行政院及所屬各機關出國報告提要

出國報告書名稱：參加 WANO-TC 舉辦之「東京中心電廠共同弱點」會議

頁數：39　附件：是☑　否☐

出國計畫主辦機關/聯絡人/電話：

台灣電力公司/陳德隆/02-23667685

出國人員姓名/服務機關/單位/職稱/電話：

李文達/台灣電力公司/核能三廠/品質組經理/08-8893470

黃英俊/台灣電力公司/核能四廠/運轉組經理/02-24903550

出國類別：☐1 考察☐2 進修☐3 研究☐4 實習☑5 其他

出國期間：97 年 10 月 19 日至 97 年 10 月 23 日

出國地區：日本

報告日期：97 年 11 月 20 日

分類號 /目：

關鍵詞：同業評估共同弱點

內容提要：（二百至三百字）

台電核三廠品質組經理李文達及核四廠運轉組經理黃英俊，奉派參加世界核能發電協會東京中心(WANO-TC)舉辦之「東京中心核電廠共同弱點」研討會，瞭解東京中心各核能電廠，近年來接受 WANO 同業評估，所發現之共同缺失(如電廠管理效能、自我評估及改正行動計畫、人員績效與消防等)，逐項加以研討；期能藉由與 WANO 其他成員電廠間相互討論，能提出有效的改善及解決方法，以應用於提高台電公司核能營運績效，並有效防範人為疏失。

本文電子檔已傳至出國報告資訊網(http：//open.nat.gov.tw/reportwork）

行政院及所屬各機關出國報告

(出國類別：開會)

參加WANO-TC舉辦之「東京中心電廠共同弱點」會議

服務機關：臺電公司

姓名職稱：李文達 核三廠 品質組經理

黃英俊 核四廠 運轉組經理

出國地區：日本

出國期間：97年10月19日 至 97年10月2:

報告日期：97年11月20日

摘　　要

台電核三廠品質組經理李文達及核四廠運轉組經理黃英俊，奉派參加世界核能發電協會東京中心(WANO-TC)舉辦之「東京中心核電廠共同弱點」研討會，瞭解東京中心各核能電廠，近年來接受WANO 同業評估，所發現之共同缺失(如電廠管理效能、自我評估及改正行動計畫、人員績效與消防等)，逐項加以研討；期能藉由與 WANO 其他成員電廠間相互討論，能提出有效的改善及解決方法，以應用於提高台電公司核能營運績效，並有效防範人為疏失。

目　　次

（頁碼）

壹、 目的

本次研討會為世界核能發電協會東京中心（WANO-TC），針對近年來 TC 會員電廠，在接受 WANO 同業評估（WANO Peer Review），所發現的共同缺失（Common Weakness），邀請各會員派代表與會，讓各會員瞭解共同缺失所在，並研擬適當的改善方法，以有效協助各會員解決及防止類似共同弱點，進而提昇核能發電整體安全與營運績效。為此，台電公司派遣職（核三廠品質組經理李文達及核四廠運轉組經理黃英俊）等兩人，參加本項研討會。上述研討會，於 2008.10.20 至 10.22）於日本新瀉縣十日町市召開（詳附件一，2008 TC Common Weakness Seminar Programme）。

貳、 WANO 同業評估共同缺失研討會

一、 本項研討會由 WANO 東京中心（WANO - TC）所主辦，參加成員除 TC 副局長與各計畫經理外，TC 主要會員（含台電公司 TPC、韓電 KHNP、印度核電 NPCIL、巴基斯坦核電 PAEC、大陸核工業集團公司 CNNC，與日本各核能發電公司）計 22 人共同參加（詳細名單，如附件二 Participants List）

會議緣由：主要係 WANO 東京中心，在 2005 年至 2007 年間，對 TC 區域 16 個核能電廠，進行同業評估（Peer Review）時，發現有下列共同缺失及待改進事項（Common Weaknesses and Areas for Improvement ，即 AFIs），主要集中在下列四大共同領域：

- 組織管理的有效性（Management Effectiveness）（12/16）
- 電廠自我評估與改正行動的落實(Self-Assessment & Corrective Action Program）（9/16）
- 人因疏失的防範（Human Performance）（9/16）
- 消防措施的精進（Fire Protection）（10/16）

括弧內數字，為 16 個電廠內缺失的比率；數字顯示，四項領域確為一般皆有的缺失。

除此之外，常見的其他缺失，尚包括下列諸小項：

- 工安措施待改進（如未使用工安護具或電氣/吊掛作業中的工安防範）
- 運轉員的缺失（如控制室管制進出的績效，與對反應度管理的落實）
- 防範異物入侵（FME）（針對在設備維修階段，與對燃料池的特別管制等）
- 運轉設備狀況的提昇（落實預防保養與對設備狀況的有效監測）
- 輻防領域的加強（如 ALARA 措施，與污染防制的再強化等）

但由統計數字顯示，有上述缺失的電廠佔比，尚未達普遍化現象；為此，研討會僅針對四大共同領域缺失，進一步探討原因與尋求改進方法。

二、 高效能的組織管理（講稿詳附件三）

組織效能或目標管理常見的缺失，在 WANO 在同業評估時，對核電廠經營管理，常開立的 AFI，是電廠的管理常未建立高標準的管理目標，經由組織的溝通，落實到基層的認知，藉由推動與落實，來強化電廠整體的表現。

在未落實此種高效能組織管理的具體事例上，包括：

- 電廠未能採取系統化的有效措施，來降低或預防各類失誤。
- 發生在許多電廠有關反應度管理的案例，歸究原因，常見是組識管理有效性的問題。
- 對發生在電廠的虛驚（Near Miss）或微小事件（Minor Event），未能建置較低門檻（Lowest threshold）的機制，來有效蒐集與運用分析，進而達到防範於未然的目的，這也是組織管理中，常遇到的缺失。

有鑑於此，如何達成組織管理的有效性，WANO 建議電廠經營者，首先需建立高標準的組織目標與管理期望（high standard of organization goals and management expectations），與下屬充分溝通與轉達後，訂定計畫來推動（plan and implementation），過程中監測與評量績效的優劣（monitor and assess），經由改正行動方案來教導員工與改進自我缺失，並與標竿電廠或同業學習（benchmarking），進而提高組織目標的標準或層級（higher expectations），達成持續績效改進的組織功能。此一循環過程，環環相扣，任一環節的誤失，將會影響整體組織管理的有效性，過程中組織分工與權責明確劃分（clear accountability），避免有責無權、有權無責或權責混淆，也是管理者需要注意的重點。

三、 電廠自我評估（Self-Assessment）與改正行動方案（Corrective Action Program，CAP）

【自我評估】包括各管理階層現場走動管裡、作業觀察或透過定期性內部或外來組織評量，找出電廠/員工待改進之缺失或領域；

而【改正行動方案】，是透過上述自我評估作法所發現的缺失，能夠回報（reporting），並依據缺失嚴重程度，決定報告層級及採取行動優先順序（prioritization），進而由權責部門，採取改正行動，進行改進。

