

- **NGFANG ELECTRIC REVIEW**



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[illegible]

DONGFANG ELECTRIC REVIEW



2021

2021-12-25 Vol. 35 No. 4
(Quarterly, since 1987)

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Workbench
Miner

PSD Miner
U469.72 TM911.4 A 1001-9006 2021 04-0001-05

Random Vibration Life Analysis of A Fuel Cell Power System Support Structure

1 1 2 1 1

(1. Dongfang Fuel Cell Technology Co. , Ltd. , 611731, Chengdu, China;
2. Dongfang Turbine Co. , Ltd. , 618000, Deyang, Sichuan, China)

Abstract: In recent years, fuel cell attracts people' s attention with its zero emission. The vehicle fuel cell power system support structure is fixed together with the vehicle frame. The system support structure carries the static and dynamic loads of the entire fuel cell, so its structural performance determines the stability of the fuel cell system under on-board conditions. This paper uses Workbench to analyze the random vibration of a fuel cell system support structure. The analysis shows that the fuel cell system can pass the durability random vibration test. The system support structure meets the vehicle durability requirements which damage assessment is based on with Gaussian distribution and miner' s linear cumulative damage law.

Key words: carbon neutrality; fuel cell power system; random vibration; PSD; Miner; damage

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2060

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1987 - 2017

2021 – 2035

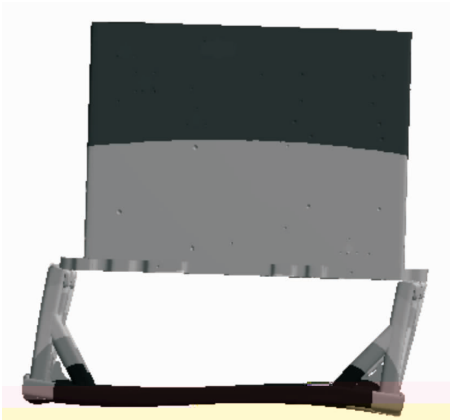
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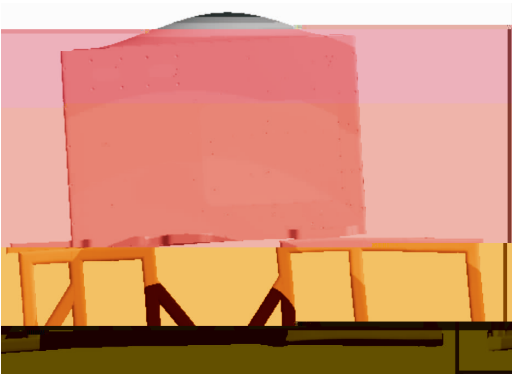
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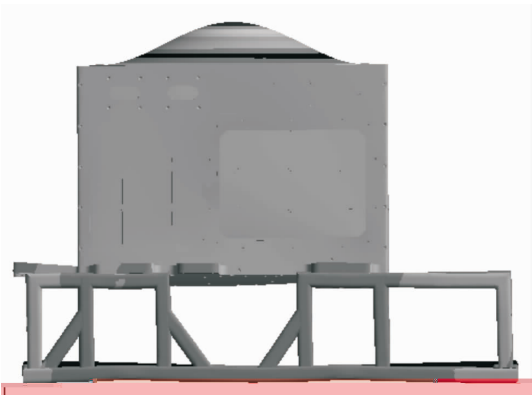
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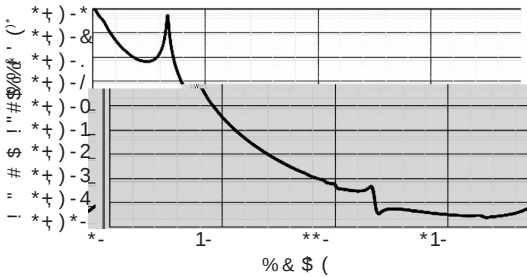
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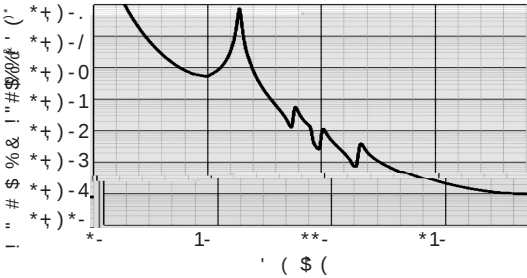
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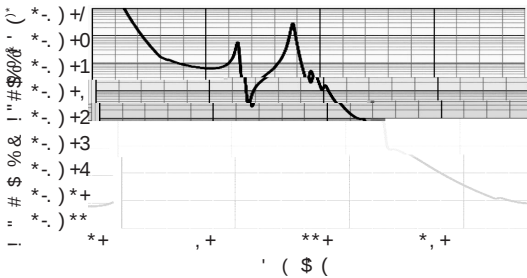
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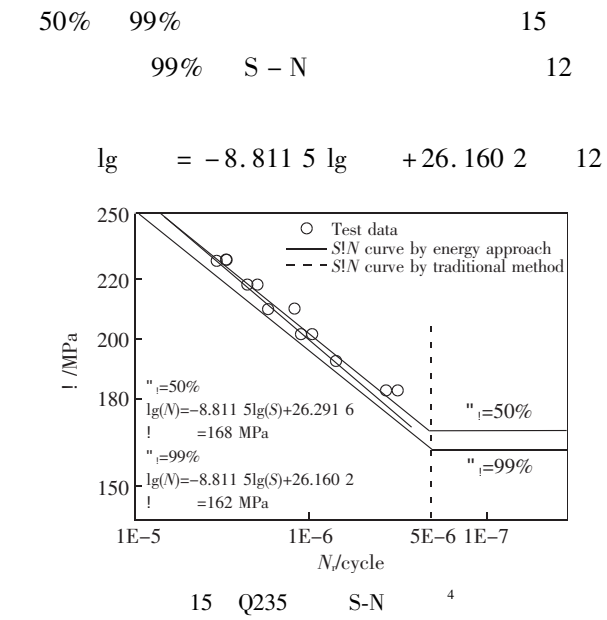
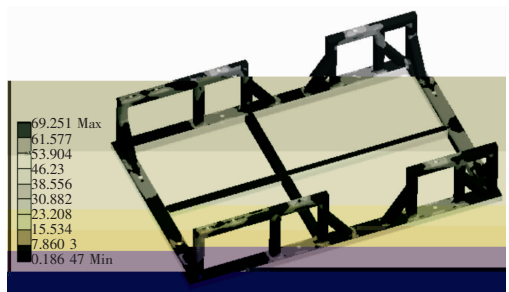
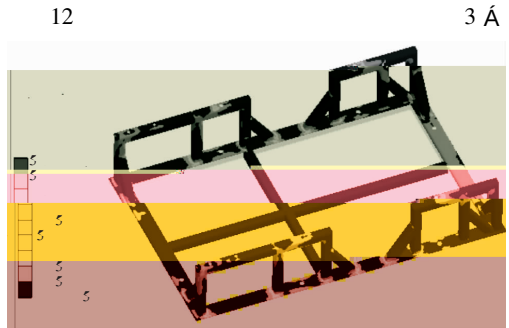
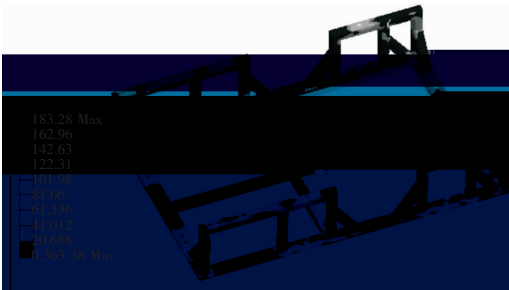
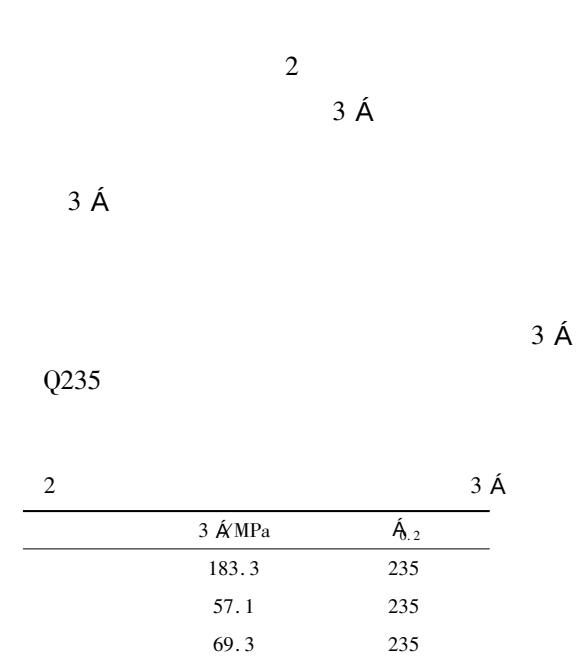
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10



11



8

$= 4 \times 10^6$

$_0^+ = 5 \text{ Hz}$

$_1 \text{ Å} = 0.683 \times \times _0^+ = 1.366 \times 10^7$

$_2 \text{ Å} = 0.271 \times \times _0^+ = 5.42 \times 10^6$

$_3 \text{ Å} = 0.043 \times \times _0^+ = 8.66 \times 10^5$

12

10^7

11

3

0.52 0.75

3

1 Å	1 Å	2 Å	2 Å	3 Å	3 Å	3 Å
61.1	+ ∞	122.2	+ ∞	183.3	1.65×10^5	0.52
19.1	+ ∞	38.1	+ ∞	57.1	+ ∞	0
23.1	+ ∞	46.2	+ ∞	69.3	+ ∞	0

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7

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TP393

A

1001-9006 2021 04-0006-06

Analysis of Network Security Elements of Energy Equipment

1 H

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3

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- (1. DEC Academy of Science and Technology Co. , Ltd. , 611731, Chengdu, China;
2. National Energy Administration Information Center, 100824, Beijing, China;
3. Xi'an Jiaotong University, 710049, Xi'an, China)

Abstract: The intensification of cyberspace security confrontation gradually extends network security attacks from information domain to physical domain, network attacks from information systems to control systems and finally to energy equipment. The security elements of information system and control system are relatively clear, while the network security research of energy equipment is still relatively lacking. This paper analyzes the network security elements of energy equipment with the goal of ensuring the availability of energy equipment, and discusses the differences and relationships between energy equipment security and information system security and control system security.

