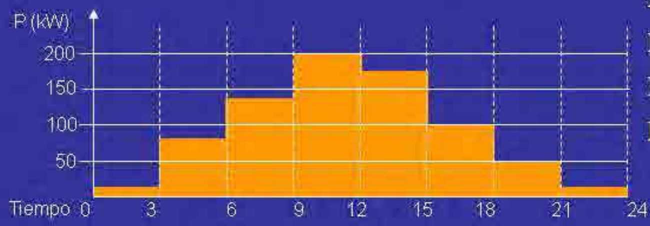

Projecto de Desarrollo de Capacidades de ANDA para el Mejoramiento Operacional
2. Capacidad de los capacitores compensatorios
Esta formula significa…
θ2
θ1
Potencia activa(kW)
Q2 potencia reactiva mejorada (kVAR)
Potencia aparente mejorada (kVA)
Potencia aparente (kVA)
Q1 : potencia reactiva (kVAR)
Potencia reactiva (kVAR)
Potencia aparente mejorada (kVAR)
Q1
—
Q2
=
Q


Projecto de Desarrollo de Capacidades de ANDA para el Mejoramiento Operacional
2. Capacidad de los capacitores compensatorios
Ejemplo1 : capacitor de compensacion para cada equipo
Motor 200HP (132kW)
Factor de potencia actual: 0.85
Factor de potencia meta: 0.97
Q = 132 x [√(1/(0.85)² - 1) - √(1/(0.97)² - 1)]
= 48.72393… → 50
RESULTADO
50(kVA) Capacitor (2 unidades de 25 (kVA))
50kVA
IM
Motor 200HP

