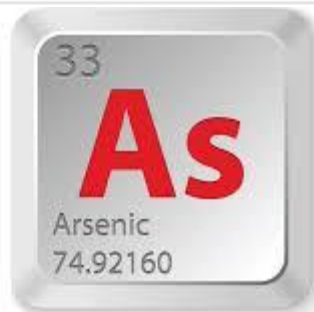
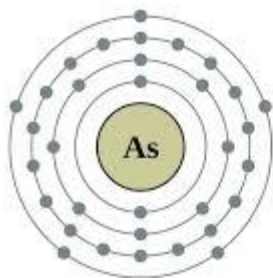


Arsenic, Radiation and Organic Solvents: A History of Environmental Toxins and Health in Taiwan

Yi-Ping LIN (林宜平)

Institute of Science, Technology and Society,
National Yang-Ming University, Taipei, Taiwan



Environmental Toxins and Health in Taiwan

□ Arsenic

- Black-Foot Disease (BFD)

□ Radiation

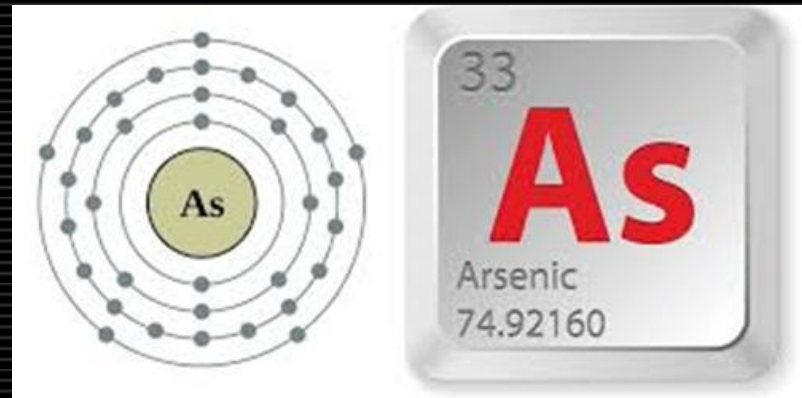
- Radiation-Contaminated Buildings (RCB)

□ Organic Solvents

- Radio Corporation of American (RCA)

Black-Foot Disease (BFD)

Arsenic



Black-Foot Disease (BFD)



- An endemic peripheral vascular disease, first reported in 1920
- Reported as “spontaneous gangrene” in J Formosan Med in 1954
- 高聰明、高上榮〈考察特發性脫症的原因〉,《臺灣醫學會雜誌》, 53: 2 (台北, 1954), 頁 272。

Epidemiological Investigation (1962)



Early BFD Studies

- ❑ Tseng, W.P., Chen, W.Y., Sung, J.L., Chen, J.S. A **clinical study** of blackfoot disease in Taiwan, an endemic peripheral vascular disease. Mem. College Med. Natl. Taiwan Univ., **1961**;7:1-18.
- ❑ Wu HY, Chen KP, Tseng WP, Hsu CL. Epidemiologic studies on blackfoot disease: I. **Prevalence and incidence** of the disease by age, sex, year, occupation and geographical distribution. Mem College Med. Natl. Taiwan Univ., **1961**;7,:33-50.
- ❑ Chen KP, Wu HY, Wu TC. Epidemiologic studies on blackfoot disease in Taiwan. 3. **Physicochemical characteristics of drinking water** in endemic blackfoot disease areas. Mem Coll Med Nat Taiwan Univ. **1962**;8(1-2):115-129.
- ❑ Chen KP, Wu HY. Epidemiologic studies on blackfoot disease: 2. A study of **source of drinking water** in relation to the disease. J Formosan Med Assoc. **1962**;61(7):611-618.

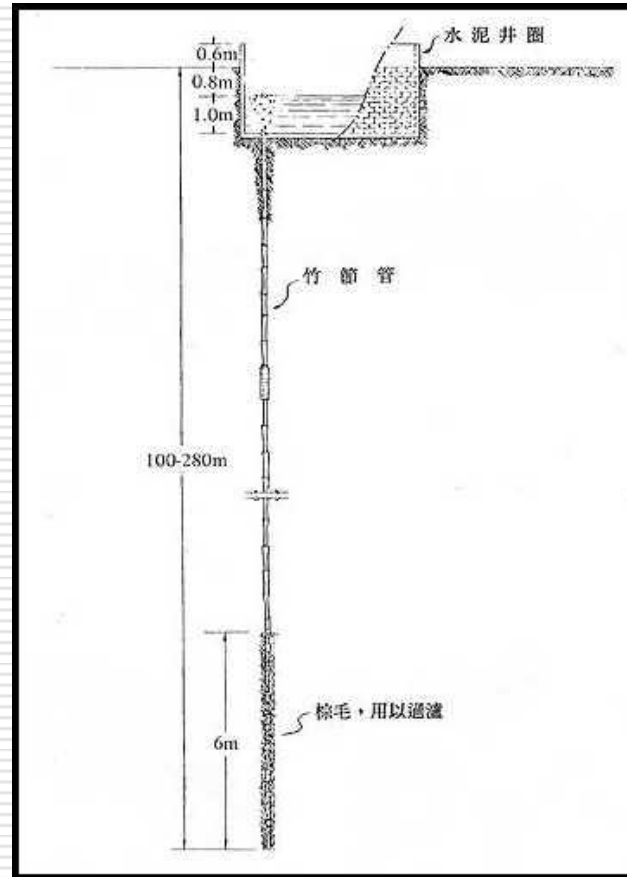
Shallow Well or Deep Well?



