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SOCIALIST REPUBLIC OF VIET NAM

VIETNAM ELECTRICITY

HYDROPOWER PROJECT MANAGEMENT UNIT NO.4

SE SAN 4 HYDROPOWER PROJECT

3*120MW Turbine Generator, 125rpm, 56.0m

PACKAGE 41

SUPPLY OF ELECTRO-MECHANICAL EQUIPMENT, CONTROL AND COMMUNICATION SYSTEM

Contract N° : 1999/HD-ATD4-P6

BETWEEN	PURCHASER VIETNAM ELECTRICITY Hydropower Project Management Unit No.4
	SUPPLIER: ECIDI - ALSTOM CONSORTIUM ALSTOM
TITLE :	**CSCS SYSTEM** **PROTECTION PARAMETER CALCULATION**

SUMMARY

1 AIMS

This document is aimed at describing the SE SAN 4 CSCS system protection setting calculation. It includes the protections setting value calculation method and commendatory value.

2 GENERATOR PROTECTION SETTING CALCULATION(发电机保护整定计算)

2.1 PARAMETERS(参数)

The Generator Parameters that provided by customer relative to protections are listed below:
根据客户给定参数如下表所示：

参数名称(Parameters)	一次值(Primary)	二次值(Secondary)	备注(Notation)
容量(Capacity)	141.2MVA/120MW		
额定频率(fn)	50		
发电机额定电流(Ign)	5176A	0.69A	
暂态阻抗 Xd'(Transient impedance) 直轴瞬变电抗	0.2875Xrg/0.5051 Ω	26.458 Ω	Xrg=1.7568
次暂态阻抗 Xd"(Subsychronous Impedance) 直轴超瞬变	0.2033 Xrg/0.3572	18.708	
同步阻抗 Xd(sychronous Impedance)	1.06 Xrg/1.8622	97.54	
系统阻抗 Zs(System Impedance Zs)	0.0418 Xrg/0.0734	3.8466	
系统功率因数 (Power factor)	0.85		Calculated by Capacity
升压变阻抗 Zt(Transformer impedance Zt)	12%		
发电机最小负荷阻抗 Zl.min(Generator minimum Impedance under load condition)	Calculated as 1.2* full load.		按 1.2 倍额定负荷算?
额定电压(Vn)	15.75kV		
主 PT 变比(PT Ratio)	15.75/ √3kV	0.11/ √3kV	
发电机中性点接地 PT 变	15.75/ √3kV	0.24/ √3kV	

比			
主 CT 变比(Main CT Ratio)	7500A	1A	
主 CT 型号(Main CT Type)	5P20		
横差 CT 变比(Transverse CT Ratio)	400A	1A	
横差 CT 型号(Transverse CT Type)	5P20		
热容量值(Kg)	20	This parameter is made according to IEC Standards.	按 IEC 非直接冷却机组计算

2.2 SETTING CALCULATION(保护计算书)

2.2.1 Generator Differential Protection(发电机差动保护)

2.2.1.1 Differential Protection Charastistics (差动保护特性)

Biased differential protection is applied in MiCOM P343, it has two slopes which shows as figure 1, both slopes can be settable in a reasonable range. The differential current can be calculated using following formulate: $I_{Diff}= \bar{I}_1+\bar{I}_2$, The biased current can be calculated using following formulate: $I_{Bias}=1/2（I_1+I_2）$.

MiCOM P343 差动保护一般采用比率制动特性，它具有二段折线，如下图-1 所示，其中二段斜率均可整定。差动电流计算公式为：$I_{Diff}= \bar{I}_1+\bar{I}_2$；制动电流计算公式为：$I_{Bias}=1/2（I_1+I_2）$

The operating current of the biased differential element, for any value of through current, can be calculated using the following formulae:

$I_{Diff}>K1* I_{Bias}+Is1$ Where $I_{Bias}<Is2$

$I_{Diff}>K2* I_{Bias}-(K2-K1)Is2+Is1$ Where $I_{Bias}>Is2$

比率制动特性动作方程为：

$I_{Diff}>K1* I_{Bias}+Is1$ 当 $I_{Bias}<Is2$ 时

$I_{Diff}>K2* I_{Bias}-(K2-K1)Is2+Is1$ 当 $I_{Bias}>Is2$ 时

The setting values need to be calculated are Differential current threshold Is1, First slope K1, Bias current between K1 to K2 Is2, Second slope K2.