Projecto de Desarrollo de Capacidades de ANDA para el Mejoramiento Operacional

2. Capacidad de los capacitores de compensacion

Ejemplo 2 : Capacitor de compensacion en masa

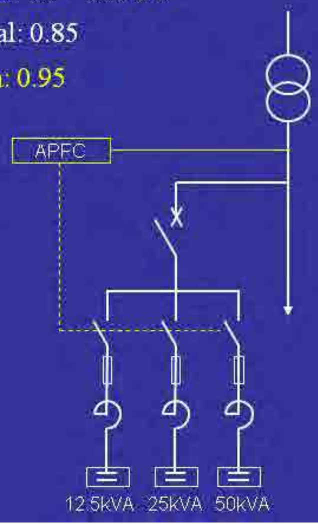


Planta de tratamiento

Potencia : 20 – 200 kW

FP actual: 0.85

FP meta: 0.95

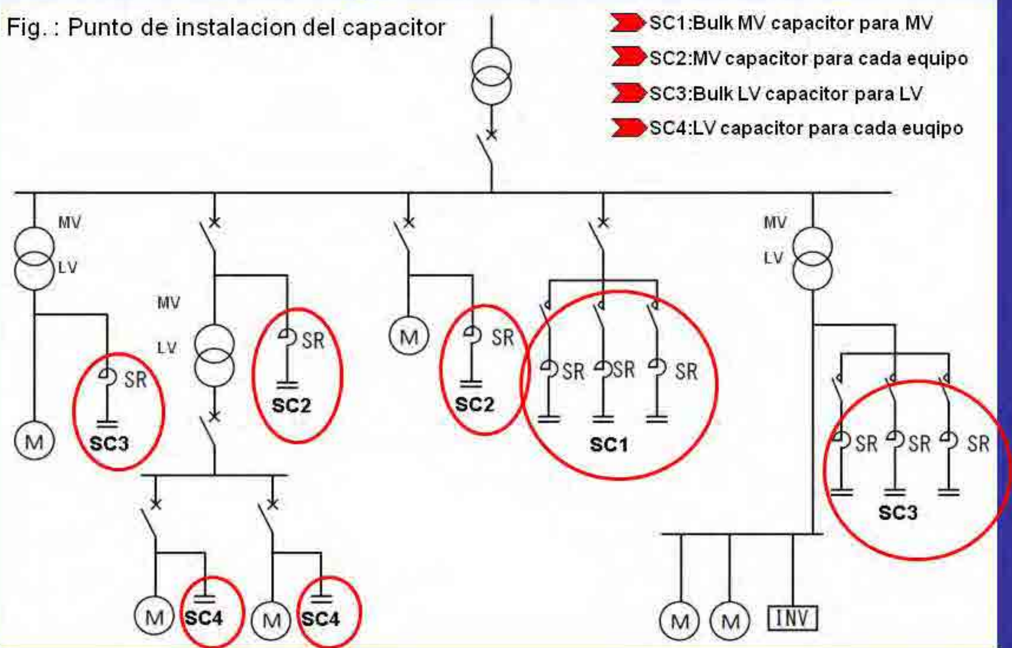


Hora	3	6	9	12	15	18	21	24
P (kW)	20	80	140	200	170	100	50	20
Act. F.P.	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
12.5kVA	X	X	X	X				X
25kVA		X		X	X		X	
50kVA			X	X	X	X		
Total (kVA)	12.5	37.5	62.5	87.5	75	50	25	12.5
F.P Meta	0.99	0.96	0.96	0.95	0.96	0.97	0.97	0.99

Projecto de Desarrollo de Capacidades de ANDA para el Mejoramiento Operacional

Apropiadamente seleccione el punto de instalación según la situación del factor de potencia del sistema eléctrico.

Fig. : Punto de instalacion del capacitor



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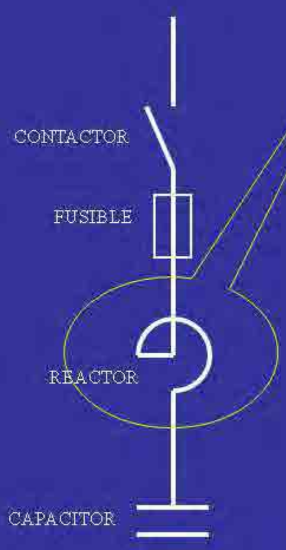
3. Rol del Reactor en Serie



Que es esto?

Este es el reactor que esta conectado en serie con el capacitor

Cual es su rol?

Supresion de corriente de Armonicos

El armónico actual es suprimido por el circuito que se desplaza a inductividad con el reactor en serie

2. Corriente de Represión

A veces, la corriente de pico del capacitor llega a decenas de veces de corriente nominal. El reactor en serie absorbe al aproximar 5 veces de corriente nominal.

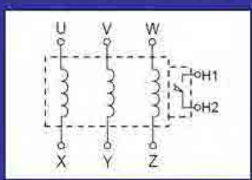


Fig : Diagrama de reactor en serie

El reactor en serie es seleccionado con el 6 % de la capacidad de Capacitor en caso de armónicos habitual actuales.

En el caso de armónicos terribles, es seleccionado con 13%.

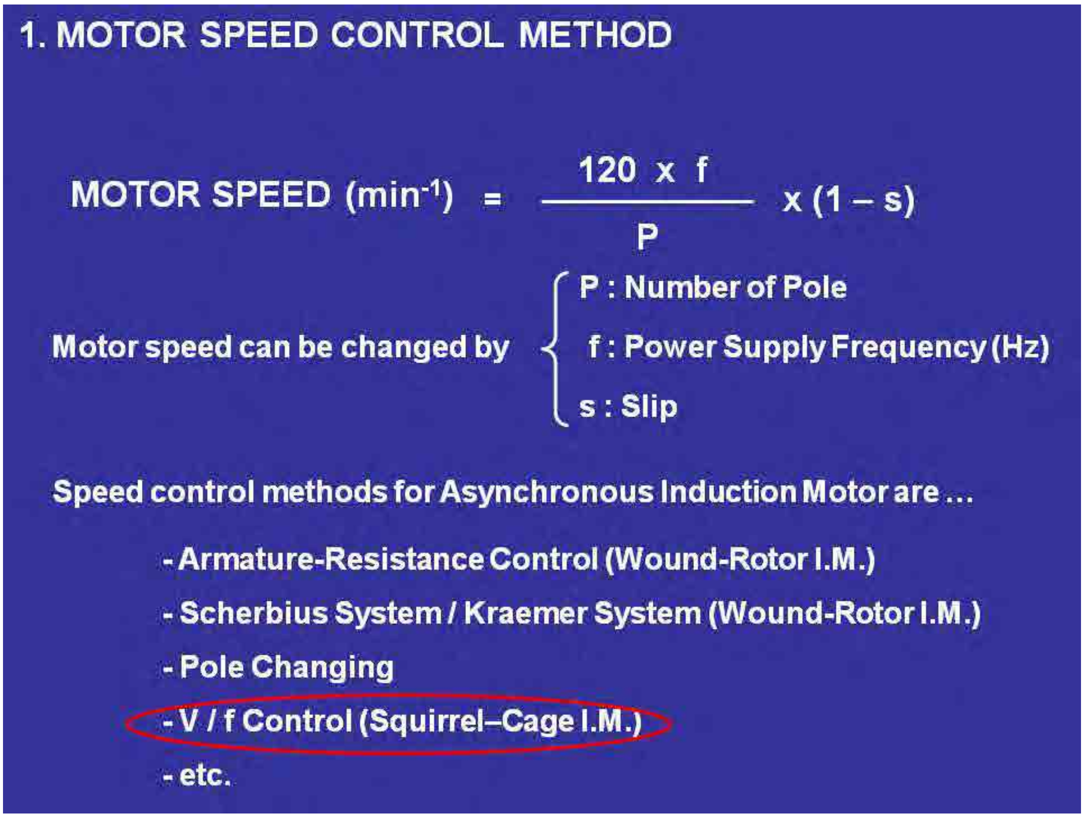
El reactor en serie tiene un sensor térmico que lo protege contra el desgaste de armónicos más actual.

