# Recent HRD Topics in the Nuclear Field of China and Support on the Development of Nuclear Training Technology

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## 1.Nuclear power industry localization promotes the human resources development in China

Nuclear power industry localization promotes the human resources development in the nuclear power field in China. China is a developing country with high increasing rate of power consuming. Up to 2003, there are 8 units of nuclear power stations under operation with total generation capacity of 6300 MW in the mainland of China. 3 units are under construction with total generation capacity of 2600MW. 3 projects are under evaluation. Nuclear power is becoming more and more important in China's power energy resources because of cleanliness, safety and high efficiency properties.

Self-development is one of the principles of Chinese government in order to develop the nation's own nuclear power industry. In the meantime, developing nuclear industry can also promote mechanical, electronic, instrumentation industry modernization and buildup the national high technology capacity.

Following the principle of 'Depend on ourselves, cooperate with overseas counterparts, import advanced technology and promote the localization of manufacturing industry. China will gradually achieve the localization of nuclear power station design, manufacture and construction. The phase 2 of Qinshan nuclear power plant is the example of localization. The first 600MW unit construction period was 70.5 months with 47 days ahead of the schedule. The construction cost is 1330 dollars per kW, which is 670 dollars lower compare with that of the import unit. On the other hand, the most valuable payback from localization is that the nuclear technology expert team has build up and remained stable and intact. Human resources development in nuclear power field is very important for developing nuclear power industry system. It creates an economic and effective path for our localization.

Self-design, self-construction, manufacturing localization of the main equipment and operation on self-reliance are four key localization issues in China. The purpose is not only construct a nuclear power station, but also through these process to cultivate our own design expertise, manufacturing expertise, construction expertise, management expertise, operation expertise and maintenance expertise.

## 2.Support on the development of nuclear power training technology

Training curriculums, training materials and training experience sharing are three important mutual support on the development of training technology and needs for human resources development in nuclear field.

In China most of the nuclear power training curriculums and training materials are developed and setup in the training centers, which locate in each nuclear power plant. They are organized by the plants and managed by their staffs.

Up till now, there are 5 training centers in nuclear power industry in mainland China. 2 in Guangdong Dayabay nuclear power plant, 2 in Zhejiang Qinshan nuclear power plant and 1 in Jiangsu Tianwan nuclear power plant. Their main target is to train the construction team and operation team to buildup the competency and technical service on nuclear power station construction, operation, maintenance and technical support area.

The Dayabay nuclear power operation training center is one of the large-scale nuclear training institute with all the necessary training equipment and has developed a lot of curriculums. It has 9000 $m^2$ training building, 2 full scope simulators, more than 70 managers and teachers. All these facilities serve for staffs who work in the plant and also provide mutual support to other power plants staffs training in China. Nowadays, the training center is searching for the mutual support from WANO, IAEA and other countries such as USA, France, South Africa and Korea, etc. They also look forward to getting the support from FNCA concerning teachers' training, training material introduction and experience feedback from different training centers of FNCA.

## 3.Summary of Survey of the training data on Human Resources Development

The appendix hereafter is the survey of nuclear training courses in China Dayabay nuclear power plants. They are classified in three aspects: Control room simulator training curriculums, authorization to work in nuclear field training curriculums and working skill in nuclear field training curriculums. 88258 trainees participated these courses before 2002. During 2002, 13542 trainees participated 565 times in some of these courses. All these courses are taken from the experience accumulated of nuclear power technology, which contribute to develop our human recourse. This set of training courses matches the general requirement of nuclear power plant staff's skill and competency. They also add value to the human resources development in the nuclear power industry.

