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|  |
| W3000-111-95风力发电机组 |
|  |
| 基础设计载荷 |
|  |
| CA-09A.71.00-A ECN：DFBxxxxxx |
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|  |
|  |
| 2017年8月 |

编制： 齐娟娟 日期： 2017.08.23

校对： 齐娟娟 日期： 2017.08.24

审核： 日期：

标审： 日期：

审定： 日期：

更改页

| ECN | 更改位置 | 更改内容描述 | 签字 | 日期 |
| --- | --- | --- | --- | --- |
|  |  | 初版 | 叶晟 | 2017.08.23 |
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# 1 概述

本文提供了机组基础设计的参考载荷，机组运行特征参数见表1。

1. 机组运行特征参数

|  |  |  |
| --- | --- | --- |
| 参数 | 单位 | 数值 |
| 设计标准 | -- | IEC 61400-1(2014) |
| 设计等级 | -- | II |
| 设计湍流强度 | -- | B |
| 切入风速 | m/s | 3.0 |
| 切出风速 | m/s | 25.0 |
| 设计年平均风速 | m/s | 8.5 |
| 50年一遇最大风速（10min） | m/s | 42.5 |
| 50年一遇极大风速（3s） | m/s | 59.5 |
| 设计空气密度 | kg/m3 | 1.225 |
| 风轮额定转速 | rpm | 11.2 |
| 额定功率 | kW | 3450 |
| 轮毂中心高度 | m | 90 |
| 风轮直径 | m | 146 |

机组的质量特性，见表2与表3。

1. 风轮质量特性

|  |  |  |  |
| --- | --- | --- | --- |
| 风轮质量特性 | | | |
| 质量 / t | 约102.346 | | |
| 转动惯量 / kgm2 | 5.071E+07（绕主轴方向） | | |
| 重心位置 / m | x  到塔架中心线水平距离 | y  侧向距离 | z  到塔顶竖直距离 |
| 4.376 | 0 | 2.171 |

1. 机舱质量特性

|  |  |  |  |
| --- | --- | --- | --- |
| 机舱质量特性 | | | |
| 质量 / t | 约135.00 | | |
| 转动惯量 / kgm2 | Ixx  （相对塔架轴线） | Iyy  （相对重心，机舱侧向） | Izz  （相对重心，机舱轴向） | |
| 1.571E+06 | 1.462E+06 | 3.77768E+05 | | |
| 重心位置 / m | x  塔架中心线后方水平距离 | y  侧向距离 | z  到塔顶竖直距离 | |
| 0.35 | 0.09 | 1.58 | | |

机组允许的频率范围及基础刚度要求，见表4。

1. 频率范围

|  |  |
| --- | --- |
| 名称 | 频率（Hz） |
| 塔架一阶耦合频率 | 0.28775 |
| 1P额定频率（额定转速下） | 0.18653 |
| 最小旋转刚度（绕水平轴） | 8.0E+10 Nm/rad |