Projecto de Desarrollo de Capacidades de ANDA para el Mejoramiento Operacional

CONTINUARA…

J. YAMAMOTO, NSC JAPAN

2010 年 2 月 26 日 パイロット施設の節電手法について 6



1. MOTOR SPEED CONTROL METHOD

V / f Constant Operation Method

The flux and the excitation current of Motor are increased when the frequency is decreased and voltage is maintained at 460V, thus, Motor is heated up, and is burned out finally.

Therefore, the flux must be maintained at steady value.

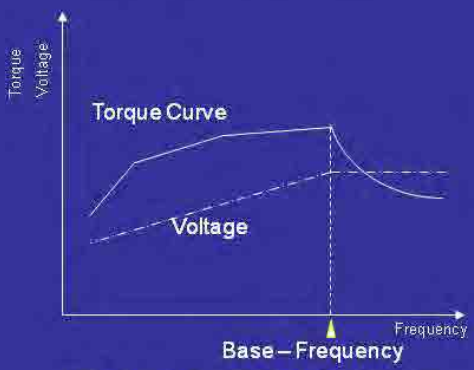


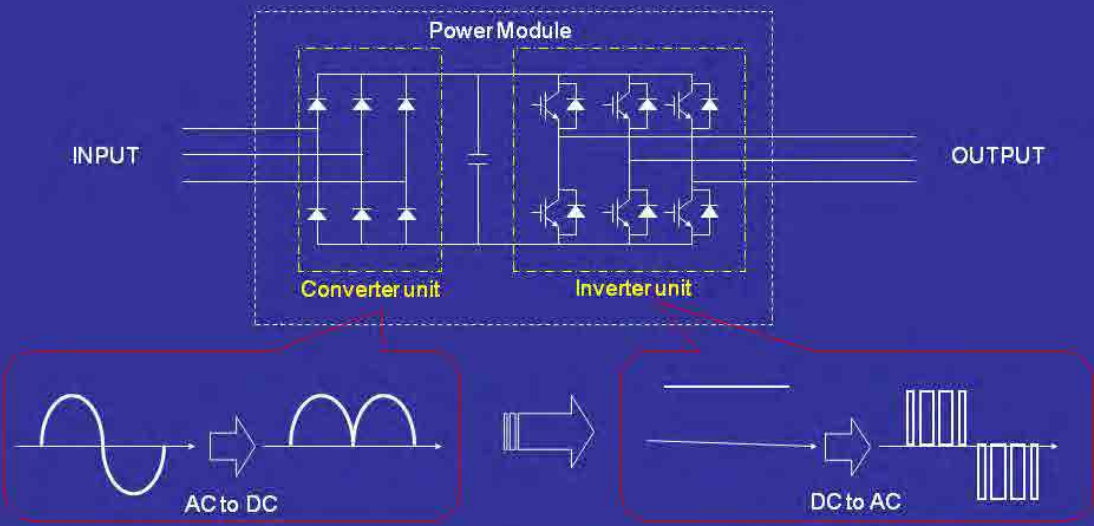
Fig.1 Torque Curve by V / f Operation

$$\text{Flux} \propto \frac{\text{Voltage}}{\text{Frequency}} = \text{Constant Ratio}$$