Key words: energy equipment; cyber-physical systems; confidentiality; integrity; availability; network security

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IEC 62443¹

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ISO/IEC 13335 – 1 2004
Confidentiality

Integrity
Availability

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systems CPS

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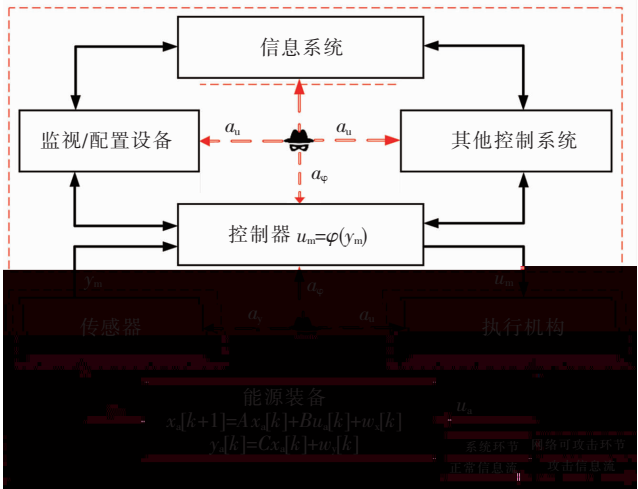
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1. 1

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- 13 ISO/IEC 13335-1 2004 — —
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- 14 ISA99/IEC 62443-1-1 — — 1-1
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2016
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2017 R . 2017-03
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- 23
J . 2019 45 1 5 –24

基于时间自动机的汽轮机控制保护系统建模

11221

1. 南京理工大学 南京 210094 2. 东方电气能源装备工控网络安全工程实验室 成都 611731

摘要

UPPAAL

关键词

UPPAAL

中图分类号 TP393

文献标识码 A

文章编号 1001-9006 2021 04-0012-06

Modeling of Steam Turbine Control and Protection System Based on Time Automata

11221

(1. Nanjing University of Science and Technology, 210094, Nanjing, China;

2. Academia Sinica of Dongfang Electric, 611731, Chengdu, China)

Abstract: In recent years, the safety threat of steam turbine control and protection system attracts extensive attention from academia and industry. Different from the previous attacks on communication protocols, the attacker gradually shifts the target to the controller itself. In order to deal with this new threat, scholars begin to study how to establish an effective model of the controller to describe and analyze the impact of this attack on the system operation, and then design timely and effective defense strategy. On the basis of summarizing the relevant research, this paper proposes a formal method based on time automata to model the turbine protection system. At the same time, UPPAAL software is used to simulate and verify the established model. The results show that the proposed model can describe the working process of steam turbine control and protection system well, and lay a foundation for subsequent safety research.

Key words: steam turbine control and protection system; time automata; UPPAAL

“ ” “ ”

收稿日期 2021 - 11 - 19

基金项目

61973163

ZKZF200001

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1998 - 2020

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1973 - 2013

yuanxs@ dongfang. com

1985 - 2012

sangzi@ dongfang. com

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1UPPAAL

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DEH		ETS
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open1 close1

3

UPPAAL

stop2 =

4. 1

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10 ~ 11

close2

start1 1

Close1

Open1

stop1 = 1

open1

close1

Stop

Trasition

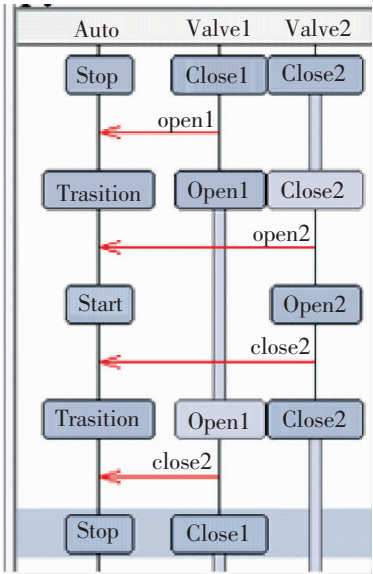
```
(Stop, Close1, Close2, Slow, T_low, V_short, P_low, Close3)
open1: Valve1 → Auto
/*Transition: Open1, Close2, Slow, T_low, V_short, P_low, Close3)
open2: Valve2 → Auto
/*(Start, Open1, Open2, Slow, T_low, V_short, P_low, Close3)
/*Close2: Valve2 → Auto
/*(Transition, Open1, Close2, Slow, T_low, V_short, P_low, Close3)
/*Close1: Valve1 → Auto
/*(Stop, Close1, Close2, Slow, T_low, V_short, P_low, Close3)
Auto
```

4. 2

4. 1

10

= 3 000 = 150 = 13 = 330



urget = 1

12 ~ 14

3 300

Slow

Fast

stop1 = 1

urget = 1

Close3

Open3

urget_close

11

start2 = 1

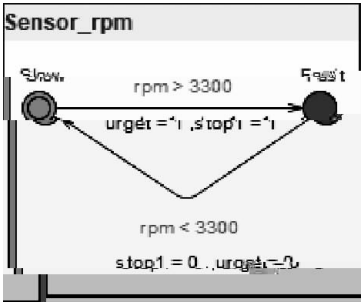
Close2

Open2

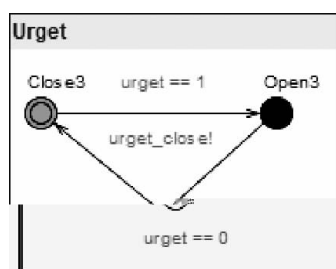
open2

= 3 000

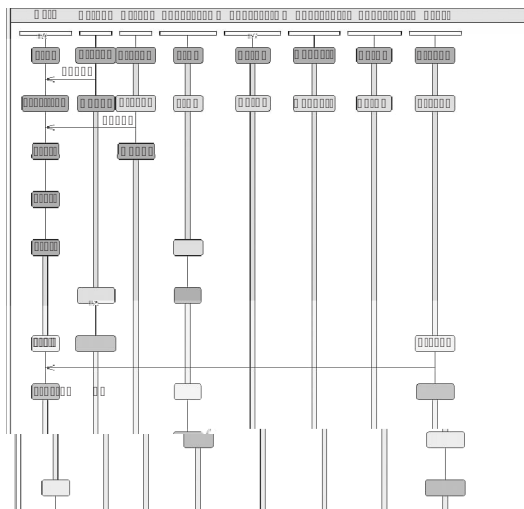
Start



12



13



TQ326.9

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1001-9006 2021 04-0018-05

Study on the Aging Characteristics of the Main Insulation Composite Material of the Large Generator Stator Bar under Multiple Working Conditions

(DEC Academy of Science and Technology Co., Ltd., 611731, Chengdu, China)

Abstract: Aiming at the thermal/oxygen aging of the main insulation composite material of generator stator bar, artificial accelerated simulated aging experiments under high temperature and high temperature/oxygen environment were carried out respectively. Studies show that oxygen accelerates the aging degradation reaction of the free radical reaction mechanism caused by high temperature during the aging process, generates a large number of free radicals during the aging process, and accelerates the destruction of the molecular network structure. The participation of oxygen accelerates the rapid decrease of free radical content and aggravates the aging degree of materials. As the aging progresses, the interaction force between different phase structures decreases, resulting in a large number of fragmented structures on the surface. This study provides the basic data of material evolution for the life assessment of large generator insulation system and promotes the improvement of the accuracy of the assessment.