## Survey of Nuclear Training Courses in China

| Field | Code | Course | Duration | Trainee before FY2002 | Time in FY2002 | Trainee in FY2002 |
|---|---|---|---|---|---|---|
| Simulator | 500 | Simulator pre-training | 10D | 179 | 3 | 12 |
| Simulator | 501 | UNIT normal operation | 10D | 267 | 3 | 12 |
| Simulator | 502 | UNIT failure operation | 10D | 245 | 3 | 12 |
| Simulator | 503 | UNIT accident operation | 10D | 238 | 4 | 16 |
| Simulator | 504 | Unit electric power failure disposal | 10D | 180 | 4 | 19 |
| Simulator | 505 | General condition simulator retraining | 5D | 827 | 26 | 144 |
| Simulator | 506 | Simulator actual circumstance training I (complex condition) | 5D | 436 | 25 | 140 |
| Simulator | 507 | Simulator actual circumstance training II (complex condition+SPI/SPU/U) | 5D | 320 | | |
| Simulator | 508 | Simulator retraining before get license | 5D | 179 | 5 | 20 |
| Simulator | 509 | Intensive M4 training | 5D | 254 | 12 | 64 |
| Simulator | 510 | Simulator “actual combat-on site”training | 5D | 82 | | |
| Simulator | 511 | Manager simulator training | 3D | 5 | | |
| Simulator | 512 | Engineer simulator training | 5D | 56 | 4 | 25 |
| Simulator | 513 | Coordinator training unit | 10D | 83 | 8 | 30 |
| Simulator | 520 | Accidental rule | 5D | 101 | 2 | 15 |
| Simulator | 521 | Operation and safety | 5D | 24 | | |
| Simulator | 354 | Basic principle simulator training | 5D | 5 | | |
| Authorization | 301A | Re-training to managers | 1D | 64 | 2 | 16 |
| Authorization | 304 | Industrial safety | 2D | 2598 | 7 | 136 |
| Authorization | 305 | Radioprotection training | 3D | 3538 | 8 | 199 |
| Authorization | 352 | Nuclear safety culture | 1D | 822 | 4 | 91 |
| Authorization | 362 | Work process | 2D | 1668 | 8 | 170 |
| Authorization | 364 | Quality control and assurement | 2D | 1992 | 5 | 112 |
| Authorization | 365 | Plant safeguard | 0.5D | 561 | 1 | 20 |
| Authorization | 366 | Nuclear safety rule and accident response | 2D | 2446 | 7 | 147 |
| Authorization | 383 | Nuclear fuel loading and unloading basis | 3D | 66 | 1 | 4 |
| Authorization | 384 | Refuel technique and | 5D | 61 | | |
| Authorization | 600 | First aid | 2-3D | 2073 | 5 | 137 |
| Authorization | 601 | Fire fighting (level 1) | 1-3D | 3058 | 6 | 132 |
| Authorization | 610 | RP retraining | 0.5D | 6819 | 38 | 952 |
| Authorization | 611 | QA/QC retraining | 0.5D | 6105 | 17 | 473 |
| Authorization | 612 | QA/QC retraining | 1D | 5987 | 36 | 1004 |
| Authorization | 613 | QA/QC retraining | 1D | 4763 | 31 | 747 |
| Authorization | 614 | Emergency plan retraining | 0.5D | 7152 | 16 | 392 |
| Authorization | 615 | First aid retraining | 1D | 2803 | 21 | 741 |
| Authorization | 616 | Project principal and QC inspector training | 1D | 1206 | 3 | 288 |
| Authorization | 618 | Nuclear culture retraining | 0.5D | 2749 | | |
| Authorization | 619 | Environment protection retraining | 0.5D | 3464 | 58 | 2066 |
| Authorization | 620 | Work process retraining | 1D | 1047 | | |