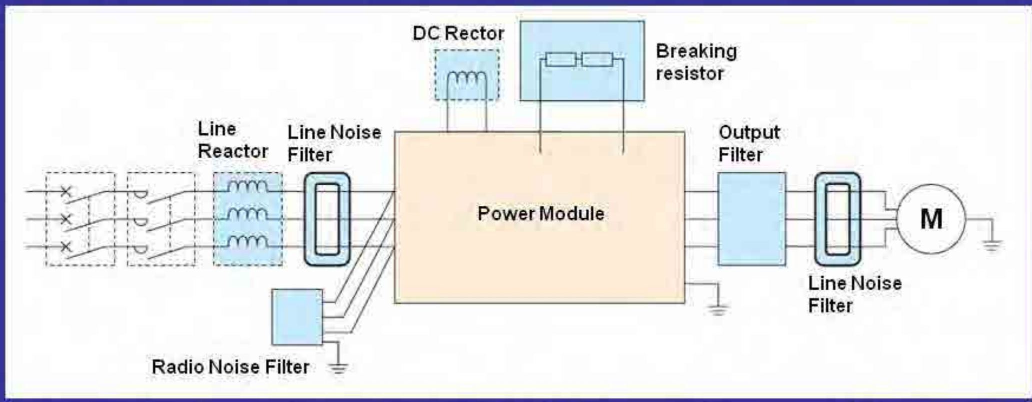
2. INVERTER SYSTEM for MOTOR SPEED CONTROL

Inverter System consists of several components. That main component is “Power Module” which controls output voltage and frequency.

Power Module has principal units such as “Converter” and “inverter”.



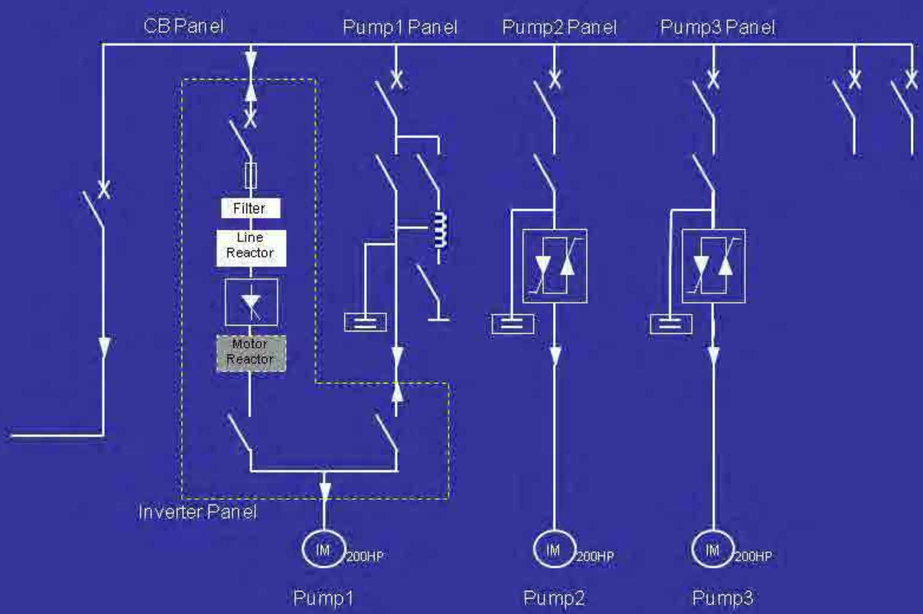
3. COMPONENTS of INVERTER SYSTEM



Component		Function, Effect, etc.	Note
Line Noise Filter Radio Noise Filter		Radio disturbance prevention	
Line Reactor		Harmonics reduction, PF improvement, Surge protection	Power capacity > 500kVA, Unbalanced voltage > 3%, Thyristor-controlled equipment
DC Reactor		Harmonics reduction, PF improvement	
Breaking Resistor		Power module protection from regenerated energy	
Output Filter	Motor Reactor	Voltage load reduction on motor winding	High surge voltage, Low insulation of winding
	Sine-wave Filter	Noise restraint, Vibration control	

4. INVERTER SYSTEM for PILOT FACILITY

200HP Inverter System : CAITES DEL DIABLO Pumping Station



NEED TO BE CONSIDERED 1 : MOTOR TEMPERATURE

The temperature of Motor is increased when Motor speed is decreased, because Cooling coefficient of Motor is also decreased.