所以自我評估與改正行動方案，是電廠謀求不斷精進改善的一貫整體作法的兩個過程。

WANO 發現各廠在辦理自我評估時，常有下列典型的 AFI 缺失存在：

- 管理階層的期待與員工實際表現，兩者之間所存在的落差，未被有效的發掘出來，而且這種落差，也沒有去做分析改進。
- 許多電廠，每兩年一度的自我評估作業，對於許多存在的電廠缺失，並未能發現與提醒。
- 電廠走動管理，常未能有效的發現問題，以尋求改善。
- 許多用來監測與改進電廠營運的有效工具或方法，未能被採納執行。

另外，在改正行動（CAP）方案上，電廠容易有下列典型的 AFI 缺失：

- 以往自我評估作業所界定的 AFI，未能有效改善，而仍持續發生相同缺失。
- 電廠在 CAP 底下，有許多各自獨立的管理機制，但未被有效整合，用來蒐集、分析並改進電廠既有缺失，亦即徒有許多管理機制，但效果未被考核追蹤。
- 電廠員工，對於現場發現的小缺失，或不當的小偏差行為，常不知提報，或者被管理階層發現，而任由問題潛藏，終致引發可能的較大問題（這項缺失的肇因，常是管理階層的期待，未能與基層有效溝通，並進而設計出一套有效機制與提報標準，去教導並鼓勵員工，勇於發現並提報問題，才可謀求改進與防範）。

四、 人因疏失的防範

常見的典型 AFI 缺失如下：

- 許多電廠常發生人因疏失，並且散見在不同工作領域，包括運轉、維護、輻防與工安等方面。
- 上述電廠，未見有系統化的人因強化改進方案（systematic Human Performance Improvement Program），包括有效的使用"防誤工具"（error prevention tools）。
- 管理階層或第一線的監督者，未能強化並告知基層員工，正確的行為標準所在。
- 電廠員工未能深化防誤技巧的運用。
- 員工未養成遵守程序書的習性，或者程序書內容品質有待加強。

細節的缺失，常見如下：

- 重要的操作程序，未逐步確認（程序因故中斷，再回來執行時，常有失誤）。

- 三向溝通未能落實，有時甚至連雙向回覆都未做到。
- 現場不良工作環境（如黯淡照明與巨大的噪音干擾），潛藏人因危機。
- 監督者自顧不暇，未能挑戰員工不良工作習性或糾正其錯誤，致喪失監督者角色。
- 工具箱會議流於形式，未能點出關鍵因子，妥為預防。

而對於有效的工具箱會議，要能做到所謂"SAFER"的精神，即：

- **S**ummary critical steps（討論並總結出關鍵操作步驟為何）。
- **A**nticipate error traps（找出操作中可能的失誤陷阱）。
- **F**oresee consequences（針對正確或錯誤的操作，預先說出其可能結果與反應）。
- **E**valuate defenses（評估操作過程中，有那些可能防誤屏蔽可供利用）。
- **R**eview experiences（回顧自我或別人以往失敗經驗，引以為戒）。

五、 消防措施的精進

WANO 東京中心轄下核能電廠，近年來發生多起或大或小的火災事件，諸如：

- 2005 年：關西電力高浜電廠，在進水口廠房焊接作業，引發火災。
- 2006 年：東京電力福島一廠六號機，停機期間在 containment 內焊接造成火災;韓電 kori 電廠四號機，大修期間在 containment 內，風扇過熱引發火災，及關西電力大飯電廠三/四號機，廢料廠房因焊接釀成火災。
- 2007 年：發生在大飯電廠一/二號機，瀝青固化廠房焊接造成火災及北海道泊電廠三號機，新建機組 containment 內施工，造成火災等。

以上消防事件，檢討成因，歸究於下列原因：

- 電廠廠務管理（Housekeeping）現況，無法預防火災發生或阻止其蔓延。
- 大量易燃物質（紙箱、夾板等），堆積在整個現場，或不必要的油桶，被攜入現場。
- 焊接施工防範不足，或現場施工完畢，未收拾妥當（如易燃物質，未用防火布遮蓋等）。
- 未考慮電氣設備或電纜，其對火災的風險。
- 許多防火門，未依規定關閉，致增加火災蔓延機會。

參：心得

1. 本研討會，集中亞洲各 WANO 主要會員推派成員參與，除了學習旨述四大領域之精進作法外，並透由與會者互相砌磋／交流／分享各領域作業經驗，我們在此研討會中獲益良多。如果業界能大力將學習成果帶回自家，並透由再教育，有效、積極推動，對提昇營運中電廠之核能安全績效或建造中的電廠的施工品質及工期掌控皆有其正面意義。

2. 本研討會，WANO 主辦單位採用 Family group discussion 模式，利用晚餐後 8~10 點時間，以房間（4 人）為單位，由 WANO 工作人員協助進行旨述四大領域各項作業經驗之交流與分享，並於會議結束前進行分組報告，另邀請與會人員對整體活動提出批評及建議。如此坦誠、求好心切之辦活動心態，值得效法學習。

肆：建議事項

1. 電廠各種管理作業因應各階段人力、物力、財力支援能力的不同，

應訂有明確的接受標準，作為共同遵循的準繩。因此，最高管理階層應建立較高標準的期望，並不斷透由溝通／交流／教育／學習，以強化員工努力的方向，提昇員工發覺問題的視野。

2. 類似之 Seminar／Workshop／benchmarking 在過去一段長時間以來一直在核能業界普遍展開，上自企業總裁、總經理、廠長，乃至不同領域經理人、工作階層都踴躍參與學習並帶回工作場所。唯依據 WANO T／C 或其他各 Center 歷年來執行同業評估之結果顯示，無論在那個電力公司、那個廠、那個領域，都仍有或多或少的 AFI 存在，有些甚至於是否可安全運轉都堪慮。到底我們從經驗／學習／交流中學到些什麼？又如何運用在自身這才是我們該深思的。

3. 因此，建議領導人該思考如何做〝對〞的事情，而不是停留在僅把事情做〝好〞而已。(Do the〝right〞things， Not just do the things 〝right〞.)