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|---|---|---|---|---|---|---|
| Authorization | 861 | Company ISO-14000 system environment protection training | 0.5D | 1973 | 3 | 67 |
| Authorization | 862 | NPP basic authorization training | 5D | 1305 | 8 | 186 |
| Authorization | 871 | 18-month refuel project authorization training | 1D | 1342 | 1 | 64 |
| Authorization | 872 | 18-month refuel project authorization training | 1D | 1391 | 30 | 1319 |
| Skill | 301 | General employee training | 4D | 107 | | |
| Skill | 302 | Introduction of Guangdong Nuclear Power Plant | 2D | 612 | | |
| Skill | 860 | General quality and safety training | 3D | 417 | 2 | 73 |
| Skill | 2000A | Lubricate training | 2D | 103 | | |
| Skill | 307 | PWR basic knowledge to executives | 5D | 259 | 3 | 32 |
| Skill | 308 | Acceptance test and material management | 4D | 4 | | |
| Skill | 312 | Safeguard & monitoring system | 15D | 3 | | |
| Skill | 314 | Safeguard & monitoring system | 10D | 35 | | |
| Skill | 320 | Daya bay nuclear plant system and operation | 30D | 992 | 3 | 59 |
| Skill | 321 | Pressurized | 10D | 573 | 3 | 56 |
| Skill | 322 | Basic operation | 15D | 199 | | |
| Skill | 323 | Welding technique | 10D | 6 | | |
| Skill | 324 | Applied mental | 7D | 113 | | |
| Skill | 325 | Freeze water system maintenance | 5D | 26 | | |
| Skill | 326 | Freeze water system maintenance | 5D | 93 | | |
| Skill | 328 | Acentric pump maintenance | 4D | 42 | | |
| Skill | 330 | Start up | 3D | 357 | | |
| Skill | 332 | Digital control and micro processor system | 3D | 16 | | |
| Skill | 333 | Industry electronics | 5D | 80 | | |
| Skill | 334 | Control and protection system | 15D | 10 | | |
| Skill | 335 | Applied physics | 4D | 19 | | |
| Skill | 338 | Second loop control system | 10D | 10 | | |
| Skill | 339 | Vibration analysis | 10D | 70 | | |
| Skill | 346 | Vibration analysis | 10D | 12 | | |
| Skill | 348 | Reactor protection | 10D | 7 | | |
| Skill | 349 | Safety during plant outage | 3D | 990 | 2 | 57 |
| Skill | 350 | Operation safety | 10D | 6 | | |
| Skill | 351 | Operation nuclear safety | 2.5D | 213 | | |
| Skill | 353 | Senior operation | 25D | 596 | 2 | 64 |
| Skill | 357 | Significant event report | 2D | 33 | | |
| Skill | 358 | Maintenance quality and safety | 2D | 88 | | |
| Skill | 367 | Danger detection and defend | 5D | 30 | | |
| Skill | 369 | Inter-action between NPP and grid | 10D | 12 | | |
| Skill | 371 | Inter-action between power supply system and grid | 3D | 19 | | |

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| Field | Code | Course | Duration | Trainee before FY2002 | Time in FY2002 | Trainee in FY2002 |
|---|---|---|---|---|---|---|
| Skill | 372 | Radiation defend under abnormal circumstance | 5D | 14 | | |
| Skill | 381 | Basic welding | 10D | 37 | | |
| Skill | 382 | False work/lifting/heavy material moving | 5D | 15 | | |
| Skill | 385 | Effective discharge management | 3D | 53 | | |
| Skill | 386 | Radiation waste system | 5D | 14 | | |
| Skill | 387 | Waste management basis | 5D | 37 | | |
| Skill | 388 | Practical decontamination technique | 5D | 26 | | |
| Skill | 389 | Material and storage training | 2D | 28 | | |
| Skill | 390 | Spare parts management | 1D | 109 | | |
| Skill | 391 | Purchase and supply management | 2D | 370 | 3 | 48 |
| Skill | 392 | Document management basic training | 2D | 450 | 2 | 33 |
| Skill | 393 | Plant safeguard system training | 3D | 7 | | |
| Skill | 394 | Pressure vessel maintenance | 3D | 14 | | |
| Skill | 396 | Spent fuel disposal | 3D | 22 | | |
| Skill | 397 | Plumbum shield technique | 2D | 10 | | |
| Skill | 398 | Ion exchange basic theory | 3D | 13 | | |
| Skill | 399 | Auto control theory | 4D | 20 | | |
| Skill | 401 | SBC software and hardware working principle and application | 7D | 22 | | |
| Skill | 402 | Principle of earth lightning proof system and anti-jamming system | 5D | 18 | | |
| Skill | 403 | Presentation of GOR FSAR and nuclear safety assessment | 4D | 57 | 1 | 22 |
| Skill | 404 | Quality management and cost control | 4D | 31 | | |
| Skill | 405 | Merlin gerin miniature plastic circuit breaker | 5D | 7 | | |
| Skill | 408 | Programmed control system design configuration | 5D | 8 | | |
| Skill | 409 | Computer control | 5D | 19 | | |
| Skill | 410 | Pneumatic valve control loop design | 5D | 19 | | |
| Skill | 411 | Traveling crane work principle and maintenance | 5D | 12 | | |
| Skill | 412 | Electronic product, board design and manufacture course | 5D | 15 | | |
| Skill | 413 | Sealing technique ----sealing glue | 4D | 26 | | |
| Skill | 414 | Electrical, electronic component inspection manner training | 5D | 15 | | |
| Skill | 415 | High voltage motor failure inspection and maintenance | 5D | 33 | 1 | 14 |
| Skill | 416 | Reactor material | 5D | 17 | 1 | 10 |
| Skill | 417 | Advanced machining technique series training (new technology) | 5D | 23 | | |
| Skill | 419 | Micro reprography | 2D | 21 | | |
| Skill | 420 | Basic electric equipment | 10D | 129 | | |