Key words: main insulation; epoxy composite; aging

KEYENCEVHX-2000100300500700

2

EPRFTIRSEM

1

1.1

5cm×5cmDHGXGQ-2000SLQ-1000150℃60h5h12

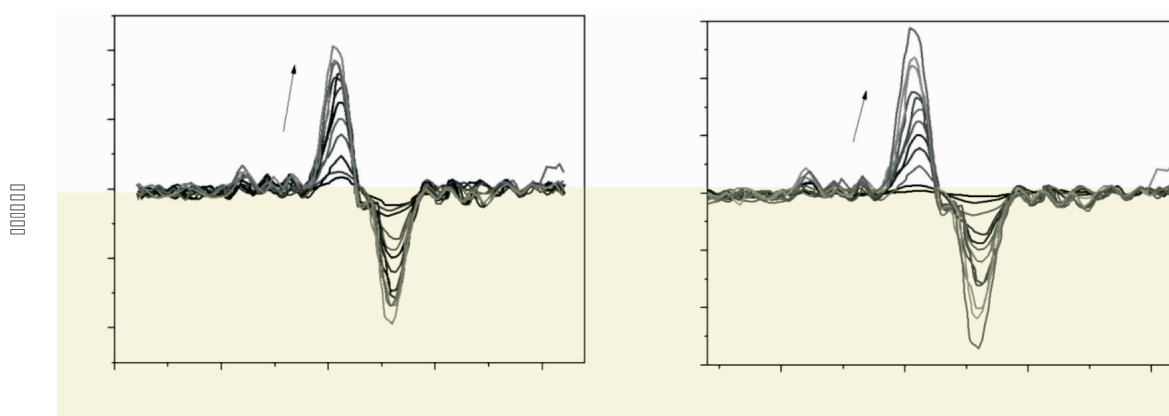
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EPRBRUKER EPR EMX PLUS

FTIRThermo FisherScientificThermo Scientific™ Nicolet™ iS50

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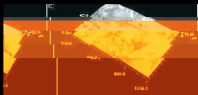
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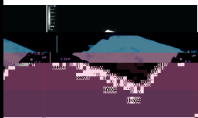
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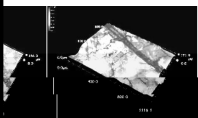
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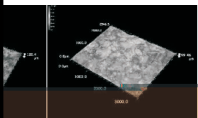
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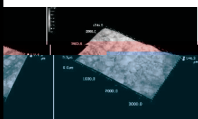
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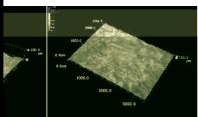
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20 h



40 h

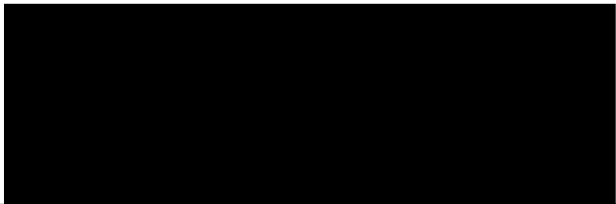


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PECVD

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TB383

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1001-9006 2021 04-0023-06

Preparation and Properties of Hydrophobic Graphene/Cu-Ni Alloy
with High Heat Transfer Coefficient

2021 - 10 - 22

1984 - 2011

OM Olympus

DP71 Raman Labram HR800-UV-

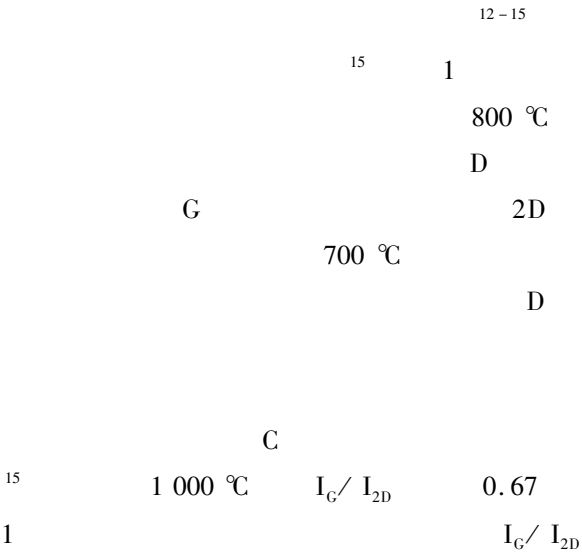
NIR 532 nm 10% – 10mW

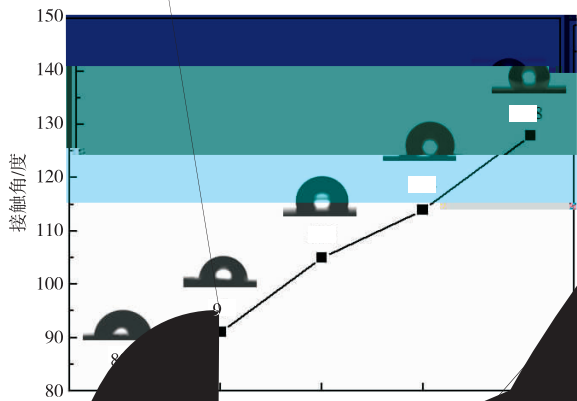
Attension Theta

D20 mm × 1 mm × 600 mm

2

2. 1





- 2 1321
- 3 Ahmed M Kishi N Soga T. Large scale bi-layer graphene by suppression of nucleation from a solid precursor J . RSC Adv. 2015 5 53 42645 –42652
- 4 Kumar A Khan S Zulfequar M et al. Low temperature synthesis and field emission characteristics of single to few layered graphene grown using PECVD J . Applied Surface Science 2017 402 161 –167
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- 7 Reina Alfonso Jia Xiaoting Ho John Nezich Daniel Son Hyungbin Bulovic Vladimir Dresselhaus Mildred S. Kong Jing. Large Area, Few-Layer Graphene Film

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Ansys Workbench

TB12

A

1001-9006 2021 04-0029-05

Research and Analysis on Assembly Dynamic Characteristics of Permanent Magnet Direct Drive Wind Turbine

(Dongfang Electrical Machinery Ltd. , 618000, Deyang, Sichuan, China)

Abstract: This paper describes the use of Ansys Workbench finite element software to build a permanent magnet direct-drive generator assembly model, using electromagnetic coupling to calculate the natural frequency of the generator assembly, that is, considering the uniform magnetic pull of the rotor permanent magnet and stator core, And the influence of eccentric magnetic pull due to deformation of the machining, assembly, rotor bracket and stator bracket itself. The accuracy of the method is verified by comparing the calculated results with the measured results of the modal test.

Key words: finite element method; electromagnetic coupling; dynamic characteristics; modal test

1

4

2

5

ANSYS

3

2021 - 09 - 24

1988 - 2019

6

1

$$\ddot{u} + \ddot{v} + \ddot{w} = 0 \quad 1$$

$$-\ddot{\zeta} + \ddot{A} = 0 \quad 2$$

$$-\ddot{\zeta} + \ddot{A} = 0 \quad 3$$

1. 1

$$\ddot{\zeta} \quad \ddot{A}$$

$$-\ddot{\zeta} \quad \ddot{A} = 0 \quad 4$$

1. 2

Lanczos 7

Lanczos

Lanczos

Lanczos 8

Lanczos

$$\begin{aligned} \ddot{u} &= 0 & \ddot{v} &= -3 & \ddot{w} &= -4 \dots 1 & 5 \\ \ddot{u}_{-1} &= \pm_{-1} & & & & & 6 \end{aligned}$$

Lanczos

2

2. 1

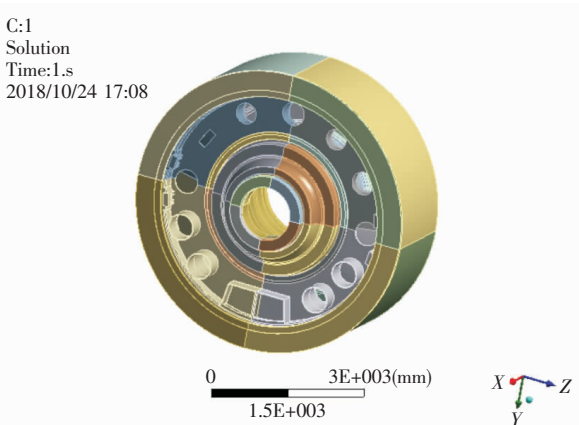
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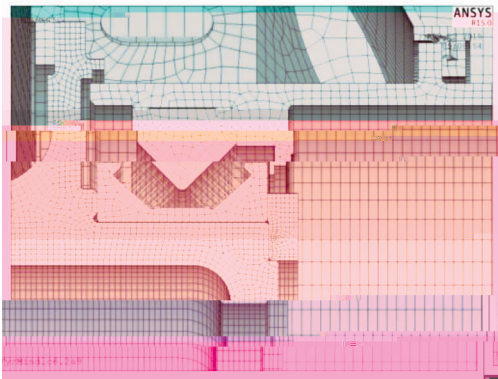
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Sweep Method Hex Dominant Method
Tetrahedrons Face eshing
Edge Size Body Size
Solid186 Solid187

Link180 Beam188



1



2

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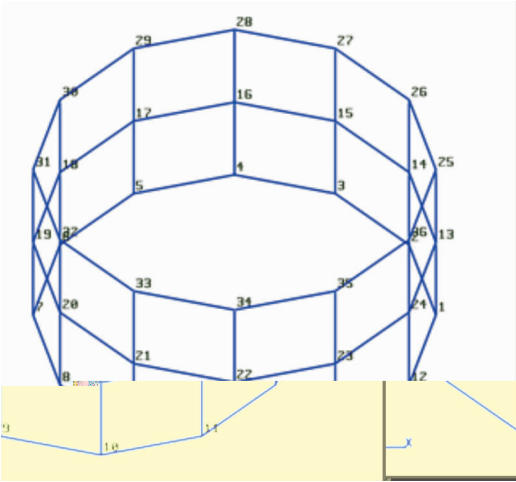
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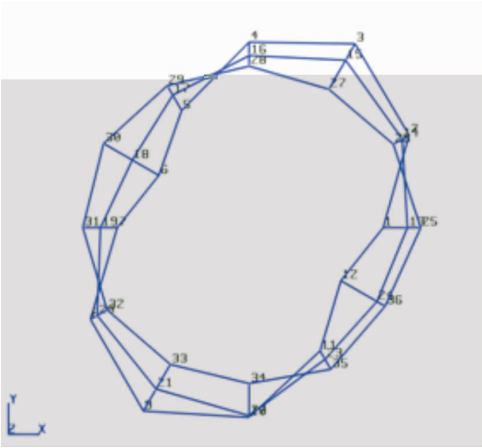
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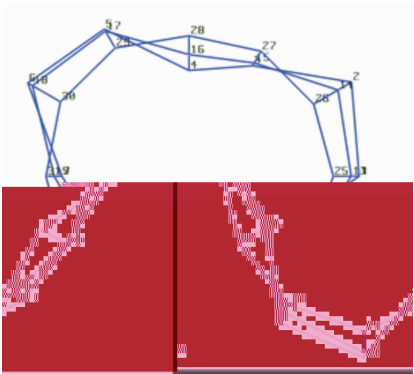
11

3.3

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4	Hz
1	40.1
2	103.9



12 40.1 Hz



13 103.9 Hz

4

5	
6	
5	Hz
1	40.1 38.698 39.644
2	103.9 113.45 107.66
6	%
1	-3.50 -1.14
2	9.19 3.62

4

6	8	12	7	9
13			5	

5

1	2
2	
	3.62%
	9.