塔架重量分布详见塔架主体图DA-09A.09.00-A。

# 2 基础设计载荷

### 2.1 坐标系

本文档给出的载荷均为塔底与基础顶部接口处的载荷。载荷分量按图1所示坐标系给出：



图1 坐标系

### 2.2 极限载荷

基础极限载荷见表5~表7。

1. 所有载荷工况下的极限载荷，有安全系数

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Mx | My | Mxy | Mz | Fx | Fy | Fxy | Fz | Safety factor |
|  |  | Load case | kNm | kNm | kNm | kNm | kN | kN | kN | kN | - |
| Mx | Max | 62\_ab#03 | 95342 | -6420.0 | 95558 | 2916.9 | 82.9 | -1140.3 | 1143.3 | -5685.9 | 1.10 |
| Mx | Min | 62\_aj#05 | -93062 | -10714 | 93677 | -3705.0 | -76.6 | 1194.5 | 1197.0 | -5650.7 | 1.10 |
| My | Max | 42\_ca-16 | 6782.0 | 114745 | 114945 | 759.7 | 1314.4 | -22.9 | 1314.6 | -7140.8 | 1.35 |
| My | Min | 42\_db-08 | 4907.2 | -109363 | 109473 | -4091.7 | -1162.2 | -26.3 | 1162.5 | -7002.5 | 1.35 |
| Mxy | Max | 42\_ca-16 | 6782.0 | 114745 | 114945 | 759.7 | 1314.4 | -22.9 | 1314.6 | -7140.8 | 1.35 |
| Mxy | Min | 42\_db-08 | 2.47 | -8.04 | 8.41 | 162.4 | 93.1 | -1.86 | 93.1 | -6945.9 | 1.35 |
| Mz | Max | 22\_cb+07 | 8804.3 | -8701.9 | 12379 | 13151 | 17.0 | -84.6 | 86.3 | -5819.7 | 1.10 |
| Mz | Min | 13\_ea#06 | -2365.0 | 39391 | 39462 | -13710 | 564.8 | 99.7 | 573.6 | -6938.6 | 1.35 |
| Fx | Max | 42\_ca-16 | 6695.7 | 114710 | 114905 | 716.6 | 1315.0 | -22.2 | 1315.2 | -7140.4 | 1.35 |
| Fx | Min | 42\_db-08 | 5620.7 | -109230 | 109374 | -4484.5 | -1163.1 | -36.4 | 1163.7 | -7007.0 | 1.35 |
| Fy | Max | 62\_aj#05 | -92945 | -10391 | 93524 | -3677.5 | -75.0 | 1199.8 | 1202.2 | -5654.9 | 1.10 |
| Fy | Min | 62\_ad#02 | 90869 | -14852 | 92075 | 2640.5 | -100.5 | -1154.5 | 1158.9 | -5702.8 | 1.10 |
| Fxy | Max | 42\_ca-16 | 6695.7 | 114710 | 114905 | 716.6 | 1315.0 | -22.2 | 1315.2 | -7140.4 | 1.35 |
| Fxy | Min | 42\_ab-03 | -149.5 | -7170.9 | 7172.5 | -9.67 | -0.028 | -0.023 | 0.036 | -7023.6 | 1.35 |
| Fz | Max | 62\_aa#02 | -13520 | 22573 | 26312 | 1737.7 | 407.8 | 183.6 | 447.2 | -5192.6 | 1.10 |
| Fz | Min | 81c\_de#06 | 3247.8 | -3098.6 | 4488.8 | 641.2 | 83.4 | -1.90 | 83.5 | -7900.1 | 1.50 |