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| Field | Code | Course | Duration | Trainee before FY2002 | Time in FY2002 | Trainee in FY2002 |
|---|---|---|---|---|---|---|
| Skill | 422 | Electric safety system | 5D | 99 | | |
| Skill | 423 | Power electronic system | 10D | 21 | | |
| Skill | 424 | Programmed controller | 5D | 11 | | |
| Skill | 426 | Converter | 5D | 17 | | |
| Skill | 428 | KIT and periphery system | 25D | 7 | | |
| Skill | 429 | Plant in and out monitor system | 20D | 3 | | |
| Skill | 431 | Testing technique | 1D | 16 | | |
| Skill | 437 | Senior chemistry analysis | 20D | 12 | | |
| Skill | 438 | Reactor chemistry | 10D | 422 | | |
| Skill | 439 | Radioactivity measurement | 15D | 29 | | |
| Skill | 441 | Engineer chemistry | 10D | 4 | | |
| Skill | 443 | Metal antisepsis | 15D | 8 | | |
| Skill | 445 | Turbine | 10D | 10 | | |
| Skill | 447 | Locksmith basic training | 15D | 11 | | |
| Skill | 448 | Beilei electronic adjuster | 10D | 47 | | |
| Skill | 449 | Instrument control loop startup basic skill training | 5D | 4 | | |
| Skill | 499 | DayaBay NPP technique adaptability course | 4D | 47 | | |
| Skill | 617A | Event analysis | 1D | 20 | | |
| Skill | 712 | Human mistake identification and decrease technique | 2D | 1606 | 52 | 1540 |
| Skill | 713 | Organization and procedure root cause analysis technique | 2D | 18 | | |
| Skill | 714 | Event root cause analysis | 1D | 806 | 2 | 65 |
| Skill | 750 | Piping workers training | 15D | 7 | | |
| Skill | 751 | Mechanical workers training | 15D | 169 | | |
| Skill | 761 | Handling knowledge for work supervisor | 1D | 56 | | |
| Skill | 762 | Regulations about chemical hazard products | 1D | 81 | | |
| Skill | 800 | Simulation data indication instrument | 5D | 6 | | |
| Skill | 801 | TR01630 failure wave recorder | 10D | 5 | | |
| Skill | 802 | KBS system thermocouple code end compensation | 10D | 6 | | |
| Skill | 803 | TSX-47 programmed logical controller and TSXT407 programmed terminal | 10D | 5 | | |
| Skill | 805 | CDE-1000 programme terminal | 10D | 6 | | |
| Skill | 806 | GEM- 80 programmed controller | 10D | 78 | | |
| Skill | 807 | SACMO operation and maintenance | 10D | 4 | | |
| Skill | 808 | ROSEMOUNT4001 and chemistry instrument maintenance | 10D | 6 | | |
| Skill | 809 | Nuclear plant safety | 5D | 270 | | |
| Skill | 810 | Reactor thermal dynamic and hydraulics | 5D | 413 | | |
| Skill | 811 | Reactor structure | 5D | 512 | | |
| Skill | 812 | Reactor physics | 5D | 565 | 2 | 42 |