伍、附件

附件一、會議議程

附件二、研討會參加人員名單

附件三、Management Effectiveness簡報

附件四、SA&CAP Weaknesses簡報

附件五、Human Performance Weaknesses簡報

附件六、Fire Protection簡報

附件一

2008 TC Common Weakness Seminar Programme

WANO-TC Stations Common Weakness Seminar

Programme

Oct. 2008	**WANO-TC Common Weakness Seminar**	Accommodation
10/19 Sun	International participants arrive at Narita/Tokyo	Tokyo Shinjuku
10/20 Mon		
9:15	Leave Washington Hotel by Bus	
12:45	Arrive at Belnatio	
	[Lunch and Break]	
15:00	Overview TC Common Weakness: Iwaki	
15:30	Session 1: Self assessment: Kim - How to identify GAP - Effective self-assessment	
18:00	[Dinner]	
After dinner	Group Discussion: Weakness@your station	Atema Resort Belnatio
10/21 Tue		
8:30	Session 2: Human Performance: Kim - Human performance events - Error prevention tools	
11:30	[Lunch and Break]	
13:00	Session 3: Fire Protection: Iwaki - Fire events - Effective fire protection	
14:00	Session 4: Management Effectiveness: Iwaki - Roles of leaders - How to lead change	
17:00	[Dinner]	
18:00	Group Discussion: Improvement@your station	
After dinner		Atema Resort Belnatio
10/22 Wed		
8:30	Session 5: Group discussion - Identify issues - Recommendations for improvement	
12:00	[Lunch] - Presentation	
	Leave Velnatio for Tokyo	
14:30	Arrive at hotel	Tokyo Shinjuku
18:30		Washington Hotel
10/23 Thu	Move to Narita	
	International participants leave for home	

Participants List of WANO-TC Peer Review Common Weakness Seminar
in Niigata on Oct. 20-23, 2008

附件二

No	Name	Position/ Company	Utility
1	Koremutsu KOSHIBA	Deputy Director Shimane	CHUGOKU
2	Shi-Ming XU	Manager Nuclear Safety & Licensing Department, QNPC, CNNC	CNNC
3	Sujia LI	Vice President Research Institute of Nuclear Power Operataion, CNNC	CNNC
4	Masashi MURATA	Nuclear Safety Network Devision Japan Nuclear Technology Institute	JANTI
5	Yang Eun KIM	Senior manager Quality Assurance Office, KHNP	KHNP
6	Heung-Gyun YUN	Assisitant Manager KHNP	KHNP
7	Akhileshwar Kumar SINGH	Maintenance Superintendent TAPS1&2, NPCIL	NPCIL
8	Mukeshbhai HANSORA	Maintenance Superintendent NPCIL	NPCIL
9	Syed Yusuf RAZA	Chief Engineer DPM (Engineering) Chashma Nuclear Power Plant 1, PAEC	PAEC
10	Khusro DURRANI	Director, DNPO PAEC	PAEC
11	Muhammad Ayaz KHAN	Principle Engineer KANUPP, PAEC	PAEC
12	Jun-ichi OIZUMI	Consulting Manager ONAGAWA NPS, Tohoku EPC	TOHUKU
13	Tsunehiro TADA	Manager Engineering Sec.,Higashidoori NPS Tohoku EPC	TOHUKU
14	Koji NAKAMURA	Manager Tokyo EPC	TOKYO
No	**Name**	**Position/ Company**	**Utility**

15	Wen-Da LEE	Manager, Quality Section Maanshan NPP, TPC	TPC
16	Eng-Chung HWANG	Manager, Operation Section Lungmen NPP, TPC	TPC
17	Katsuhiko IWAKI	Manager, Peer Review, WANO-TC	WANO-TC
18	Hyo Jin KIM	Team Leader, Peer Review, WANO-TC	WANO-TC
19	Hak Jin KIM	Programme Manager, WANO-TC	WANO-TC
20	Kenichi YOKOYAMA	Programme Manager, WANO-TC	WANO-TC
21	Yoshikazu TSUCHIHASHI	Programme Manager, WANO-TC	WANO-TC
22	Bing DAI	Programme Manager, WANO-TC	WANO-TC

附件三

WANO-TC 4th Common Weakness Seminar

Management Effectiveness

October 21, 2008

Katsuhiko Iwaki
WANO Tokyo Center

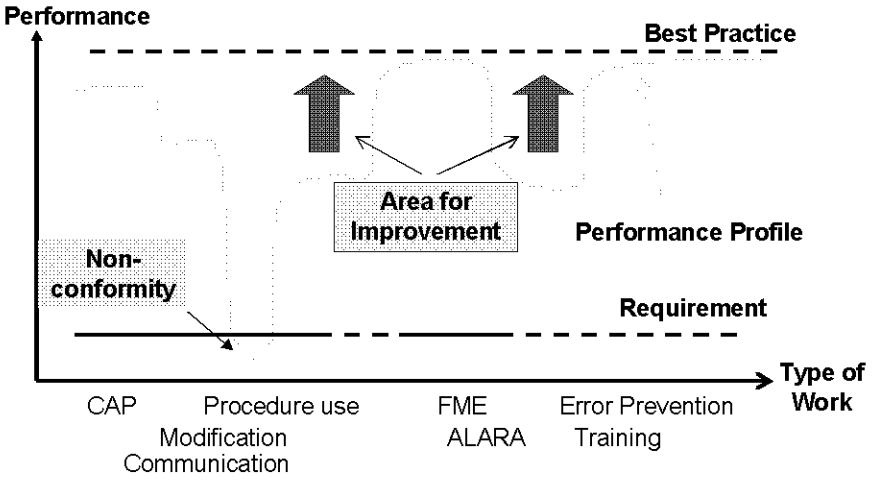
Typical AFI Statement in Management Effectiveness

- Higher standards of performance need to be established, communicated, or reinforced especially in the areas of human performance, industrial safety, conduct of operations, …
- Station has not stayed current and implemented industry best practices to improve safety and reliability in some areas

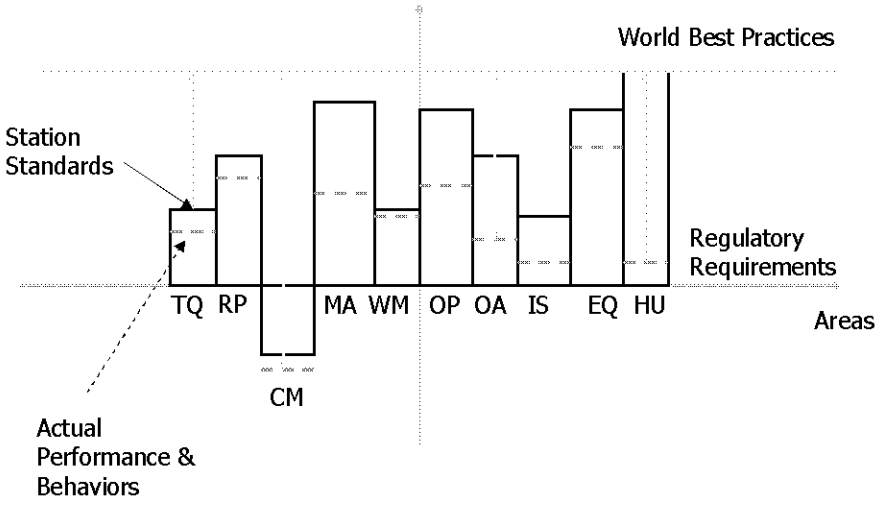
Typical areas needing higher standards:

- Systematic approach to error reduction
- Reactivity management
- Undesirable condition collection with lowest threshold

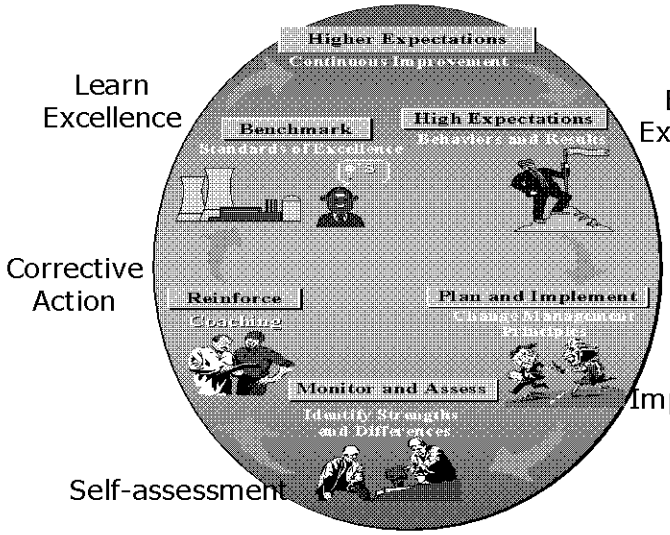
Setting Higher Standard



Standards and Actual Performance

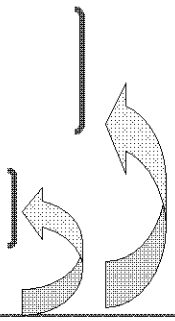


Management for Continuous Improvement



Elements of Management

- Establishing high expectations
- Communicating the expectations
- Holding personnel accountable
- Monitoring performance
- Providing feedbacks (coaching)



<u>Higher standards</u> of performance need to be established, communicated, or reinforced, especially in the areas of human performance, industrial safety, conduct of operations, …

Why are High Expectations not set?

- Mindset of Asian culture
  - Leaders should not instruct too much
- Isolation syndrome
  - Believing we are good enough
  - Lack of benchmarking
- Minimum requirement syndrome
  - Just to meet regulations
  - Higher standards would increase non-conformities identified by regulators
- Over-confidence
  - Believing that workers are doing well

Why are Expectations not Communicated?

- Lack of whole picture
  - Not clear why the expectation has been set
- Few direct talks
  - Just to send them by e-mail or post them on the station intranet
  - Communication not repeated
- Barrier between contractors
  - Passing message from one to another
- Inconsistency between expectations

Why are Expectations not Reinforced?

- Lack of field monitoring
  - Don't know if workers are doing as expected
  - Don't know why workers are not doing as expected
- Low presence of managers
  - Workers may not follow management message under low management presence
- Lack of coaching
  - Managers missing chances of direct talk
  - Workers may compromise if not coached

Making Expectations Real

- You MUST monitor performance
- You MUST demonstrate the expectations in your own work
- You MUST confront poor performance
- You MUST adapt expectations to changing conditions
- You MUST continually communicate your expectations
- You SHOULD confront peers when expectations are not met

Typical Suggestions

- Many peer review team have provided suggestions:
  - Check the current expectations and compare them with those of excellent stations
  - Conduct management observation

附件四

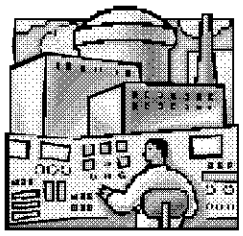
WANO-TC Peer Review
Common Weakness
SELF ASSESMENT & CAP

Hyo-Jin Kim (kim@wano-tc.or.jp)
Team Leader
WANO-TC

How can you improve performance of our station?

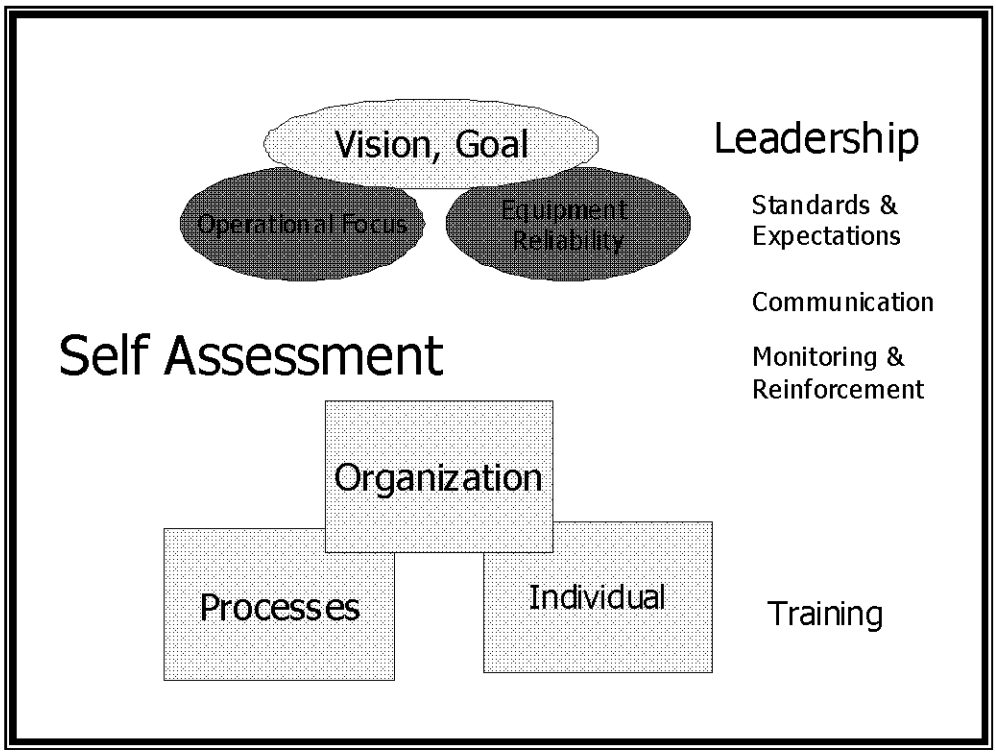
- 1st Select an area to improve (PO&C, PI, OE)
- 2nd Set your goal (PO&C)
- 3rd Understand the gap (Monitoring, observation)
- 4th Find the causes of the gap (Analysis)
- 5th Plan improvement actions (Planning)
- 6th Implement the actions (Implementation)
- 7th Check if the actions are improving your performance (Periodic effectiveness evaluation)
- 8th Redo from step 1.