表6 所有载荷工况下的极限载荷，无安全系数

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Mx | My | Mxy | Mz | Fx | Fy | Fxy | Fz | Safety factor |
|  |  | Load case | kNm | kNm | kNm | kNm | kN | kN | kN | kN | - |
| Mx | Max | 62\_ab#03 | 86675 | -5836.4 | 86871 | 2651.8 | 75.4 | -1036.7 | 1039.4 | -5169.0 | 1.00 |
| Mx | Min | 62\_aj#05 | -84602 | -9739.7 | 85161 | -3368.2 | -69.6 | 1085.9 | 1088.2 | -5137.0 | 1.00 |
| My | Max | 23\_ca-16 | 1110.7 | 85240 | 85247 | 826.9 | 977.3 | 104.5 | 982.9 | -5294.2 | 1.00 |
| My | Min | 23\_da-16 | -2100.2 | -83661 | 83688 | -3042.6 | -840.8 | 61.0 | 843.0 | -5211.1 | 1.00 |
| Mxy | Max | 62\_ab#03 | 86675 | -5836.4 | 86871 | 2651.8 | 75.4 | -1036.7 | 1039.4 | -5169.0 | 1.00 |
| Mxy | Min | 42\_db-08 | 1.83 | -5.95 | 6.23 | 120.3 | 69.0 | -1.38 | 69.0 | -5145.1 | 1.00 |
| Mz | Max | 22\_cb+07 | 8003.9 | -7910.9 | 11254 | 11955 | 15.4 | -76.9 | 78.4 | -5290.7 | 1.00 |
| Mz | Min | 22\_ec2+02 | -1003.8 | 22017 | 22040 | -11541 | 285.6 | 33.9 | 287.7 | -5116.7 | 1.00 |
| Fx | Max | 23\_ca-16 | 4975.8 | 85236 | 85381 | 888.4 | 977.6 | -33.2 | 978.2 | -5291.0 | 1.00 |
| Fx | Min | 23\_da-12 | 1342.3 | -80533 | 80545 | -3671.7 | -891.8 | -62.3 | 894.0 | -5160.5 | 1.00 |
| Fy | Max | 62\_aj#05 | -84496 | -9446.2 | 85022 | -3343.2 | -68.2 | 1090.8 | 1092.9 | -5140.8 | 1.00 |
| Fy | Min | 62\_ad#02 | 82608 | -13501 | 83704 | 2400.5 | -91.3 | -1049.6 | 1053.6 | -5184.3 | 1.00 |
| Fxy | Max | 62\_aj#05 | -82866 | -18775 | 84966 | -1946.2 | -173.2 | 1083.4 | 1097.1 | -5145.8 | 1.00 |
| Fxy | Min | 42\_ab-03 | -110.7 | -5311.8 | 5313.0 | -7.16 | -0.021 | -0.017 | 0.027 | -5202.6 | 1.00 |
| Fz | Max | 61\_ab#02 | -12291 | 20521 | 23920 | 1579.7 | 370.7 | 166.9 | 406.5 | -4720.5 | 1.00 |
| Fz | Min | 71\_bd#06 | -705.4 | 11205 | 11227 | 6025.5 | 281.9 | 24.6 | 283.0 | -5607.6 | 1.00 |

表7 需要考虑与地震载荷叠加的载荷，无安全系数（正常运行工况）

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Mx | My | Mxy | Mz | Fx | Fy | Fxy | Fz | Safety factor |
|  |  | Load case | kNm | kNm | kNm | kNm | kN | kN | kN | kN | - |
| Mx | Max | 12\_kc-02 | 24525 | 32205 | 40480 | 5760.3 | 431.5 | -250.7 | 499.0 | -5249.8 | 1.00 |
| Mx | Min | 12\_ja-02 | -10243 | 15826 | 18852 | -4056.9 | 256.6 | 162.6 | 303.8 | -5183.1 | 1.00 |
| My | Max | 12\_ea-02 | 2812.1 | 61934 | 61998 | 746.4 | 724.0 | 8.21 | 724.1 | -5299.8 | 1.00 |
| My | Min | 12\_ka-02 | -8224.4 | -4119.8 | 9198.6 | -4934.0 | -81.9 | 140.7 | 162.8 | -5141.2 | 1.00 |
| Mxy | Max | 12\_ea-02 | 2812.1 | 61934 | 61998 | 746.4 | 724.0 | 8.21 | 724.1 | -5299.8 | 1.00 |
| Mxy | Min | 12\_ab-02 | 13.0 | -20.6 | 24.4 | -176.4 | 35.2 | -2.16 | 35.2 | -5215.3 | 1.00 |
| Mz | Max | 12\_jc-01 | 7505.0 | 27471 | 28477 | 8033.6 | 316.2 | -39.3 | 318.7 | -5242.7 | 1.00 |
| Mz | Min | 12\_ka-02 | 880.3 | 18348 | 18369 | -9472.6 | 220.8 | 34.9 | 223.5 | -5125.4 | 1.00 |
| Fx | Max | 12\_ec-02 | 5473.8 | 60673 | 60919 | 2337.3 | 772.9 | -16.2 | 773.1 | -5292.7 | 1.00 |
| Fx | Min | 12\_ka-02 | -8224.4 | -4119.8 | 9198.6 | -4934.0 | -81.9 | 140.7 | 162.8 | -5141.2 | 1.00 |
| Fy | Max | 12\_ja-01 | -10020 | 20591 | 22899 | 3679.6 | 298.3 | 216.7 | 368.7 | -5299.5 | 1.00 |
| Fy | Min | 12\_kc-01 | 24316 | 26770 | 36164 | 234.3 | 273.4 | -265.7 | 381.2 | -5183.7 | 1.00 |
| Fxy | Max | 12\_ec-02 | 5473.8 | 60673 | 60919 | 2337.3 | 772.9 | -16.2 | 773.1 | -5292.7 | 1.00 |
| Fxy | Min | 12\_ab-01 | 138.7 | -2238.9 | 2243.2 | 85.1 | 2.05 | 1.01 | 2.28 | -5226.2 | 1.00 |
| Fz | Max | 12\_ka-02 | 5848.8 | 29052 | 29635 | -2242.9 | 262.9 | 5.34 | 263.0 | -5049.4 | 1.00 |
| Fz | Min | 12\_kc-01 | 9563.9 | 15542 | 18249 | 3012.8 | 232.1 | -52.7 | 238.0 | -5365.8 | 1.00 |