Motor has self cooling fan at end of shaft. This cooling fan can perform it's cooling effect at nominal speed.

Therefore, Cooling fan's cooling effect decreases with the decrease of motor speed.

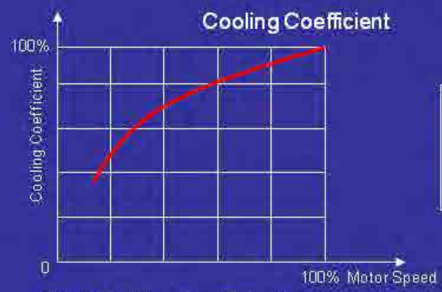


Fig.2 Cooling Coefficient Curve

$$\text{Temperature Rise} \propto \frac{\text{Winding Loss}}{\text{Cooling Coefficient}}$$

NEED TO BE CONSIDERED 1 : MOTOR TEMPERATURE

In the other hand, Motor current consists two type of current such as "Torque Current" and "Excitation Current".

Temperature rise of Motor winding can be controlled by suppressing "Excitation Current".

Method which can control "Excitation Current" is "V / f and Sensor-less Vector control".

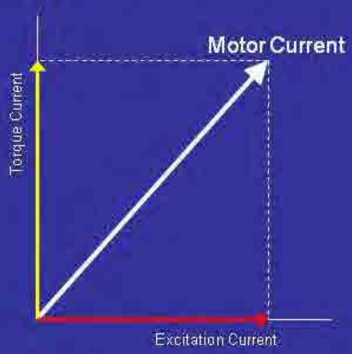


Fig.3 Vector of Current

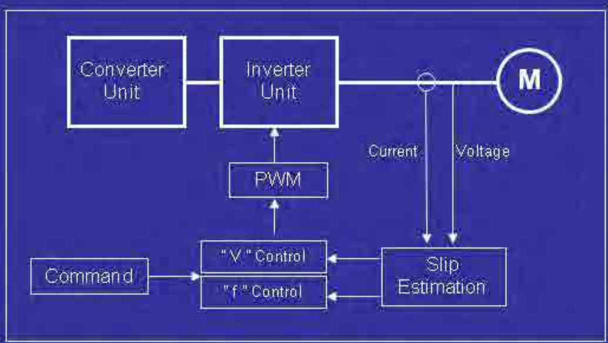
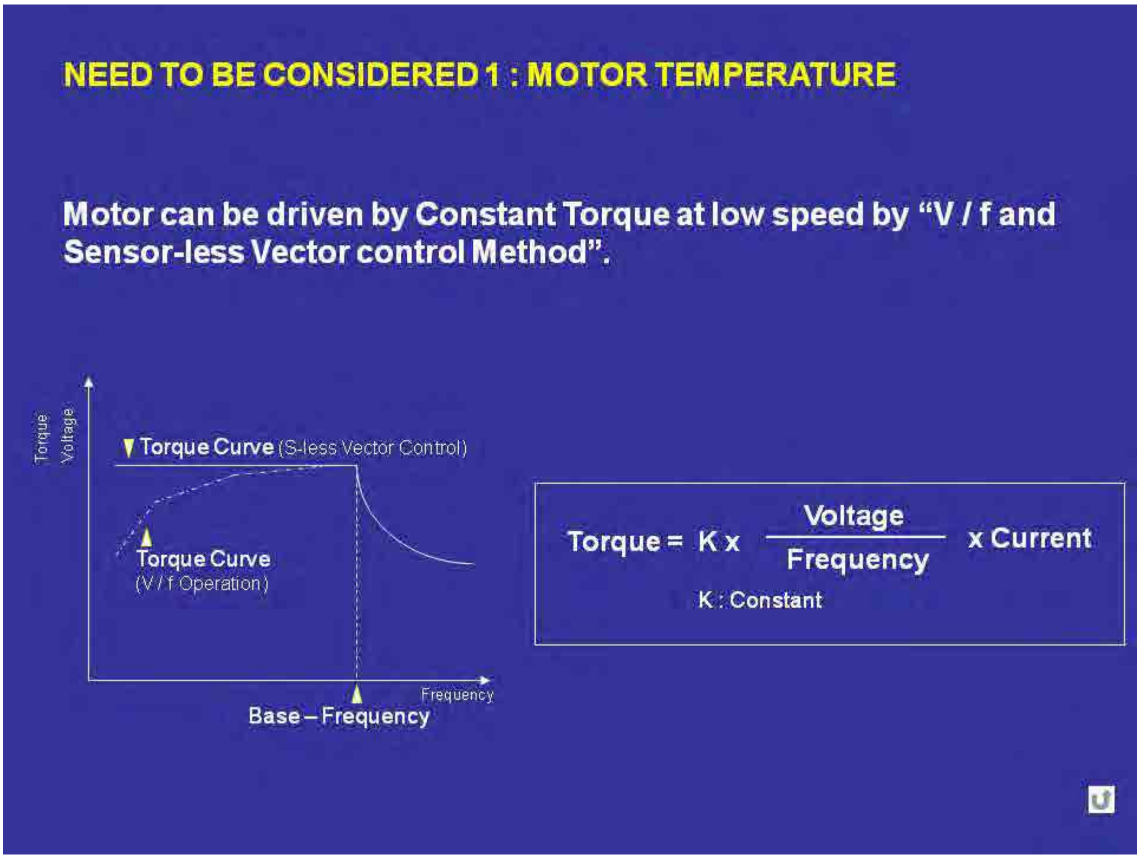
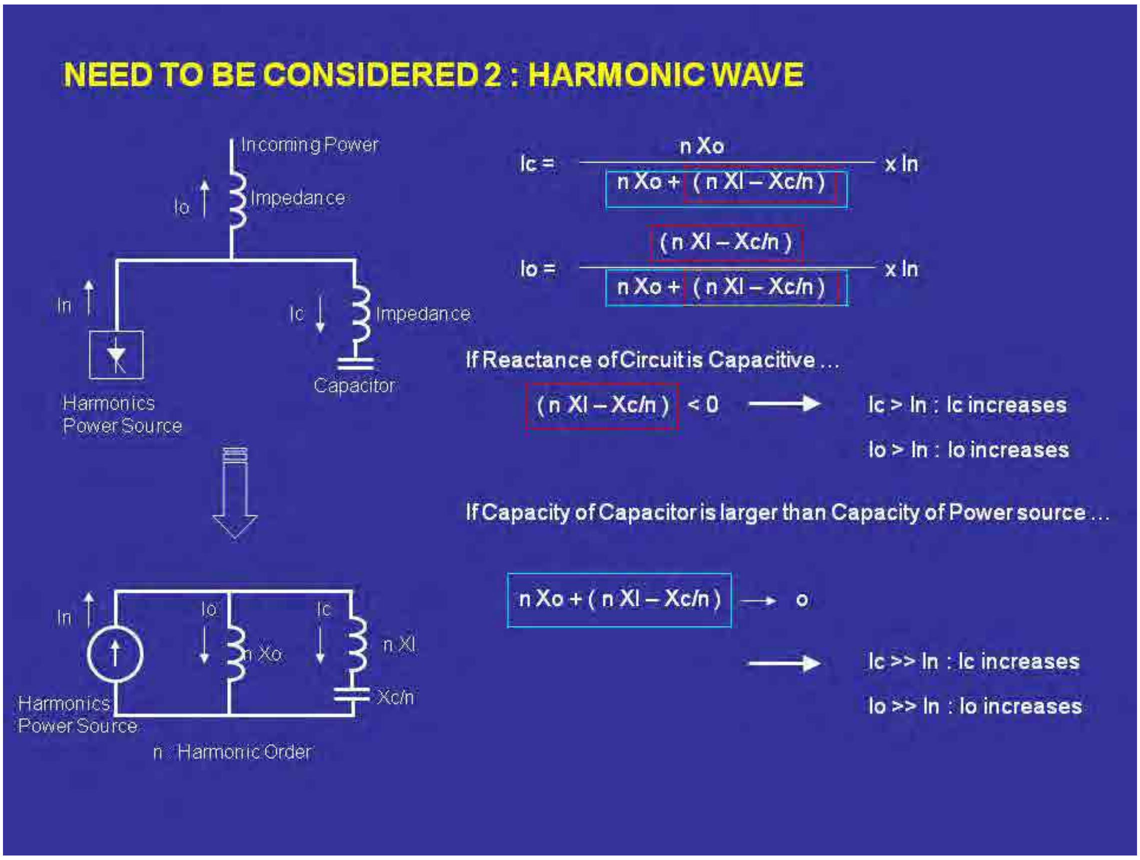