19%	
3	
4	

46

VPN		
	1	2
1.	618000	2. 735000

VPN

VPN

SCADA

TM614A1001-9006 2021 04-0034-04

Application of VPN in Centralized Monitoring of WTGs

12

(1. Dongfang Electric Automatic Control Engineering Co. , Ltd. , 618000, Deyang, Sichuan, China;

2. Jiuquan Vocational Technical College, 735000, Jiuquan, Gansu, China)

Abstract: It is essential for off-site monitoring of WTGs to enhance remote management of wind farms, to reduce WTG operation and maintenance costs, to check and eliminate potential safety hazards. A remote monitoring center can not only achieve cost-saving purposes through a virtual private network (VPN) , but also meet the requirements of the State Electricity Regulatory Commission’ s “Safety Protection Regulations for Secondary Power Systems”. This paper analyzes and discusses the remote monitoring and safety of WTGs through VPN.

Key words: virtual private network (VPN); remote monitoring; WTG; network security; SCADA

SCADA

SCADA

SCADA

1

APP

SCADA

“

2021 -06 -01

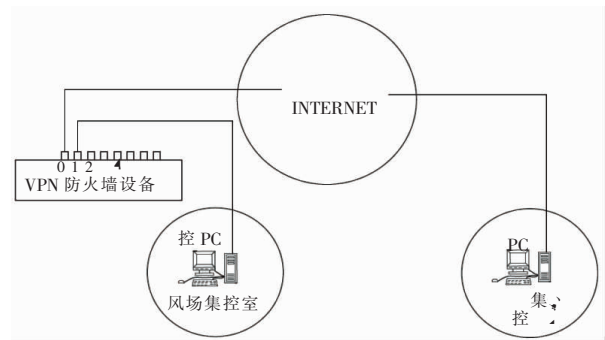
1984 - 2007

”

1

2

Internet



1 VPN

2.2 SCADA

SCADA

USB

U USB

VPN

5

VPN

4

VPN

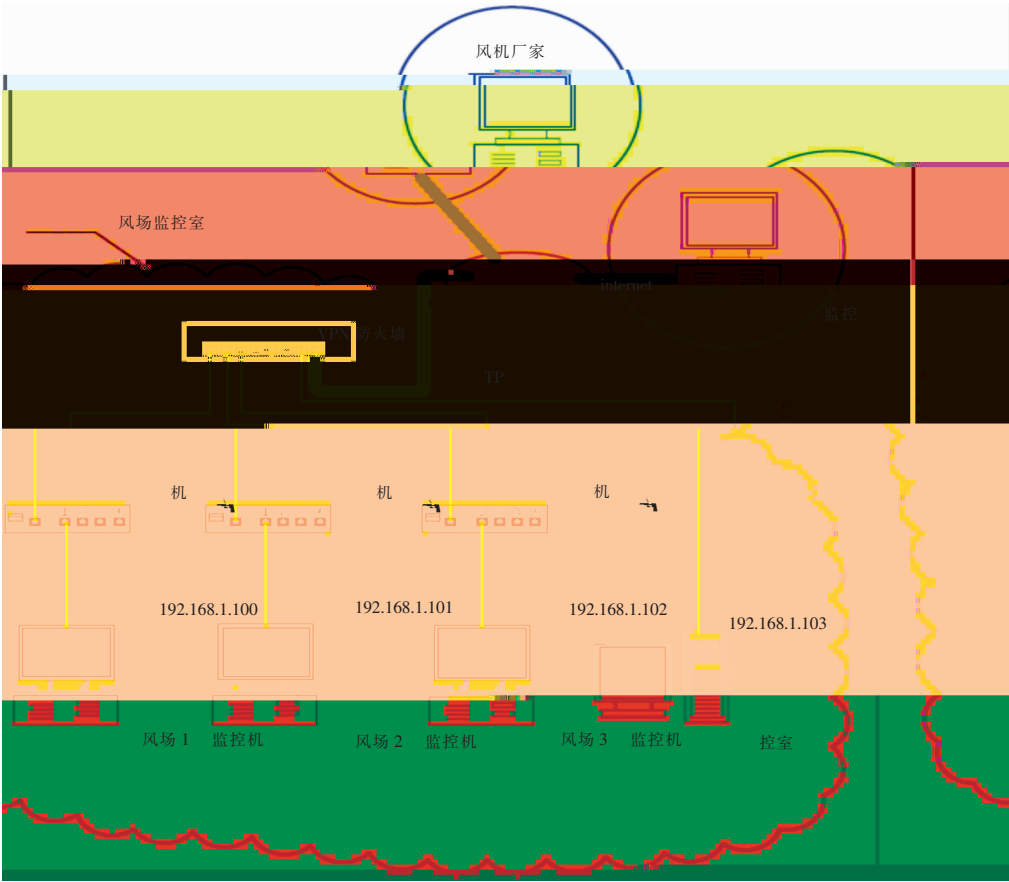
VNC

VPN

VNC

SCADA

SCADA



2 VPN

3

VPN

VPN

VPN

VPN

2 . R . 2005

3 . J .

2013 32 6 23 – 25

4 . Internet SCADA

J . 2006 17 89 – 93

5 . IPSec VPN J .

2014 22 20 139 – 141 + 145

6 . VPN

J . 2011 3 = Ğ

1 . J .

2014 6 137

CANopen

611731

CANopen
TMS320F28377D CAN
Controller Area Network CANopen PLC Programmable Logic Controller
CANopen PLC CAN
TM614 TP273 A 1001-9006 2021 04-0038-04

Development of CANopen Communication Function for
Wind Power Converter Control System

(DEC Academy of Science and Technology Co. , Ltd. , 611731, Chengdu, China)

Abstract: The intelligence of wind power system is an important trend, so the development of an independent, flexible and open converter communication system becomes an important task. CANopen communication has the advantages of simple hardware structure, strong anti-interference ability, and high real-time performance, so it is widely used in the field of industrial control. This paper developed CANopen communication function based on the CAN(Controller Area Network) module of TMS320F28377D, so that it could be used in wind power control systems with PLC (Programmable Logic Controller) as the main controller. Finally, the reliability and accuracy of the developed communication function were verified through experiments.

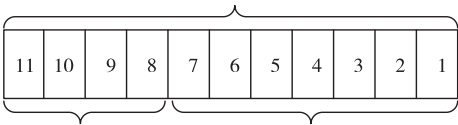
Key words: CANopen; converter; PLC; CAN

CAN Controller Area Network
BOSCH
1 CAN
2 CAN
CAN



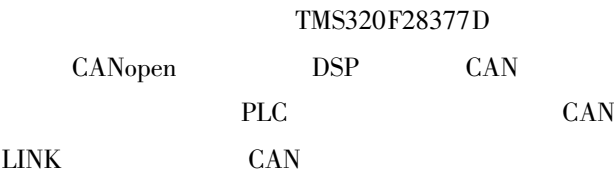
			32	
	SDO			32
		SDO		
3	PDO	PLC		
	PDO	TPDO		
RPDO	PDO	8		
PDO				
4	PLC		SYNC	
		PDO		

3	CANopen			
	CANopen	11	CAN-	
ID	COB-ID	Communication	Object	
Identifier				
	4			
7				
3				



4

CANopen



1	1	1	2	3	4	4	4		
1.			611731	2.				618000	
	3.		611731	4.				618000	

“ ”

6 17

“ ”

1

1

1

1

2

3

4

5 6% 70%
23%

6

7

8

9

+ + + +
0

2

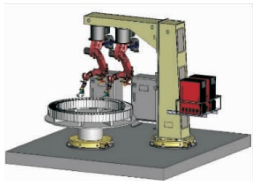
“

”

2. 1

1

1

			1	30%	
	14 m × 14 m	GMAW GTAW	2		
	× 5 m	GMAW	3		
			1	35%	
	6 m × 6 m	GMAW	2		
	× 5 m		3		
TIG	6 m × 6 m	TIG	1	45%	
	× 5 m		2	50%	
			3	2	
				1	

2. 2

2

2

2. 3



2

2

TIG	1		1/24	
	2	80%		
	3			
	4	90%		
	1		1/4	
	2		1/5	
	3		RT	
		60%	99%	
	4			

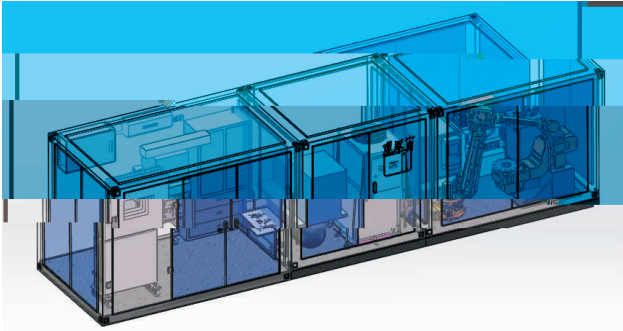
2.4

3

“ ”

3 1

“ ”



3

2

4

5

4

33

1 . 2018 45 9 117 – 124 J .