Common Attributes of Excellent Nuclear Power Plants



Five common attributes

- Excellent plants have strong leadership
- Excellent plants make a habit of being self-critical
- Excellent plants are operationally focused
- Excellent plants have exceptional equipment performance
- Excellent plants use training to continuously improve performance



Excellent plants have strong leadership (1)

- Leaders understand the current level of performance, have a clear vision of where they want to go, and communicate how they are going to get there.
- Standards and expectations for performance are clearly communicated to all levels of the organization.

Excellent plants have strong leadership (2)

- Leaders align the organization around the vision and the standards.
- Priorities are well understood.
- Workers are engaged and regularly offer input to solve problems and make improvements.
- Accountability is clear.

Excellent plants make a habit of being self-critical

- They use self-assessment, performance indicators, corrective action programs, and benchmarking to implement best practices.
- Constantly looking for gaps to excellence, finding them, and fixing them.
- Complacency is never tolerated.

Excellent plants are operationally focused

- Operations leadership is not only observed in the control room, but is evident in day-to-day decision-making and in determining plant priorities.
- There are high operational standards throughout the organization, including those in maintenance, work control, and engineering.
- Supporting safe, reliable operation is the "rhythm" and basis for everything they do.

Excellent plants have exceptional equipment performance

- The plant operates event-free due to excellent material condition and a proactive focus on equipment performance.
- There is intolerance for equipment problems that can challenge safety system performance and unit reliability or burden operators.
- This is a leadership issue, not just a technical issue.

Excellent plants use training to continuously improve performance

- The plant makes innovative uses of training to prepare workers.
- Most importantly, line managers are involved.

The Five Most Common Characteristics of Plants With Declining Performance

1. Leadership does not set, communicate or reinforce high standards.
2. A self-critical attitude is missing.
3. Basic day-to-day operations are weak.
4. Broad and often long standing equipment performance problems exist.
5. Fundamental skill and knowledge deficiencies exist.

Self Assessment AFIs (1/4)

- The gaps between management expectations and actual implementation in some areas at the station are not effectively measured and analyzed.
  - The self-assessment and audit processes do not work to ascertain the overall problems at the station

Self Assessment AFIs (2/4)

- More frequent and comprehensive focused self-assessment of station programs, processes, and work activities would help the station identify areas where improvement in effectiveness and efficiency could be made.
  - The station has started developing a self-assessment and corrective action program. Training on these principles have been provided to some line managers. However, the program has not been implemented.

Self Assessment AFIs (3/4)

- Station self-evaluation activities are not sufficiently critical and are not effectively identifying and correcting some behavior, process, and condition problems that need improvement.
  - Station personnel sometimes do not report low level deficiencies or instances when behavior/performance does not meet expectations

Self Assessment AFIs (4/4)

- Some important tools to monitor and improve station performance have not been defined and implemented.
- Clear picture of plant problems are not systematically identified and not corrected according to its priority to safety significance. Problems are not systematically collected, trended and solved according to its important to safety

Corrective Action Program AFIs(1/5)

- Additional management attention is needed to ensure that issues that could potentially impact safe plant operation are identified, critically evaluated, and addressed in a timely manner.

CAP AFIs(2/5)

- A more comprehensive station-wide process for reporting, documenting, trending, and analysis of deficiencies, especially those related to worker performance, would improve the station's ability to monitor and correct performance shortfalls.

CAP AFIs(3/5)

- Undesirable conditions are not effectively collected and analyzed for continuous improvement of the station.
  - The station has many separated undesirable condition collecting systems. However these systems do not effectively monitor, evaluate and analyze undesirable conditions including minor events and near misses to take appropriate corrective actions

CAP AFIs(4/5)

- The plant does not actively encourage the use of insights from low level events and occurrences at the plant for further performance enhancement.
  - The system of collecting and analyzing (for adverse trends) the minor events and problems occurring during the day-to-day operation of the plant are inadequate.

CAP AFIs (5/5)

- The station-wide human related events collecting system is not effectively operated to monitor and correct performance shortfalls.

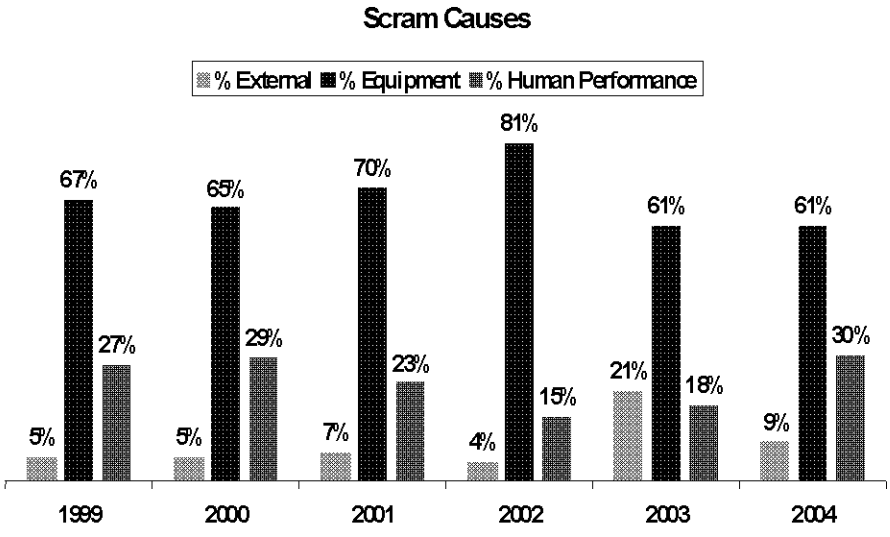
附件五

Human Performance

Hyo-Jin Kim
Team Leader
WANO-TC

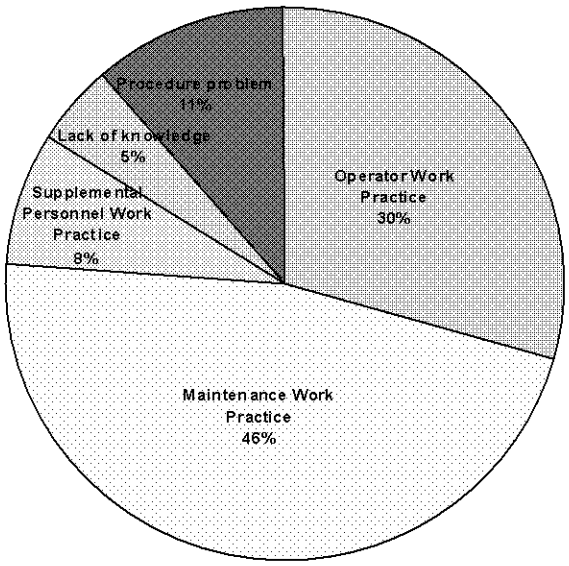
Why Human Performance?