Fig.4 Diagram of Sensor-less Vector Control


NEED TO BE CONSIDERED 1 : MOTOR TEMPERATURE
Motor can be driven by Constant Torque at low speed by "V / f and Sensor-less Vector control Method".
Torque
Voltage
Torque Curve (S-less Vector Control)
Torque Curve (V / f Operation)
Frequency
Base – Frequency
Torque = K x Voltage / Frequency x Current
K : Constant


NEED TO BE CONSIDERED 2 : HARMONIC WAVE
Incoming Power
Io
Impedance
In
Ic
Impedance
Capacitor
Harmonics Power Source
In
Io
Ic
n Xo
n Xl
Xc/n
Harmonics Power Source
n : Harmonic Order
Ic = n Xo / (n Xo + (n Xl – Xc/n)) x In
Io = (n Xl – Xc/n) / (n Xo + (n Xl – Xc/n)) x In
If Reactance of Circuit is Capacitive …
(n Xl – Xc/n) < 0
Ic > In : Ic increases
Io > In : Io increases
If Capacity of Capacitor is larger than Capacity of Power source …
n Xo + (n Xl – Xc/n) → o
Ic >> In : Ic increases
Io >> In : Io increases

NEED TO BE CONSIDERED 3 : HARMONIC WAVE

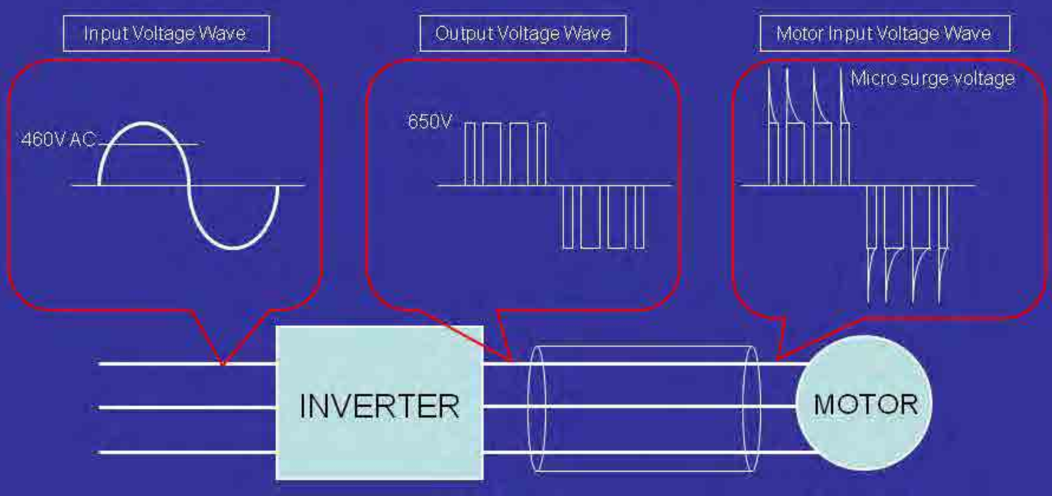
Harmonic Wave causes a lot of inconvenient situations.

Capacitor, Reactor	:	Heat up by over current, Burnout, Noise, Vibration
Fuse, Breaker	:	Burnout by over current, Malfunction
Transformer	:	Heat up, Noise, loss Increasing
Protection Relay	:	Malfunction
Instruments	:	Malfunction
Computer	:	Malfunction
TV, Radio	:	Noise, Flicker, Malfunction

etc…

Note : Harmonic Wave above-mentioned is including "Higher Harmonics" and "High Frequency Wave".

NEED TO BE CONSIDERED 3 : SURGE VOLTAGE



Theoretical Motor Input Peak Voltage = Input Voltage (RMS) x $\sqrt{2}$ x 2

Actual Motor Input Peak Voltage Depending on …
- **Switching (Pulse) Frequency : kHz**
- **Cable Installation Condition : m, L(H), C(F)**


THE PROJECT FOR CAPACITY DEVELOPMENT OF ANDA
FOR OPERATIONAL IMPROVEMENT
TO BE CONTINUED…
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