2 . M . 1986

“ ”

11 1
D705

VM60

VM60

1 . M . 2015 289

2 . J . 2019 1 146 – 147

3 . J . 2016 26 16 94

4 . J . 2001 4 436 – 439

5 . J . 2015 29 2 67 – 71 + 75

6 . ANSYS10.0 M . 2007

7 . ANSYS J . 2018 18 10 120 – 122

8 . M . 2003

VM60 19
“ ”

来源 东方电气网

611731

SA – 335P92

F426

A

1001-9006 2021 04-0047-02

Boiler Industry Import Large-calibre Pipe Procurement Dilemma and Countermeasures

(Dongfang Boiler Group Co. , Ltd. , 611731, Chengdu, China)

Abstract: This paper analyzes the procurement status and difficulties of imported large-diameter pipes (SA-335P92 and other materials) , puts forward countermeasures, achieves good results, saves procurement cost and ensures delivery cycle.

Key words: imported large-diameter pipes; procurement difficulties; measures; results

SA- 335P92

1

SA- 335P92

Vallourec Deutschland GmbH

2021 – 10 – 18

1970 – 1991

3

49

1

1.1

3

CO20%1.6~1.81m³

N₂CO₂0.595~0.85m³

2800~3800kJ/Nm³1.6~1.8m³

19

2104

1

N ₂	H ₂	O ₂	CO	CO ₂	CH ₄	C _m H _n			H ₂ S
			%				kJ/Nm ³	mg/Nm ³	mg/Nm ³
51.3	3.8	0.1	22.1	22.7	0	0	~3200	<10	—
27.8	2.3	0.1	53	16.6	0.2	0	~7000	<10	—
4.9	59	0.5	5.8	4	24.1	1.7	~17500	<10	050

1.2

CO

50%6500~7800kJ/

Nm³1

1.3

H₂CH₄

85%

16000~18500kJ/Nm³

1800℃



2.2

50%

)

SA - 213TP347H

4

-

1

5

NO_x

SCR

1

6

2

3

7 SCR

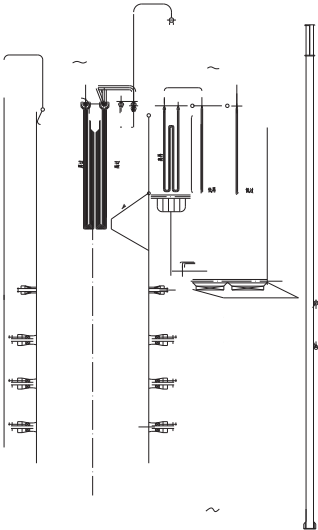
SCR

NO_x

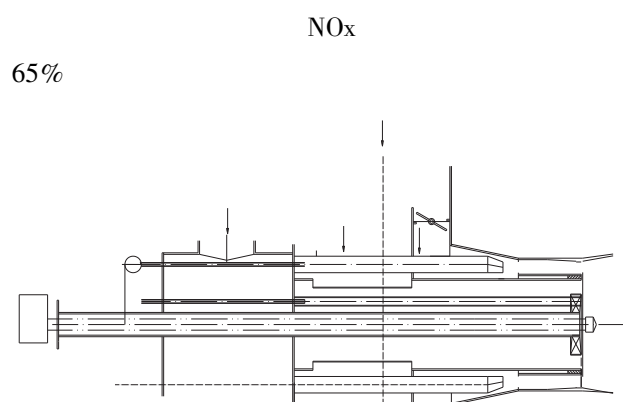
SCR

NO_x

50 mg/m³







	55 ~ 80	5	. 135 MW	—
MW 150 MW			J .	2014 45 4 23 - 26 + 44
		6	.	
			J .	2015 12 35 - 38
		7	. 100 MW	
			J .	2019 10 70 - 73
		8	. 110 MW	
			J .	2019 6 5 - 8 + 28
		9	.	J .
			2015 44 3 21 - 27	
		10	.	
			J .	2014 28 3 169 - 172
		11	.	
			J .	2019 2 60 - 64
		12	.	
			D .	. 2018
1	. 2012 12			
	R . 2012			
2	. 2	J .		
	2019 9 64 - 68			
3	.			
	J .	2018 8 63 - 64 + 137		
4		D .		
	2017			
	48			

1 2		
1.	613001 2.	618000

TH16 V263

A

1001-9006 2021 04-0055-04

Method of Using Lapped Jiont Profile Disk Milling Cutter to

Decrease Deformation and Vibration of Thin Wall Part

1 2

(1. Southwest Jiaotong University, 610031, Chengdu, China;
2. Dongfang Electrical Machinery Co., Ltd, 618000, Deyang, Sichuan, China)

Abstract: Thin wall part is easy to deforming when it is milled, because of its low strength. What is more, As its low stiffness, thin wall part is more likely to vibrate. This will decrease machined surface roughness. This paper presents that using indexable disk milling cutter, further subdivision of finish milling, one time to complete the ordinary finish milling and wiper finish milling, exploring the optimal cutting parameters can decrease cutting force and vibration of thin wall part, improve processing quality and efficiency. Furthermore, a processing example is utilized to demonstrated the validity of those method.