### 2.3 疲劳载荷

由机组正常发电引起的疲劳载荷在表8中给出，安全系数γF=1.0。载荷作用在塔底与基础顶部接口处。每个载荷分量循环次数在表9中给出。

### 基础法兰处等效疲劳载荷

表8 等效疲劳载荷，无安全系数，等效循环次数1E+8

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Slope | Mx(kNm) | My(kNm) | Mz(kNm) | Fx(kN) | Fy(kN) | Fz(kN) |
| 3 | 6651.7 | 13765.35 | 3699.78 | 252.56 | 112.55 | 84.59 |
| 4 | 7591.37 | 15684.45 | 3935.86 | 252.68 | 116.67 | 82.04 |
| 5 | 8628.71 | 17821.24 | 4309.83 | 266.6 | 126.63 | 84.63 |
| 6 | 9672.76 | 19992.93 | 4736.03 | 285.03 | 138.3 | 89.3 |
| 7 | 10690.97 | 22269.08 | 5171.65 | 304.95 | 150.38 | 94.97 |
| 8 | 11670.12 | 24815.28 | 5596.24 | 325.95 | 162.46 | 101.13 |
| 9 | 12605.23 | 27734.52 | 6001.77 | 349.01 | 174.46 | 107.49 |
| 10 | 13495.36 | 30947.21 | 6386.13 | 375.47 | 186.47 | 113.86 |
| 11 | 14341.73 | 34267.13 | 6749.59 | 405.73 | 198.63 | 120.11 |
| 12 | 15146.7 | 37538.98 | 7093.2 | 438.63 | 211.04 | 126.18 |