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|---|---|---|---|---|---|---|
| Skill | 813 | DRS system training | 10D | 3 | | |
| Skill | 819 | Spending fuel disposal | 1D | 106 | | |
| Skill | 820 | Pump and valve | 5D | 425 | | |
| Skill | 822 | Nuclear plant general mechanism equipment | 5D | 80 | | |
| Skill | 823 | Probability risk analysis (part I) | 5D | 128 | | |
| Skill | 824 | Electronic equipment and operation | 5D | 29 | | |
| Skill | 825 | Nuclear physics and radiation defend | 4D | 380 | | |
| Skill | 826 | Reactor instrument and control | 8D | 441 | | |
| Skill | 827 | Reactor protection | 4D | 79 | | |
| Skill | 828 | Turbine principle | 8D | 135 | | |
| Skill | 829 | Power plant thermal system | 5D | 134 | | |
| Skill | 830 | Power plant metal material | 2.5D | 24 | | |
| Skill | 831 | Thermal instrument and control | 5D | 24 | | |
| Skill | 832 | Instrument usage manner and technique | 5D | 88 | | |
| Skill | 835 | Recharge | 4D | 13 | | |
| Skill | 836 | Motor principle and application | 5D | 32 | | |
| Skill | 837 | Generator excitation system | 5D | 51 | | |
| Skill | 838 | High pressure test | 5D | 18 | | |
| Skill | 840 | Mechanical seal | 1D | 30 | | |
| Skill | 843 | Assistant boiler start up | 0.5D | 79 | | |
| Skill | 845 | Equipment management | 2D | 137 | | |
| Skill | 846 | Engineering mathematics | 7.5D | 55 | | |
| Skill | 847 | Hydrodynamics | 4D | 74 | | |
| Skill | 848 | Engineering energetic | 2.5D | 74 | | |
| Skill | 849 | Heat transfer ology | 2.5D | 74 | | |
| Skill | 856 | Environment inspection and evaluation | 3D | 17 | | |
| Skill | 857 | Environment inspection and evaluation | 1D | 39 | 1 | 17 |
| Skill | GSJ001 | Radiation solid waste disposal system | 3D | 14 | | |
| Skill | GSJ002 | Water filter changing disposal | 5D | 6 | | |
| Skill | GSJ003 | Condense liquid solidation technique | 3D | 12 | | |
| Skill | GSJ004 | Resin exchange and disposal of ion exchanger | 5D | 8 | | |
| Skill | GSJ007 | Refueling machine principle and operation | 3D | 17 | | |
| Skill | GSJ008 | New fuel receival and refueling bypass operation training | 5D | 16 | | |
| Skill | GSJ009 | Relative assembly exchange tool training | 3D | 19 | | |
| Skill | GSJ010 | Heat washhouse wacher and roast machine usage | 5D | 11 | | |
| Skill | GSJ011 | NPP decontamination equipment usage | 3D | 7 | | |
| Skill | GSJ012 | Refuel supervisor training | 5D | 14 | 1 | 6 |
| Skill | GSJ016 | Fuel technical preparation | 4D | 7 | | |
| Skill | GSJ018 | COMIS tool software training | 5D | 22 | | |