Key words: thin wall part; milling; processing deformation; processing vibration



2021 - 07 - 01

1987 - 2010

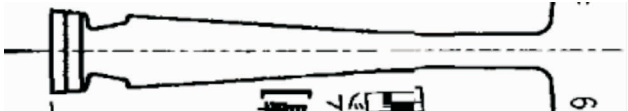
1

1. 1

1

1/8
Cr Ni Mo V

±0.02 mm
0.9
150 mm
m²
30



2



3



1

1. 2

2
3

0.12

~0.31 mm

$d = 50 \text{ mm}$

$v_c = 60 \text{ m/min}$

$n = \frac{v_c}{\pi d} \times 382 \text{ r/min}$

$n = 5$

$F = \frac{v_c}{n} \times 1910 \text{ Hz}$

$F = 31.8 \text{ Hz}$

511455

ASME

TH121

A

1001-9006 2021 04-0059-03

Analysis on the mt o

a a

2021 - 01 - 08

1983 – 2007

Miller

ASME

/ R

I R

0.9

TM153

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1001-9006 2021 04-0062-04

3D FEM Analysis about Stator Winding Force

(Dongfang Electric Machinery Co. , Ltd. , 6W

2021-02-13

1986 – 2012

3

S2S3S1

1

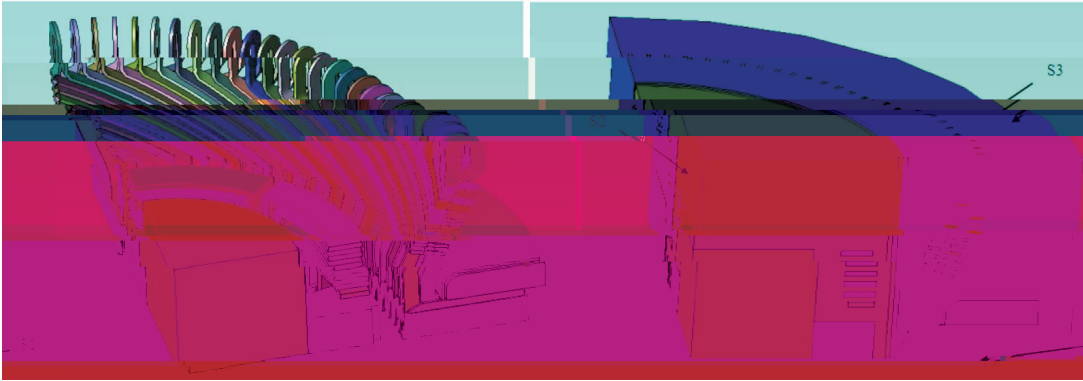
S1

xzy

0

3

S1



1

$9.60 \times 10^6 \text{ N/m}^3$

3

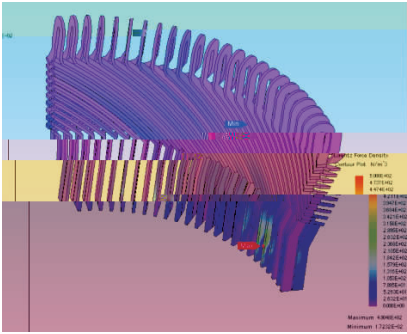
$2.34 \times 10^6 \text{ N/m}^3$

2

2.1

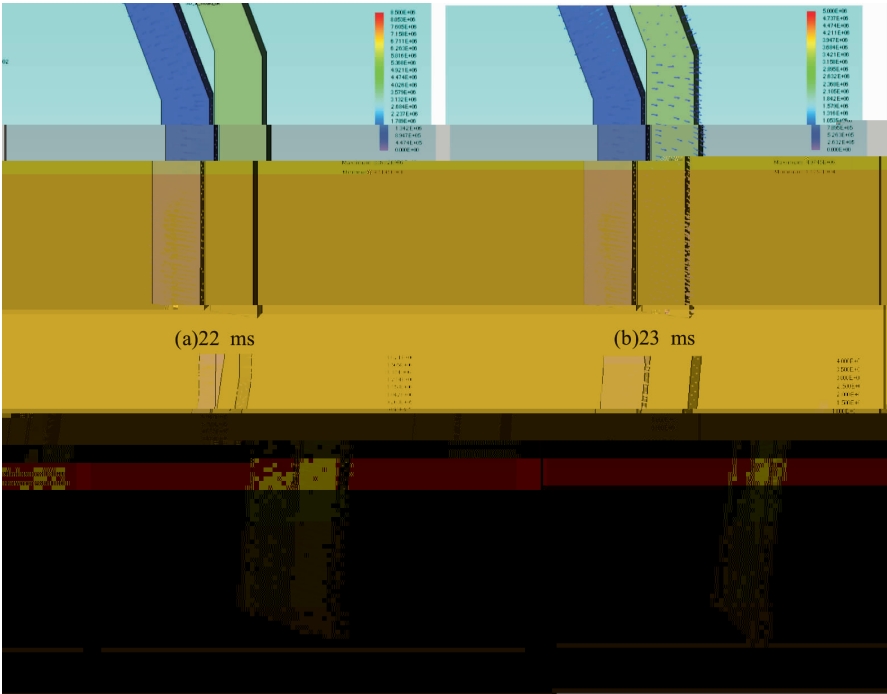
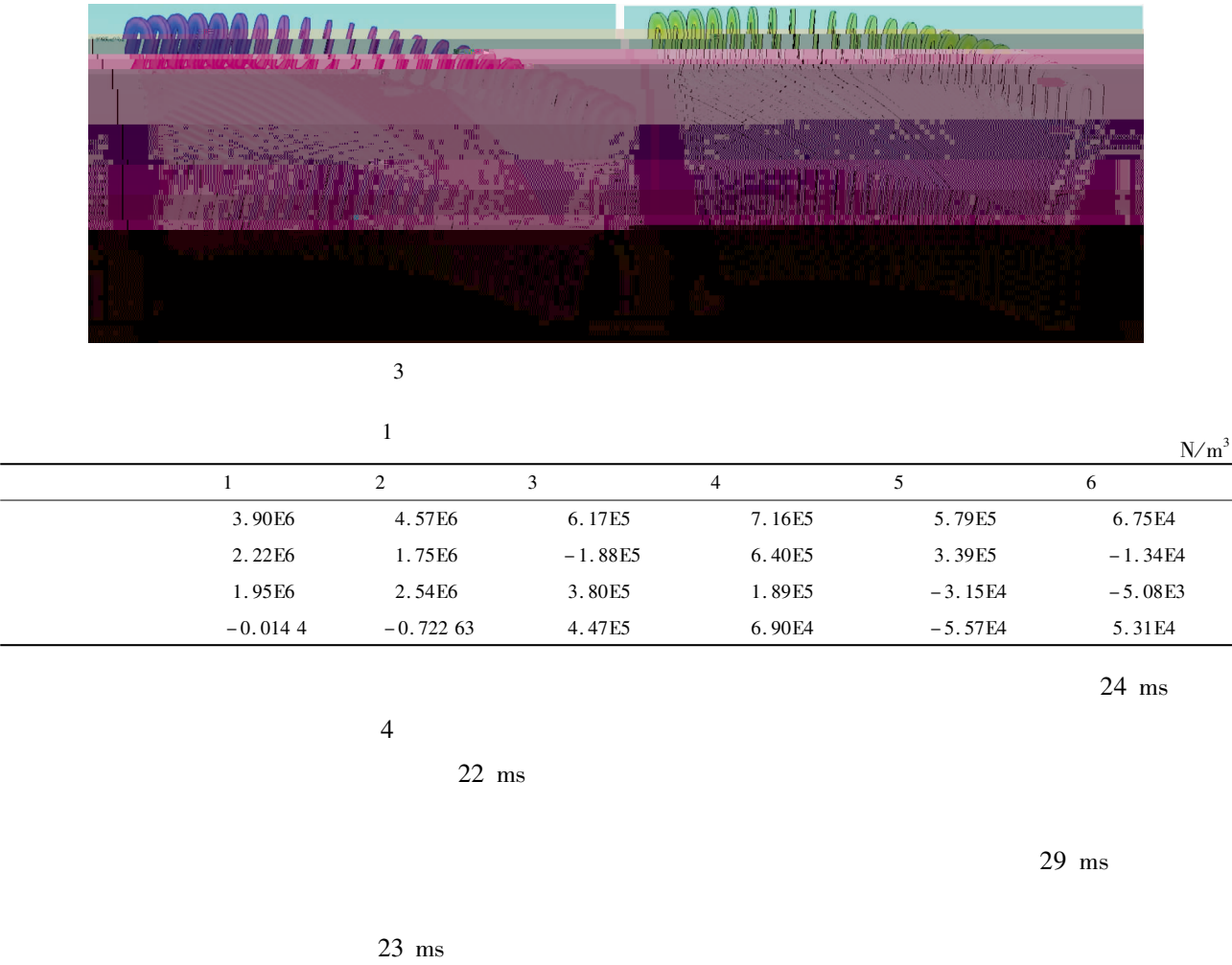
02

490 N/m^3

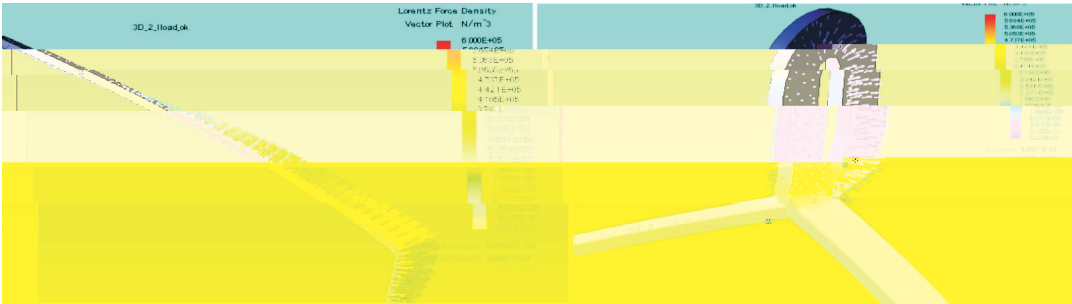


2.2

33



5



5

2.3

0.9

6

$1.04 \times 10^7 \text{ N/m}^3$

0.9

2



6

0.9

2

0.9

N/m ³						
1	2	3	4	5	6	
4.89E6	5.07E6	7.98E5	1.17E6	7.93E5	5.34E4	
3.18E6	4.16E6	6.94E5	1.04E6	2.22E4	5.21E3	
2.43E6	2.60E6	3.80E4	4.08E5	5.97E5	5.78E3	
/N/m ³	-0.813 3	-2.049 4	-1.79E5	-5.69E4	-5.16E5	-3.32E4

1

2

0.9

0.9

10%

1

0.9

10%

3



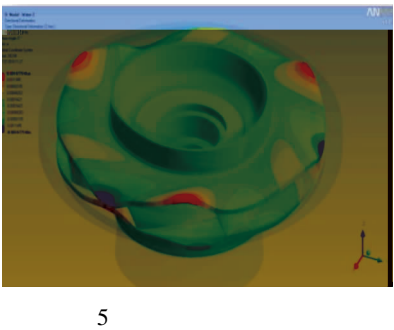
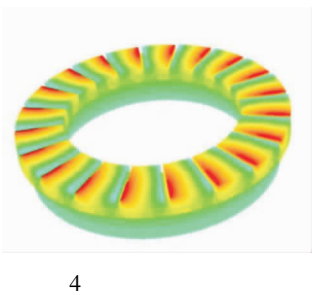
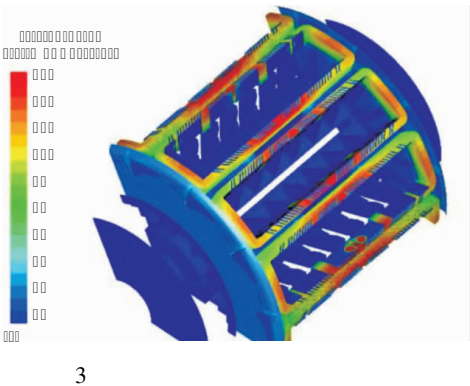
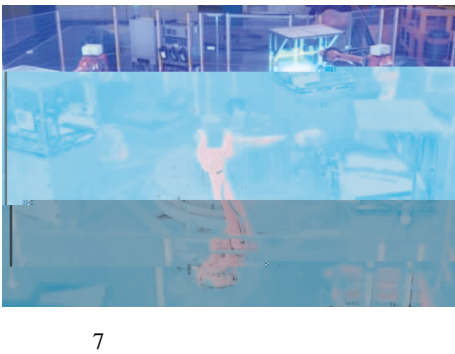
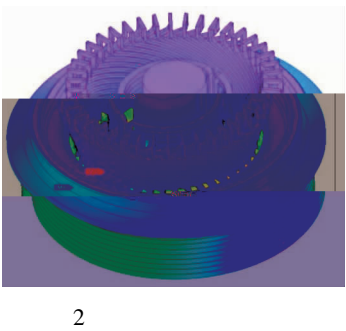
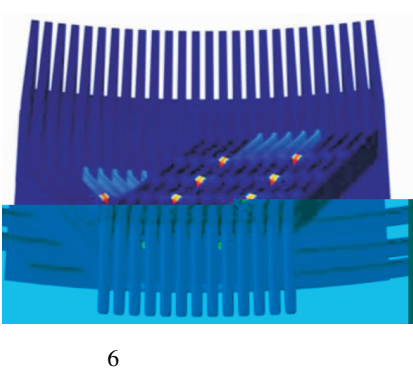
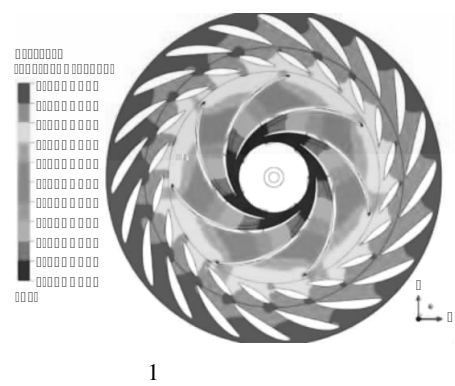
F426.4A1001-9006 2021 04-0066-06

Overview of the Innovation-driven Development of Dongfang Electric
in the 13th Five-Year Plan

(Dongfang Electric Co. , Ltd. , 618000, Deyang, Sichuan, China)

Abstract: This paper briefly reviews the main achievements of the innovation-driven development of Dongfang Electric Machinery Co. , Ltd (DFEM) “13th Five-Year Plan”, after the “13th Five-Year Plan” period of innovation drive, the comprehensive technical strength of DFEM reached the leading domestic and international advanced level.