### 载荷分量循环次数

表9 基础塔架结合面载荷分量循环次数

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mx | | My | | Mz | | Fx | | Fy | | Fz | |
| Range | Cycles | Range | Cycles | Range | Cycles | Range | Cycles | Range | Cycles | Range | Cycles |
| 000 | 1.04E+09 | 1000 | 1.00E+09 | 175 | 7.29E+08 | 12.5 | 9.59E+08 | 5.5 | 7.58E+08 | 3 | 1.40E+09 |
| 0000 | 1.17E+08 | 3000 | 1.61E+08 | 525 | 1.13E+08 | 37.5 | 3.12E+08 | 16.5 | 3.90E+08 | 9 | 4.70E+08 |
| 0000 | 4.40E+07 | 5000 | 6.99E+07 | 875 | 6.38E+07 | 62.5 | 2.05E+08 | 27.5 | 2.44E+08 | 15 | 2.77E+08 |
| 0000 | 3.50E+07 | 7000 | 3.34E+07 | 1225 | 5.46E+07 | 87.5 | 1.42E+08 | 38.5 | 1.44E+08 | 21 | 1.87E+08 |
| 3000 | 2.34E+07 | 9000 | 1.72E+07 | 1575 | 4.51E+07 | 112.5 | 9.79E+07 | 49.5 | 8.06E+07 | 27 | 1.32E+08 |
| 4400 | 1.53E+07 | 11000 | 1.04E+07 | 1925 | 3.74E+07 | 137.5 | 5.75E+07 | 60.5 | 4.34E+07 | 33 | 8.97E+07 |
| 5200 | 1.01E+07 | 13000 | 7.43E+06 | 2275 | 2.86E+07 | 162.5 | 3.35E+07 | 71.5 | 2.48E+07 | 39 | 6.40E+07 |
| 6000 | 7.18E+06 | 15000 | 4.78E+06 | 2625 | 1.93E+07 | 187.5 | 1.78E+07 | 82.5 | 1.48E+07 | 45 | 4.41E+07 |
| 6800 | 4.90E+06 | 17000 | 3.28E+06 | 2975 | 1111 | 112.5 | 1.16E+07 | 93.5 | 8.92E+06 | 51 | 3.08E+07 |
| 7600 | 3.13E+06 | 19000 | 2.29E+06 | 3325 | 9.88E+06 | 237.5 | 7.11E+06 | 104.5 | 6.52E+06 | 57 | 2.20E+07 |
| 8400 | 2.52E+06 | 21000 | 1.69E+06 | 3675 | 7.14E+06 | 262.5 | 4.63E+06 | 115.5 | 4.76E+06 | 63 | 1.62E+07 |
| 9200 | 2.12E+06 | 23000 | 1.17E+06 | 4025 | 4.27E+06 | 287.5 | 3.41E+06 | 126.5 | 3.32E+06 | 69 | 1.24E+07 |
| 10000 | 1.73E+06 | 25000 | 878974 | 4375 | 2.98E+06 | 312.5 | 2.02E+06 | 137.5 | 2.84E+06 | 75 | 8.50E+06 |
| 10800 | 1.40E+06 | 27000 | 635980 | 4725 | 2.19E+06 | 337.5 | 2.04E+06 | 148.5 | 2.08E+06 | 81 | 5.87E+06 |
| 11600 | 1.07E+06 | 29000 | 429909 | 5075 | 1.54E+06 | 362.5 | 1.22E+06 | 159.5 | 1.46E+06 | 87 | 4.80E+06 |
| 12400 | 665988 | 31000 | 392531 | 5425 | 1.14E+06 | 387.5 | 874650 | 170.5 | 1.19E+06 | 93 | 3.00E+06 |