- 21 out of 26 core-damaging accidents due to human error
- Three out of four significant events due to human error
- 70 percent of causes related to weaknesses in organization
- Also contributes to costs



Human Performance

3



Human Performance Causes

Human Performance

4

WANO AFI – Summary

- **Management not reinforcing standards (WHY)**
- **Employees not internalizing the use of error-prevention techniques**
- **Improper procedure quality for task**
- **Inadequate procedure adherence**

Approximately 60% involved standards and/or use of error-prevention techniques

WANO-TC AFIs Summary

- Human errors are contributing to plant events and non-conformities.
- Some individual behaviours and station practices do not promote error free operation. These include weaknesses in the use of procedures, supervisory oversight, and response to some unexpected conditions

WANO-TC AFIs Summary

- Lack of a station wide systematic approach to human error reduction results in missed opportunities to improve station performance and achieve event free operation.
- Some error-reduction tools, such as three-way communication, self-checking, peer-checking, procedure use and pre-job briefing are not being utilized.

Principles

of Human Performance Management

- Humans are fallible . . .
- Error is predictable. . .
- Organization influences behavior.
- Behaviors are reinforced.
- Events are avoidable.

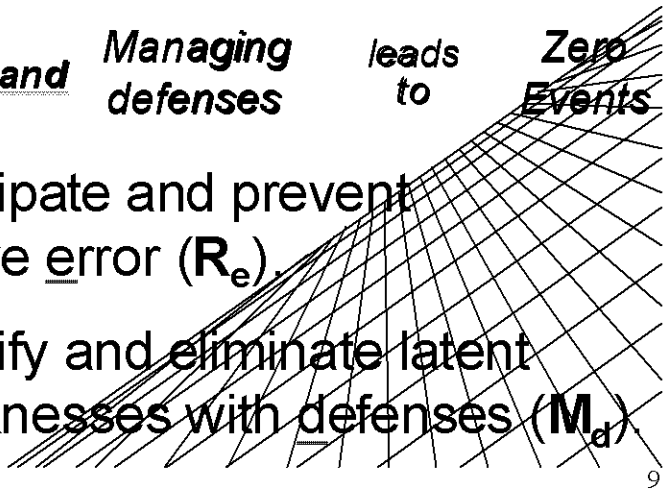
Source: INPO, *Excellence in Human Performance*, 1997.

Strategic Approach

$$R_e + M_d \rightarrow \emptyset E$$

Reducing error ***and*** ***Managing defenses*** ***leads to*** ***Zero Events***

1. Anticipate and prevent active error (R_e).
2. Identify and eliminate latent weaknesses with defenses (M_d).



Nature of Human Error initiated Events

- An analysis conducted by INPO clearly shows that member plants and utilities need to place further emphasis and take more aggressive action on preventing errors.
  - **85% is Managing Defenses (MD)**
  - **5% is Reducing Errors (RE)**
  - **10% is Equipment Failures**

Managing Defenses (Md)

- Md is the organization, which include
  - Management Expectations
  - Healthy Relationship to minimize barriers to communications; interpersonal and inter-department
  - Intolerance: Human error initiated events can be prevented
  - Communication and Reinforcement

Managing Defenses (Md)

- Md is the processes, cross-functional flow of work
  - Implemented as designed so as not to induce undue haste, distractions, stress.
  - Work Preparation
  - Procedures-clear, logical, simple, and understandable
  - Change Management
  - Root Cause Analysis
  - Training

Leadership Key Practices

1. Facilitate open communication
2. Promote teamwork
3. Reinforce desired behaviors
4. Eliminate latent organizational weaknesses
5. Value prevention of errors

You can make a difference

- Coaching, providing feedback and just being in the field (contact time) can make a difference.
- Industry indicators show us that error rates decline when managers and superviosors are providing real time coaching
- As individuals, regardless of what position in the organization, has a role and responsibilities to reduce errors

附件六

October 21, 2008
Velnatio

WANO-TC Peer Review
Common Weakness
FIRE PROTECTION

Katsuhiko Iwaki
WANO-TC

Contents

1. Common Weakness
2. TC Fire Event
3. International Guideline

Common Weakness #1

Control of combustible material storage

Uncontrolled combustible materials and flammable liquids are stored in many locations throughout the plant, and in some cases around important equipment.

- Oil-soaked wood, cans of flammable chemicals and oil stored in HPCS EDG room
- Wooden products (wooden pallets, wood boxes, plywood plates …), cardboard boxes, paper, vinyl, netting below scaffold, wicker brooms stored throughout the plant
- Oil-soaked plywood plates as flooring
- No fire loading analysis/evaluation

Common Weakness #2

Fire containment – "Open fire door"

Fire containment features are not sufficient to limit the risk of fire consequences.

- Fire doors left open even though "Keep Closed" notice, propped open
- Fire doors lost automatic closing devices, doors not closed completely
- No sign to identify as fire door
- Ventilation opening near fire door
- No compensatory measures when passive fire protection device (ex. fire protection barrier, penetration seal) found impaired, taken out of service.

Common Weakness #3

Electric component and cabling

Fire protection standards in the area of electric component and cabling may increase the risk of fire.

- Electric wire connections not properly connected and insulated, cardboard box in close proximity
- Electric breakers no protective canopy, covered with dust
- Electric drawers no protective canopy, full of dust
- Temporary cables energized in a coil
- 13.8kV transformers exposed to possible sea water through ventilation openings
- Thin plastic sheet on energized electrical power supply component, warm

Common Weakness #4

Management of fire fighting system

Management of fire fighting systems are not sufficient to limit the risk of fire consequences

- Insufficient management of fire protection system :
  - ✓ engine-driven fire pump overhaul without urgency
  - ✓ no fire alarm in fire pump room
  - ✓ mismatching overhaul timing of pump(6y) and diesel engine(10y)
  - ✓ no fire alarm in radiation protection warehouse containing many flammable materials
- On-site fire station does not have tools for connecting hoses to fire hydrants, axes for emergency access, etc.
- No fire fighting action sheet in the field
- Procedure to activate emergency control panel in case of MCR fire not known by some staff
- No oxygen mask, no warning sign outside of electrical equipment rooms using CO_2 extinguishers

Common Weakness #5

Paris Center Peer Review Feedback

- **Storage and control of combustible materials**
  - Combustible materials stored in excess of the fire load limits
  - Uncontrolled and unanalyzed storage of fire loads
  - Numerous defects on fire doors and fire resistant penetrations

    (Some fire doors are blocked in open position and some fire fighting equipment like extinguishers and hydrants are not accessible)
- **Material conditions**
  - Some fire barriers ineffective
- **Work practices**
  - Work practices hinder the achievement of a high degree of safety

    (high fire loads, inadequate storage of chemicals and flammable liquids and unsafe work practices