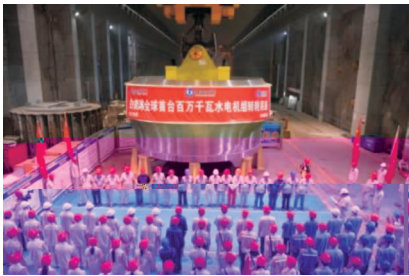
2021 -08 -30	
1964 -	1996
1965 -	2012



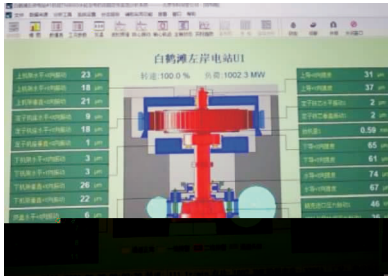
2

“ ”

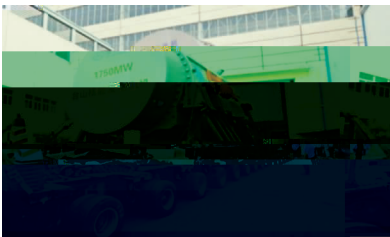
		1 000
MW	9 ~ 10	1 750
MW		



9 1 000 MW



10 1



11 ERP1 750 MW



12



13 10 MW

MVar

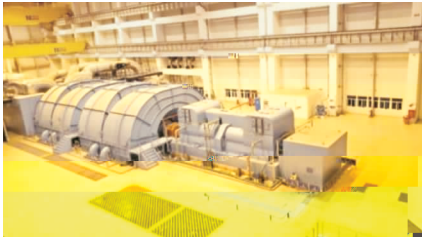
300

15

50 MVar

50 MVar

16



14



15 300 MVar

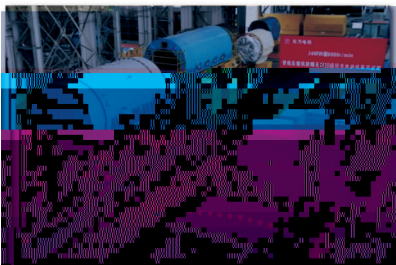


16 50 MVar

24 MW 6 000 r/min

33

17



17 24 MW

50 Hz 60 Hz 2 4 90%

4

300 MW 600 MW

165 MW 6 MW ~

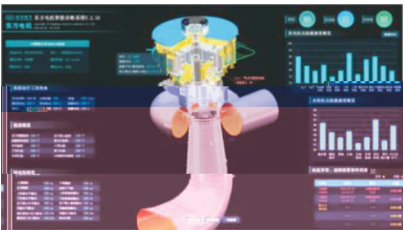
3 21

3

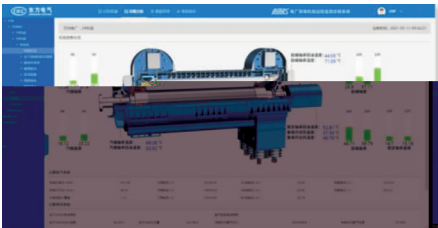
“ ”

3.1

18 ~ 19



18



19

3.2

“ ”

20 ~ 21

9 000 12 000

620% 56.6%



20



21

3.3

DF – 300 22



22 DF300

4

“ ”

4.1

“ ” “ ”

” 10

“ ”

23



23 “ ”

4. 2

“ ”

56 24 ~ 26

2 1 1

22

2 4 2 1

369 280

69 5. 1



25



26



24

5

“

”

5. 2

“ ”

6

5.3

“ ” “ ”

“ ”

“ ” “ ”

“ ”

5.4

“

”

65

2

“

Ö {

TM62

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1001-9006 2021 04-0072-04

Research and Analysis of Steam Turbine Crisis Trip Device Based on High Frequency Solenoid Valve Control

(Dongfang Electric Automatic Control Engineering Co., Ltd., 618000, Deyang, Sichuan, China)

Abstract: In this paper, a new type of high frequency solenoid valve structure and the working principle, to establish the simulation model of solenoid valve, by means of the mechanical parts of the electromagnetic loop, and the coupling between the hydraulic system simulation, the solenoid valve static and dynamic simulation results more accurate, and the applications of the high frequency solenoid valve to a steam turbine crisis trip device, completed by simulation software based on steam turbine critical of the high-frequency solenoid valve control block device simulation model is established, through the simulation of various working conditions is critical in the interrupt turbine working state, It is further verified that the critical block device of steam turbine based on high frequency solenoid directional valve has high dyT c t

2021 - 09 - 24

1983 - 2010

“ ” “ ” “ ” “ ”

4

$$\begin{aligned} \frac{1}{\dots} &= \frac{1}{\dots + \dots} - \dots - \dots \\ m &= -\frac{\ll}{\gg} \\ \dots &= m - \text{spring} \pm w - z \\ w &= d_v \cdot \sin 2 \end{aligned}$$

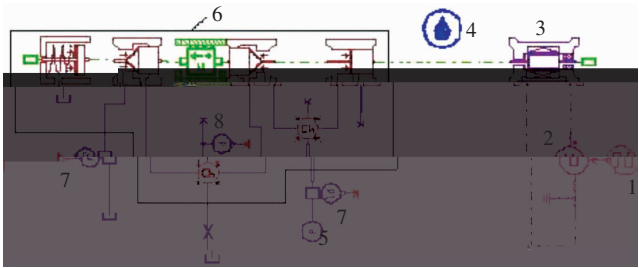
1

1

$$\begin{aligned} \dots &= \dots = \dots m \\ \text{spring} &= \dots + 0 \dots w \dots z \end{aligned}$$