需要整定计算的定值量有：差动电流启动值(Is1)、第一段折线斜率(K1)，拐点电流值(Is2)，第二段折线斜率(K2)。

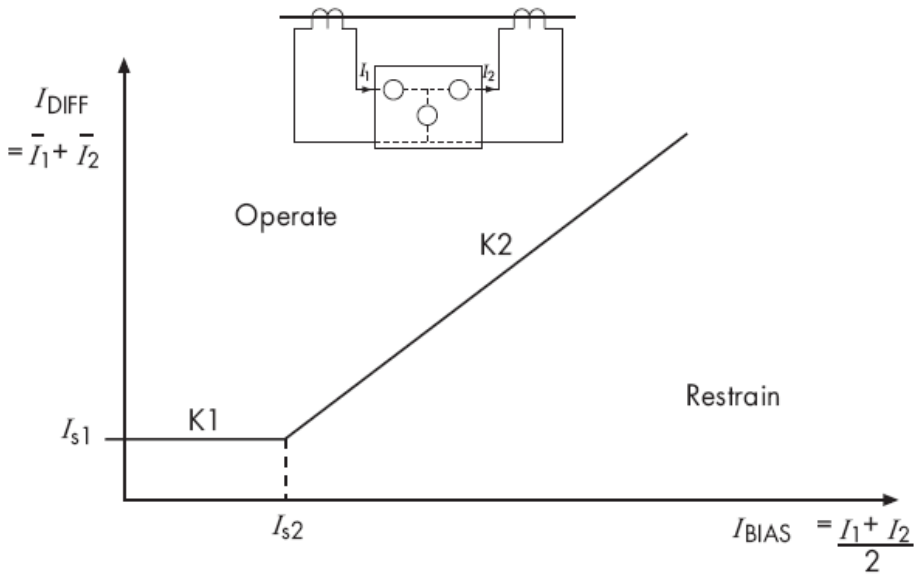

Figure 1 P343 Differential protection charactistic(图-1 P343 差动保护特性)

2.2.1.2 Differential Setting Calculation(差动保护各定值计算)

2.2.1.2.1 Differential Current Threshold Is1 差动电流启动值(Is1)

This setting should avoid the maxium unbalance current under normal load. The unbalance current under normal load condition mainly caused by CT error, the normal current error must less than 5% operating current for the 5P20 type CT, and we should multiple a reliable coefficient Krel which be 1.5 normally. Then we can calculate the Differential Setting using following formulate:

Is1=Krel*2*0.05*Ign=0.15Ign=776.4A, then secondary value is 0.104A, So 0.1A is proper.

Where Krel is Reliable coefficient.

按躲过额定负荷下最大不平衡电流整定, 此条件下的不平衡电流主要来自 CT 误差，根据主 CT 型号 5P20 知其额定综合误差小于 5%，取可靠系数为 1.5；则 Is1=Krel*2*0.05*Ign=0.15Ign=776.4A，折算到二次值为：0.104A，取 0.1A(100mA)

2.2.1.2.2 First slope K1 第一段折线斜率(K1)

For the differential current threshold value is calculated to avoid the maxium unbalance under normal load, the first slope should be 0% to assure the sensitive under normal operating current.

由于差动电流启动值按额定负荷最大不平衡电流整定，第一段折线斜率需整定为 0%，以确保差动保护在额定电流以下的灵敏度。

1.2.3Bias current between K1 and K2 Is2 拐点电流值(Is2)

This value should be same as CT rating current or generator's 120% nominal current.For CT rating current is 7500A, so Is2=7500A, then secondary value is Is2=1A.

按 CT 额定值整定，一般推荐为 100%的 CT 额定电流或 120%的发电机额定电流。Is2=7500A，折算到二次值为：1A。则取 Is2=1A

2.2.1.2.3 Second Slope K2 第二段折线斜率(K2)

Normally to avoid external max unbalance current under Max throughout fault near protection zone, this max unbalance current can be calculated according this equation:

$$I_{unb.max}= Krel *K_{ap}*K_{cc}*K_{er}*I^{(3)}_{k.max}$$

一般按躲过近区外部最大故障时不平衡电流整定，最大不平衡电流按下式计算：

$$I_{unb.max}= Krel *K_{ap}*K_{cc}*K_{er}*I^{(3)}_{k.max}$$

Where as:

Krel –Reliability factor, select 1.5 in this equation.

K_{ap}- Non-periodic factor, Normally be in range of 1.5~2.0, select 2 in this equation.

K_{cc}-CT type factor, It should be 0.5 when same type CT for each side, or be 1 when different type CT for each side.

$I^{(3)}_{k.max}$-Max three phase shortcircuit periodic current at near external zone, Normally be reciprocal of subinstanous impedance.Viz: 1/0.2033=5In

$I_{unb.max}$=1.5*2*0.5*0.1 *5In=0.5In=3882A，Convert to secondary value: 0.518A

I_{Bias} be $I^{(3)}_{k.max}$ 。

According equation:

I_{Diff} >=K2* I_{Bias}-(K2-K1)Is2+Is1

We can get K2=0.17，Select K2=0.2

其中：

Krel – 可靠系数，此处取 1.5 .

K_{ap}-非周期分量系数，一般取 1.5~2.0，在此取 2

K_{cc}-互感器同型号系数，同型号互感器一般取 0.5，不同型号的互感器一般取 1。

K_{er}-二侧互感器比误差系数，5P 级取 0.1，10P 级取 0.2。

$I^{(3)}_{k.max}$-最大外部三相短路电流周期分量，一般为次暂态阻抗值倒数，即 1/0.2033=5In

$I_{unb.max}$=1.5*2*0.5*0.1 *5In=0.5In=3882A，折算到二次值为：0.518A

此时的 I_{Bias} 为 $I^{(3)}_{k.max}$ 。

按公式 I_{Diff} >=K2* I_{Bias}-(K2-K1)Is2+Is1 推导 K2=0.17，取 K2=0.2

2.2.1.2.4 Time Delay(延时)

Differential protection should be instanous, So time delay should be zero.

差动保护一般要求为速断保护，所以延时需整定为 0 秒。