Common Weakness #5

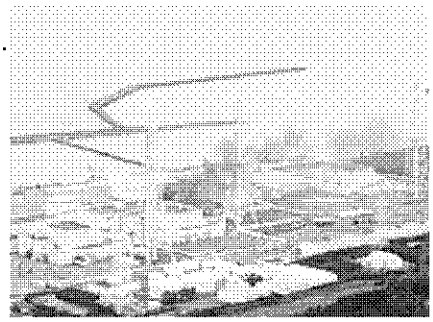
Paris Center Peer Review Feedback (continued)

- **Operating Experience Feedback**
  - Not receiving Operational Experience information on fires
- **Surveillance and maintenance program**
  - Not guarantee an optimum performance and reliability

    Technical drawings, manuals, hydraulic design calculations or functional test procedures do not exist
  - Periodic inspections failed to identify degraded conditions
  - No overall updated written surveillance program
- **Training**
  - Training program for fire brigade personnel does not assure a high degree of safety and proficiency in fire-fighting skills
  - Level of the fire brigade preparedness is not sufficient

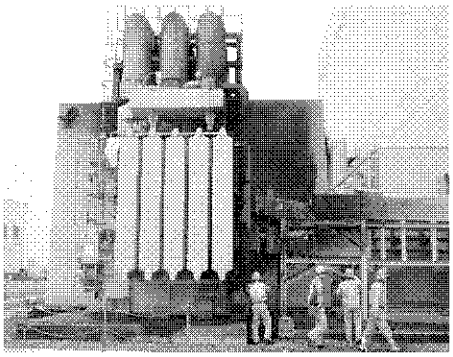
TC Fire Event #1
Kashiwazaki-Kariwa, 7/16/2001

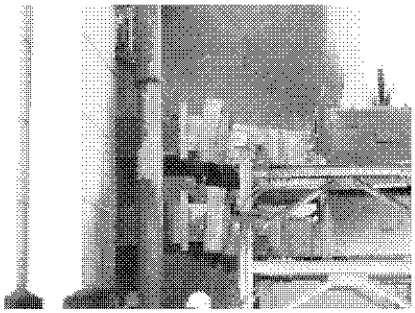
- Huge earthquake attacked KK
  - All seven units safely shutdown
- However, media reported as if…



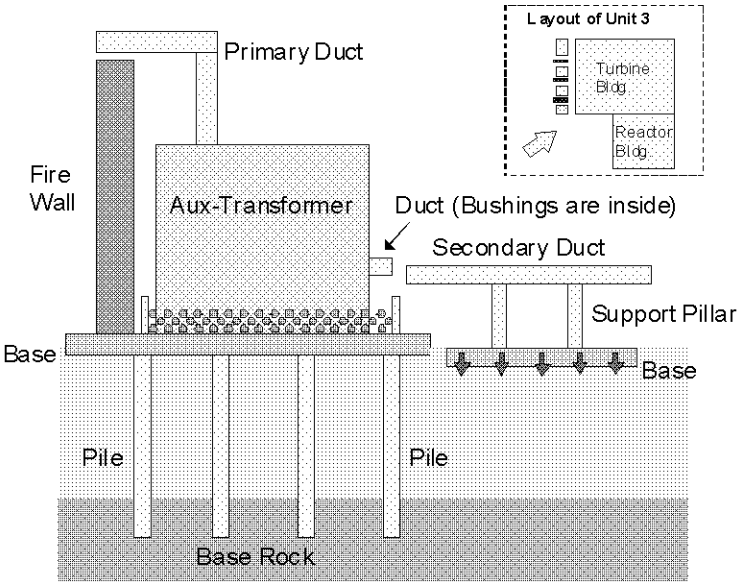
TC Fire Event #1
Kashiwazaki-Kariwa, 7/16/2001

Cause: Connecting bus bar subsided deeply causing oil leak and spark



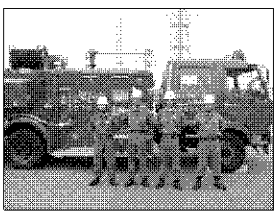


Subsidence of Secondary Duct



TC Fire Event #1
Kashiwazaki-Kariwa, 7/16/2001

- Problem:
  - Station initial fire fighting failed to extinguish
    - Fire water not available due to water line rupture
    - Fire engine not available at the station
  - Local fire department extinguished but it was two hours later
- Measures:
  - Enhance FP facilities
    - Chemical fire engine
    - Underground fire water pipelines to surface pipeline
  - Round the clock fire brigade

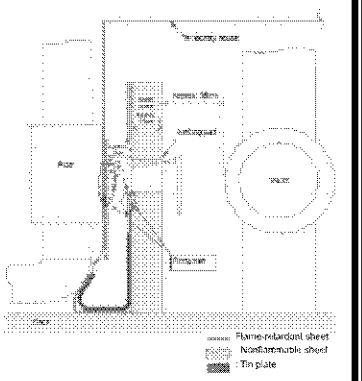


TC Fire Event #2

Fukushima Daiichi 6, during outage, 03/01/2006

- **Fire alarm went on. Smoke was observed at the 1st floor of containment** building from the fire retardant sheet used for temporary work house. Workers in the field put out the fire.
- During meltdown of a 10 cm thick steel plate, small balls of molten materials melted fire-retardant sheet and inflammable sheet outside caught fire.

What does this event tell?

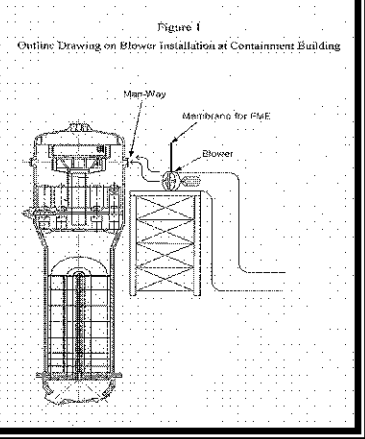


TC Fire Event #3

Kori unit 4, During refueling outage, 03/08/2006

- A fire at the containment building due to the overheating at a blower (220V, 1.1kW) which had been installed at Steam Generator B area for the replacement of the swirl vane.
- The fire extended to the membrane which had been used for the foreign material exclusion.
- Many workers inside containment including three workers inside SG; none of them were injured

What does this event tell?



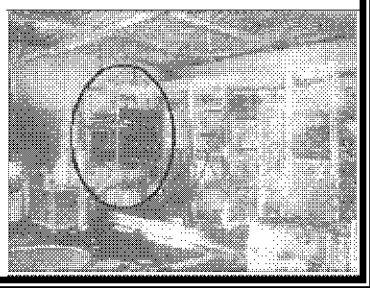
TC Fire Event #4
Ohi, unit 3&4 Radwaste Building, 03/22/2006

- Fire Alarm went on. Exit for building elevator was filled with smoke and fire protection doors were actuated.
- It was found by the local fire station and police station that the fire was initiated at the center part of storage rack for tools and materials on the second floor of filter valve room.
- It was assumed that some heated welding protective sheets may cause volatile material, such as spray cans, to get ignited.