3

2



1 - PWM 2 - 3 - 4 -
5 - 6 - 7 - 8 -

2

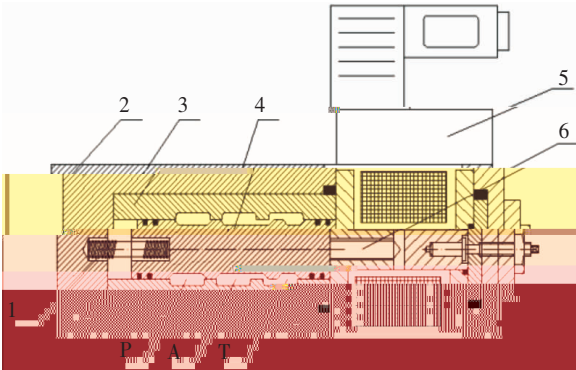
3

0.2 ~ 0.8

4

1

1



1 - 2 - 3 - 4 -
5 - 6 -

1

5

4

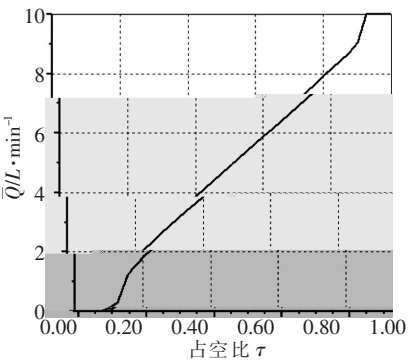
1

T A
6

4

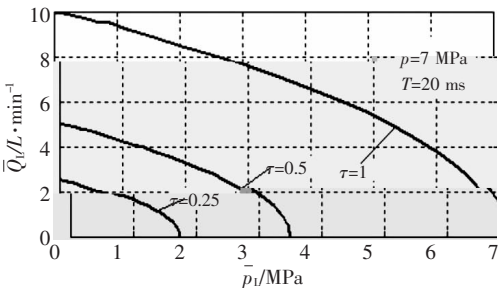
P A

2



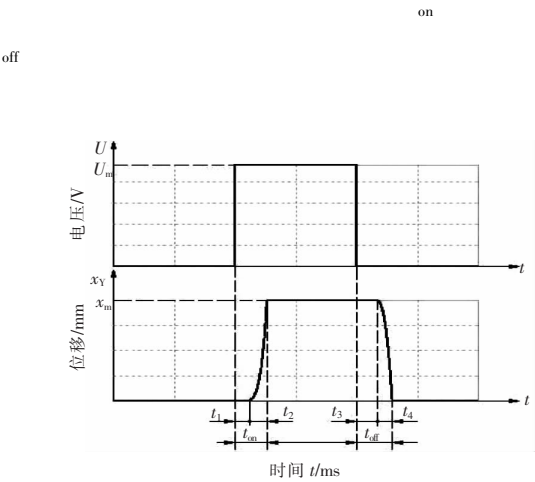
3

4



4

5



5

140 bar

4

5 s

4

0.2 s 139.6 bar 4

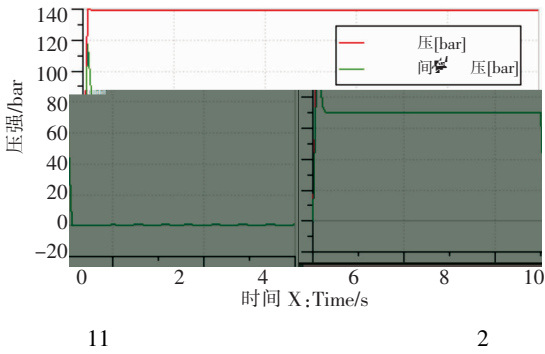
0.2 s 0.1 bar

4

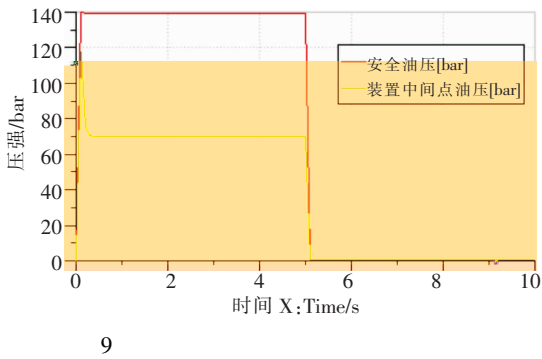
0.3 s 69.8 bar 4

0.2 s

0.5 bar 9



5



1

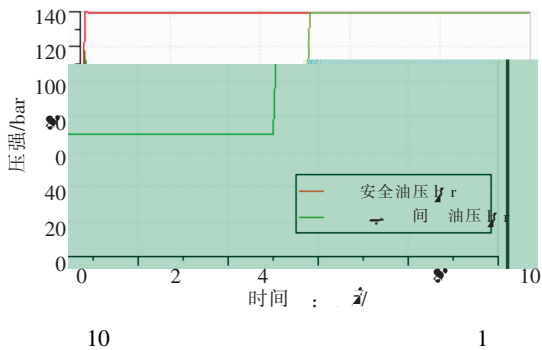
2

SV1 SV2 5

SV1

SV2 0.2s 139.1bar

10



SV3 SV4 5 s

SV1

SV2 0.2 s 0.7 bar

11

1 J . 2000 4 5 - 6

2 Ansoft AMESim J . 2008 9 104 - 105 + 108

3 J . 2004 15 84 - 88

4 M . 2005.6

5 M . 2002

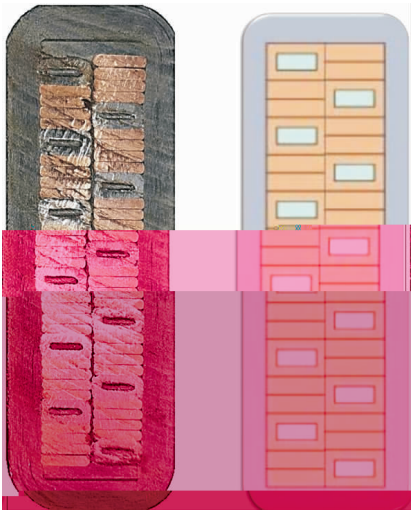
6 M . 2008

7 S . 2006 DL/T996 - 2006

1001-9006 2021 04-0076-05

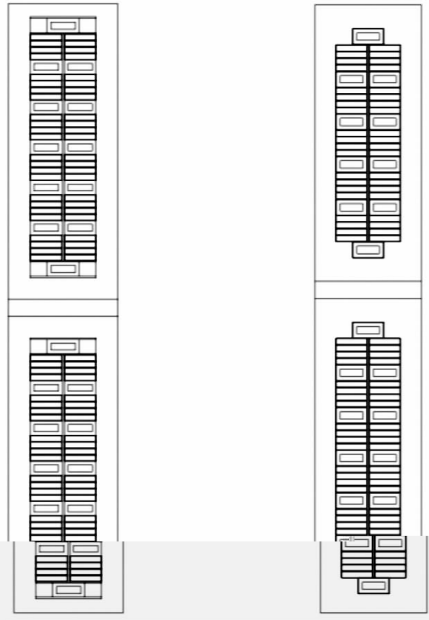
1 2 1 4
2a

2b



1

2



a

b

2

1 4

1

3

3

1

1
/
1
2

r 0

$\dot{A}$

5 AB CD

Dirichlet AE BF

Neumann

540°

In U R

R

a

6

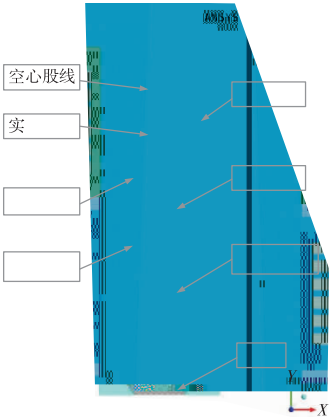


6

2.3

1 2

7



618000

A

PMBOK

PMBOK

F426

A

1001-9006 2021 04-0081-04

Project Management in Foreign Subcontracting Project

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Abstract: This article is based on the excitation system subcontracting project between DFEM and company A, in which, theory and management tools of project management in PMBOK and supply chain management are introduced in the execution of foreign subcontracting project to make sure the scope, schedule, quality of the product and service of the sub-contract project could fully satisfy the need of the main contract project.

Key

2021 - 09 - 24

1986 - 2009

2018

A

A

1

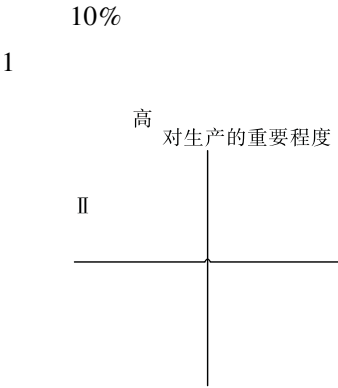
150 MW

AP1000

A

NFF

NFT



3

3.1

40

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A

2

“ ”

“ ”

41

4 CANopen Device Profile and Motion Control. CiA Draft Standard
Proposal402 S . Version 4.02 2002

5 Copley Controls Corp. CANopen Programmer 's Manual S . Version
3 2006

6 . CANopen
J . 2018 32 2 11 – 14

7 . CANopen J .
2020 33 1 72 – 74



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2021 - 09 - 24

1990 - 2012

CAREM	ACP100	2007	2017
		2020	5 22
	2010	2012	RITM-200M
ACP100			Afrikantov OKBM KLT-
2016		40S	
2017	“ ”	“ ” “ ” “ ”	
	2019	6	RITM-200M “ ”
36	2022	2	
CAREM	CNEA	ACPR50S	
	2014	2015	12
FCD	2019	11	ACPR50S
	Techint	“ ”	ACPR50S
		2016	9
2020	4		11
	2022	“	ACPR50S ”
			ACPR50S
1		2019	4
	MW e		3
ACP100	100		24
CAP200	200		15
DHR	400 MWt	2022	
CAREM	30		
RITM-200	50 × 2		
ELENA	68 kW e	2	
KARAT-45/100	45/100		
RUTA-70	70 MWt		
UNITHERM	6. 6		
VK-300	250		
mPower	195 × 2		
NuScale	50 × 12		
SMR-160	160		
W-SMR	225		
DMS	300		
IMR	350		
SMART	100		
UK-SMR	443		
	2	KLT- 40S	
RITM- 200M	ACPR50S	KLT- 40S	
Afrikantov OKBM			

2017	
2020	5 22
RITM-200M	
Afrikantov OKBM	KLT-
40S	
“ ” “ ” “ ”	
6	RITM-200M “ ”
2	
ACPR50S	
2015	12
ACPR50S	
“ ”	ACPR50S
2016	9
	11
“	ACPR50S ”
	ACPR50S
2019	4
	3
	24
2022	
2	
	MW e
ACPR50S	60
ACP100S	100
KLT-40S	70
RITM-200M	50 × 2
ABV-6E	6 ~ 9
SHELF	6. 4
VBER-300	325
	3
HTR-PM	HTR – PM
	2006
2	
2006 – 2020	2012 12
FCD	HTR-PM

3	
MW e	
HTR-PM	210
GTHTR300	300
GT-MHR	285
MHR-T	205.5 × 4
MHR-100	25 ~ 87
A-HTR-100	50
HTMR-100	35
PBMR-400	165
SC-HTGR	272
Xe-100	35
4	
300	BREST-OD-SVBR-100
300	BREST-OD-Rosatom
	2018
	Glavosexpertiza
2027	SVBR-100
AKME	
Rostechnadzor	2015 AKME
SVBR-100	
2022	
4	
MW e	
BREST-OD-300	300
SVBR-100	100
4S	10
LFR-AS-200	200
LFR-TL-X	5 ~ 20
SEALER	3
EM2	265
SUPERSTAR	120
WLFR	450
5	
IMSR	
IMSR	
Terrestrial Energy	
Terrestrial Energy	
2017	
6	CNL
IMSR	11
CNSC	IMSR
2018	12

20	
5	
MW e	
IMSR	190
CMSR	100 ~ 115
CA Waste Burner	20
ThorCon	250
FUJI	200
Stable Salt Reactor	37.5 × 8
LFTR	250
Mk1 PB-FHR	100
MCSFR	50 &
6	
eVinci	
Westinghouse Electric Corporation	
2024	2019
3	1 290
2022	eVinci
6	
MW e	
eVinci	0.2 ~ 15

4

4. 1

ACP100

28