表9 （续）

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mx | | My | | Mz | | Fx | | Fy | | Fz | |
| Range | Cycles | Range | Cycles | Range | Cycles | Range | Cycles | Range | Cycles | Range | Cycles |
| 13200 | 513322 | 33000 | 293342 | 5775 | 922457 | 412.5 | 815021 | 181.5 | 860102 | 99 | 2.40E+06 |
| 14000 | 387672 | 35000 | 282205 | 6125 | 593369 | 437.5 | 461142 | 192.5 | 613939 | 105 | 1.73E+06 |
| 14800 | 296933 | 37000 | 192299 | 6475 | 514908 | 462.5 | 397230 | 203.5 | 449263 | 111 | 1.34E+06 |
| 15600 | 264728 | 39000 | 108339 | 6825 | 390479 | 487.5 | 277083 | 214.5 | 398303 | 117 | 903004 |
| 16400 | 166475 | 41000 | 156417 | 7175 | 334978 | 512.5 | 195485 | 225.5 | 212619 | 123 | 607521 |
| 17200 | 155874 | 43000 | 84872.2 | 7525 | 167675 | 537.5 | 210850 | 236.5 | 172026 | 129 | 548016 |
| 18000 | 91142 | 45000 | 73817.9 | 7875 | 175846 | 562.5 | 125738 | 247.5 | 200303 | 135 | 373296 |
| 18800 | 89792 | 47000 | 14069.1 | 8225 | 146715 | 587.5 | 78542.2 | 258.5 | 111307 | 141 | 277272 |
| 19600 | 67401.9 | 49000 | 891.483 | 8575 | 141931 | 612.5 | 33772.6 | 269.5 | 72893.1 | 147 | 202344 |
| 20400 | 73214.2 | 51000 | 0 | 8925 | 98472.5 | 637.5 | 5881.57 | 280.5 | 82962.5 | 153 | 162174 |
| 21200 | 46015.7 | 53000 | 360.299 | 9275 | 174768 | 662.5 | 2262.93 | 291.5 | 48422.4 | 159 | 79846.3 |
| 22000 | 42777.7 | 55000 | 0 | 9625 | 70789.9 | 687.5 | 1902.63 | 302.5 | 41549.8 | 165 | 95022.7 |
| 22800 | 23369.5 | 57000 | 28.0874 | 9975 | 23578.5 | 712.5 | 28.0874 | 313.5 | 18540.7 | 171 | 68462.7 |
| 23600 | 13661.8 | 59000 | 1028.09 | 10325 | 46539.7 | 737.5 | 1000 | 324.5 | 21956.3 | 177 | 47449.5 |
| 24400 | 6785.69 | 61000 | 0 | 10675 | 20944.3 | 762.5 | 28.0874 | 335.5 | 5717.14 | 183 | 33900.5 |
| 25200 | 4984.76 | 63000 | 0 | 11025 | 10493.9 | 787.5 | 374.343 | 346.5 | 11281.5 | 189 | 25491.8 |
| 26000 | 4556.02 | 65000 | 56.1748 | 11375 | 13990.1 | 812.5 | 0 | 357.5 | 6702.09 | 195 | 7591.49 |
| 26800 | 3784.08 | 67000 | 0 | 11725 | 19501.1 | 837.5 | 1402.9 | 368.5 | 4184.27 | 201 | 14410.3 |
| 27600 | 6459.96 | 69000 | 694.754 | 12075 | 10377.3 | 862.5 | 0 | 379.5 | 4867.97 | 207 | 11973.1 |
| 28400 | 3736.72 | 71000 | 347.377 | 12425 | 13307.8 | 887.5 | 28.0874 | 390.5 | 2655.26 | 213 | 7641.4 |
| 29200 | 7281.83 | 73000 | 56.1748 | 12775 | 1441.2 | 912.5 | 42.1311 | 401.5 | 3581.38 | 219 | 7897.77 |
| 30000 | 808.243 | 75000 | 1416.94 | 13125 | 3618.64 | 937.5 | 14.0437 | 412.5 | 787.265 | 225 | 4990.09 |
| 30800 | 1276.78 | 77000 | 0 | 13475 | 0 | 962.5 | 28.0874 | 423.5 | 444.562 | 231 | 5175.02 |
| 31600 | 56.1748 | 79000 | 0 | 13825 | 1011.15 | 987.5 | 42.1311 | 434.5 | 664.982 | 237 | 2332.68 |
| 32400 | 0 | 81000 | 14.0437 | 14175 | 1385.49 | 1012.5 | 14.0437 | 445.5 | 0 | 243 | 2366.86 |
| 33200 | 584.271 | 83000.01 | 0 | 14525 | 1782.97 | 1037.5 | 0 | 456.5 | 119.29 | 249 | 762.73 |
| 34000 | 0 | 85000.01 | 0 | 14875 | 360.299 | 1062.5 | 77.1585 | 467.5 | 28.0874 | 255 | 919.571 |
| 34800 | 28.0874 | 87000.01 | 0 | 15225 | 0 | 1087.5 | 0 | 478.5 | 66.6667 | 261 | 1053.28 |
| 35600 | 195.885 | 89000.01 | 38.5793 | 15575 | 1011.15 | 1112.5 | 38.5793 | 489.5 | 38.5793 | 267 | 734.642 |
| 36400 | 28.0874 | 91000.01 | 0 | 15925 | 360.299 | 1137.5 | 77.1585 | 500.5 | 0 | 273 | 360.299 |
| 37200 | 28.0874 | 93000.01 | 77.1585 | 16275 | 0 | 1162.5 | 38.5793 | 511.5 | 0 | 279 | 28.0874 |
| 38000 | 0 | 95000.01 | 0 | 16625 | 0 | 1187.5 | 0 | 522.5 | 28.0874 | 285 | 0 |
| 38800 | 14.0437 | 97000.01 | 38.5793 | 16975 | 0 | 1212.5 | 38.5793 | 533.5 | 0 | 291 | 14.0437 |
| 39600 | 70.2185 | 99000.01 | 77.1585 | 17325 | 0 | 1237.5 | 0 | 544.5 | 0 | 297 | 360.299 |
| 40400 | 0 | 101000 | 0 | 17675 | 0 | 1262.5 | 0 | 555.5 | 28.0874 | 303 | 14.0437 |
| 41200 | 0 | 103000 | 0 | 18025 | 0 | 1287.5 | 0 | 566.5 | 0 | 309 | 0 |
| 42000 | 0 | 105000 | 0 | 18375 | 0 | 1312.5 | 19.2896 | 577.5 | 0 | 315 | 0 |
| 42800 | 0 | 107000 | 19.2896 | 18725 | 0 | 1337.5 | 19.2896 | 588.5 | 0 | 321 | 0 |