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| Field | Code | Course | Duration | Trainee before FY2002 | Time in FY2002 | Trainee in FY2002 |
|---|---|---|---|---|---|---|
| Skill | ICJ001 | PLC-5 programmed controller work principle and application | 5D | 52 | 1 | 23 |
| Skill | ICJ002 | The usage of 6800 series emulator and anti-programmed manner | 5D | 15 | | |
| Skill | ICJ003 | Converter instrument assembly | 5D | 11 | | |
| Skill | ICJ005 | DVC-5000 series localizer | 2D | 19 | | |
| Skill | ST0001 | SIEMENS PLC principle and appliance | 5D | 19 | 1 | 19 |
| Skill | ST0002 | IQ type Rotor electric actuator work principle and maintenance | 5D | 55 | 3 | 55 |
| Skill | ST0003 | Design rule and selective manner of power plant valve in common use | 5D | 45 | 1 | 45 |
| Skill | ST0004 | The usage and maintenance of 8051 series SCM | 5D | 22 | 1 | 22 |
| Skill | ST0005 | Optical fiber cable] principle and appliance of electricity system | 5D | 29 | 1 | 29 |
| Skill | ST0006 | Quality specialist occupation certificate test training | 10D | 25 | 1 | 15 |
| Skill | ST0007 | Lubricate oil dealing technique | 2D | 27 | 1 | 27 |
| Skill | ST0008 | Document taxonomy theory and application | 5D | 33 | 1 | 33 |
| Skill | ST0009 | Valve working theory and operation | 3D | 157 | 6 | 157 |
| Skill | ST0010 | QC during equipment manufacture training | 1D | 18 | 1 | 18 |
| Skill | ST0011 | Turbine main steam valve and governor valve working principle and maintenance | 3D | 22 | 1 | 22 |
| Skill | ST0012 | Pressure vessel maintenance | 5D | 21 | 1 | 21 |
| Skill | ST0013 | Probability and economic analysis of pump and fan operation | 2D | 14 | 1 | 14 |
| Skill | ST0014 | Nuclear plant radiation inspection study | 5D | 11 | 1 | 11 |
| Skill | ST0015 | Flow measurement instrument principle and type selection | 3D | 9 | 1 | 9 |
| Skill | ST0016 | Fisher check valve failure analysis and maintenance | 5D | 16 | 1 | 16 |
| Skill | ST0017 | Grid accident analysis means | 3D | 33 | 1 | 33 |
| Skill | ST0018 | Condenser maintenance techniques | 5D | 9 | 1 | 9 |
| Skill | ST0019 | metallography laboratory equipment operation training | 2D | 8 | 1 | 8 |
| Skill | ST0020 | Auto attempter and power management | 3D | 7 | 1 | 7 |
| Skill | ST0021 | Low voltage basic skill training | 1D | 40 | 3 | 40 |
| Skill | ST0022 | Sealing technique of NPP | 3D | 55 | 1 | 55 |
| Skill | ST0023 | Transform test and failure diagnosis technique | 5D | 25 | 1 | 25 |
| Skill | ST0024 | Antisepsis principle and techniques | 5D | 24 | 1 | 24 |
| Skill | ST0025 | Electronic file management | 5D | 20 | 1 | 20 |
| Skill | ST0026 | Hazard products management | 2D | 73 | 3 | 73 |
| Skill | ST0027 | Endoscopes operation | 2D | 10 | 1 | 10 |
| Skill | ST0028 | Fertilizer pipe and design principle and maintenance | 5D | 17 | 1 | 17 |

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|---|---|---|---|---|---|---|
| Skill | ST0029 | Fastness component standard and selective manner | 3D | 21 | 1 | 21 |
| Skill | ST0030 | Isolation manager electrical switch sill training | 5D | 51 | 3 | 51 |
| Skill | ST0031 | Human group health management | 5D | 8 | 1 | 8 |
| Skill | ST0032 | Low voltage motor work principle and maintenance | 5D | 8 | 1 | 8 |
| Skill | ST0035 | Fuel receivable retraining | 3D | 29 | 1 | 13 |
| Skill | ST0036 | Pump operation | 3D | 84 | 6 | 84 |
| Skill | ST0037 | Low voltage distribution charge operation | 3D | 163 | 6 | 163 |
| Skill | ST0038 | KPT system operation principle maintenance | 3D | 161 | 6 | 161 |
| Skill | ST0039 | Fire risk analysis | 1D | 42 | 3 | 42 |
| Skill | ST0040 | Generate and transfer electricity operation special training | 1.5D | 24 | 1 | 24 |