Corrective Actions

- Welding protective sheets should be stored in a designated case, away from flammable materials
- Unnecessary volatile combustibles, fire risky materials were removed and will be limited in the RCA, stored in designated area.

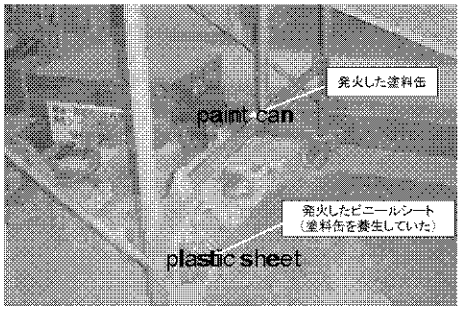
What does this event tell?



TC Fire Event #5
Ohi, unit 1&2 Asphalt Solidification Building, 09/20/2007

- During grinding and welding to install an inspection platform for heating equipment in asphalt solidification building,
- Fire balls slipped through fire sheets which were housing the work area and fell on the floor.
- A plastic sheet and a paint can on the floor caught fire,
- Worker nearby put out the fire immediately with a fire extinguisher.

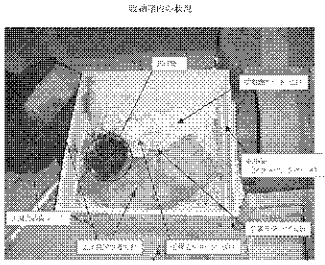
What does this event tell?

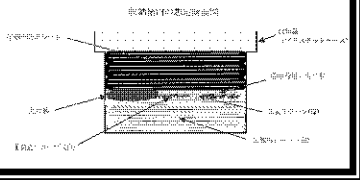


TC Fire Event #6
Tomari 3, Construction site, 09/29/2007

- White **smoke** from sheet **storage** box **was found** in **Reactor Containment site**, **workers put it out** with **water**.
- Sheet **in the** box **had burn mark**. It was assum**ed that small** ball**s of** molten **iron from** melt**down** work were **slipped into the** fire **protection** sheet, **which** were **folded and stored in the box. The** heat **from this hot** iron **caused** burn **inside the box**.

What does this event tell?





International Guideline
IAEA SAFETY STANDARDS NS-G-2.1

IAEA
SAFETY
STANDARDS
SERIES

Fire Safety in the
Operation of Nuclear
Power Plants

SAFETY GUIDE

No. NS-G-2.1

INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA

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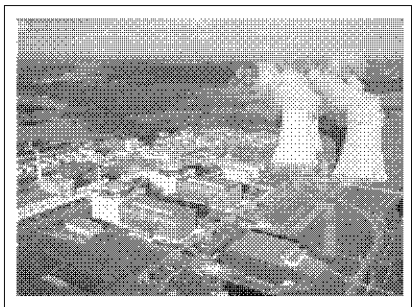
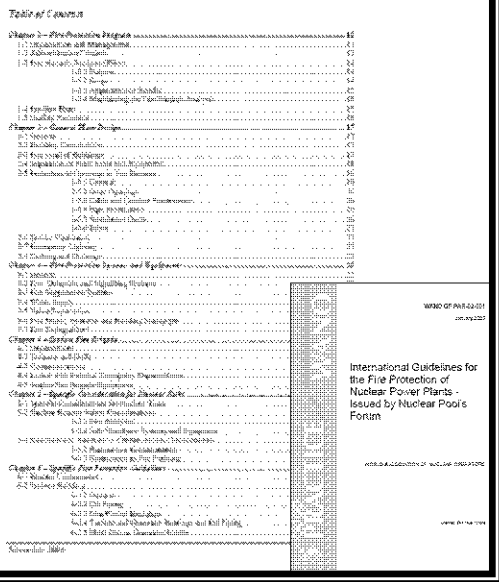
International Guideline
NUCLEAR POOLS' FORUM



INTERNATIONAL GUIDELINES
FOR THE
FIRE PROTECTION OF NUCLEAR POWER PLANTS

ISSUED IN 2006
ON BEHALF OF THE NUCLEAR POOLS' FORUM
4th EDITION



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International Guidelines for the Fire Protection of Nuclear Power Plants - Issued by Nuclear Pool's Forum

NUCLEAR POOLS' FORUM Guideline
Fire Protection Program

Fundamental Goals = Defense-in-Depth

1. to prevent fires from starting,
2. to rapidly detect, control and extinguish those fires that do occur,
3. to provide adequate protection to structures, systems, and components important to *nuclear safety* so that in the event of a fire, *safe shutdown* of the reactor can be achieved,
4. to provide reasonable assurance that the fire event will not result in an unacceptable radiological release and
5. to provide reasonable assurance that the fire event will not cause unacceptable economic consequences.

NUCLEAR POOLS' FORUM Guideline
Administrative Controls

Establish procedures to address the following areas:

1. Walk-through inspections
2. Requirements for storage, use and handling of combustible materials
   - ✓ Maximum allowable inventory of flammable and combustible material based on the Fire Hazards Analysis
   - ✓ Compensatory measures if established limits for combustible materials are temporarily exceeded
3. Control of ignition sources – welding, cutting, grinding
   - ✓ Inspection of hot work area
   - ✓ Combustibles within 10 meters moved away or safely covered
   - ✓ Trained fire watch (with appropriate equipment) has been assigned for both the work period and post work period
4. Fire protection systems remain in stand-by for long periods. Active and Passive systems are inspected, tested and maintained.

NUCLEAR POOLS' FORUM Guideline
Fire Hazards Analysis (*FHA*)

- *FHA* is performed to evaluate the potential fire hazards and appropriate fire protection systems and features used to mitigate the fire hazards.
- *FHA* should cover all relevant areas of the plant to clearly demonstrate there is a sufficient level of protection
- Include the following:
  1. Evaluation of physical *construction* and layout of buildings and equipment (including electrical cables) within *fire compartments*.
  2. Inventory of combustibles, including maximum transient combustibles, within each *fire compartment*.
  3. Description of fire protection equipment, including detection systems and manual and automatic extinguishing systems in each *fire compartment*.
  4. Analysis to assure a single fire event (in any compartment or cell) cannot impair required *safe shutdown functions* or result in the uncontrolled release of radioactive contamination to the environment.
  5. Analysis of irradiated fuel storage areas.

NUCLEAR POOLS' FORUM Guideline

Protection of Openings in Fire Barriers

■ **Door Openings**

1. All doors in *fire barrier* walls should be *approved* fire doors.
2. Each fire door should be identified and marked.
3. Fire doors should always be closed.
   When required to be kept open, hold-open devices should be installed to automatically release the door as required by the *FHA* or the door should be declared inoperable with mitigating action taken as required by plant procedures.

Reference

1. IAEA Safety Guide NS-G-2.1 "Fire Safety in the Operation of Nuclear Power Plants" September 2000
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