表9 （续）

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mx | | My | | Mz | | Fx | | Fy | | Fz | |
| Range | Cycles | Range | Cycles | Range | Cycles | Range | Cycles | Range | Cycles | Range | Cycles |
| 43600 | 0 | 109000 | 0 | 19075 | 0 | 1387.5 | 0 | 610.5 | 28.0874 | 333 | 0 |
| 44400 | 0 | 111000 | 38.5793 | 19425 | 0 | 1412.5 | 0 | 621.5 | 0 | 339 | 0 |
| 45200 | 0 | 113000 | 0 | 19775 | 0 | 1437.5 | 0 | 632.5 | 28.0874 | 345 | 0 |
| 46000 | 0 | 115000 | 19.2896 | 20125 | 0 | 1462.5 | 0 | 643.5 | 0 | 351 | 0 |
| 46800 | 0 | 117000 | 19.2896 | 20475 | 0 | 1487.5 | 0 | 654.5 | 0 | 357 | 0 |
| 47600 | 0 | 119000 | 19.2896 | 20825 | 0 | 1512.5 | 0 | 665.5 | 0 | 363 | 0 |
| 48400 | 0 | 121000 | 0 | 21175 | 0 | 1537.5 | 0 | 676.5 | 0 | 369 | 0 |
| 49200 | 0 | 123000 | 0 | 21525 | 0 | 1562.5 | 0 | 687.5 | 0 | 375 | 0 |
| 50000 | 0 | 125000 | 0 | 21875 | 0 | 1587.5 | 0 | 698.5 | 0 | 381 | 0 |
| 50800 | 0 | 127000 | 0 | 22225 | 0 | 1387.5 | 0 | 610.5 | 28.0874 | 333 | 999 |

# 3 小结

详细的基础设计应该基于载荷时间序列，基础设计方在详细设计时需向上海电气索要载荷时间序列。上海电气并非基础设计方，因此不对如何应用本文中的载荷及载荷时间序列承担责任。