淺井水(鼓井)

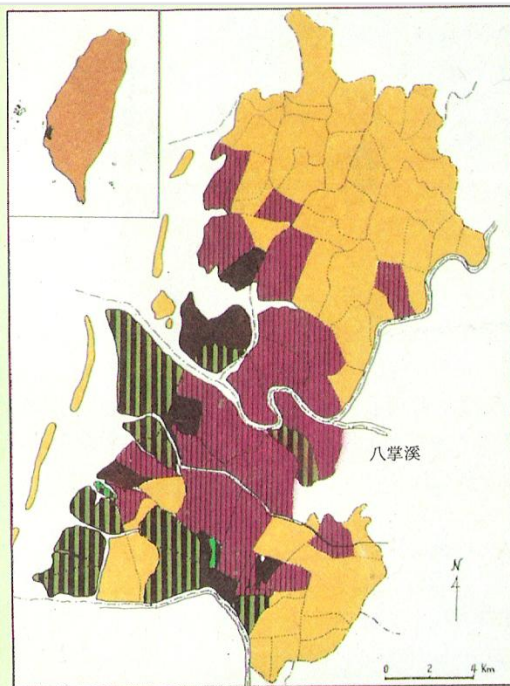


嘉南沿海一帶居民飲用的深水井(地河井)

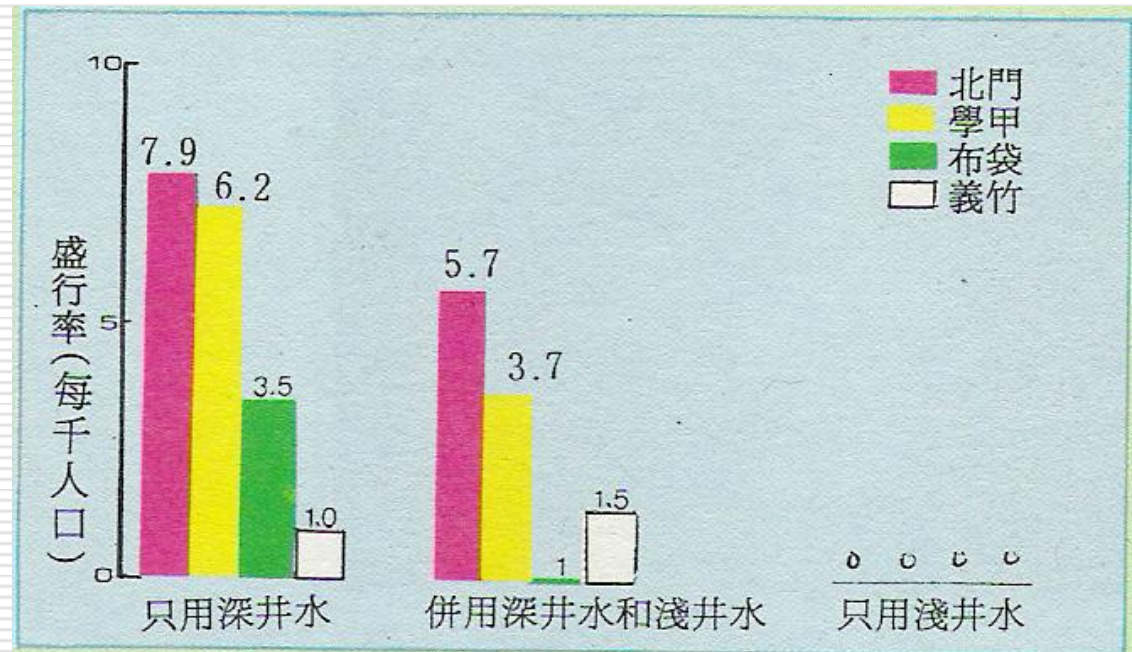


深水井(地河井)
的斷面圖

Source of Drinking Water and BFD Prevalence



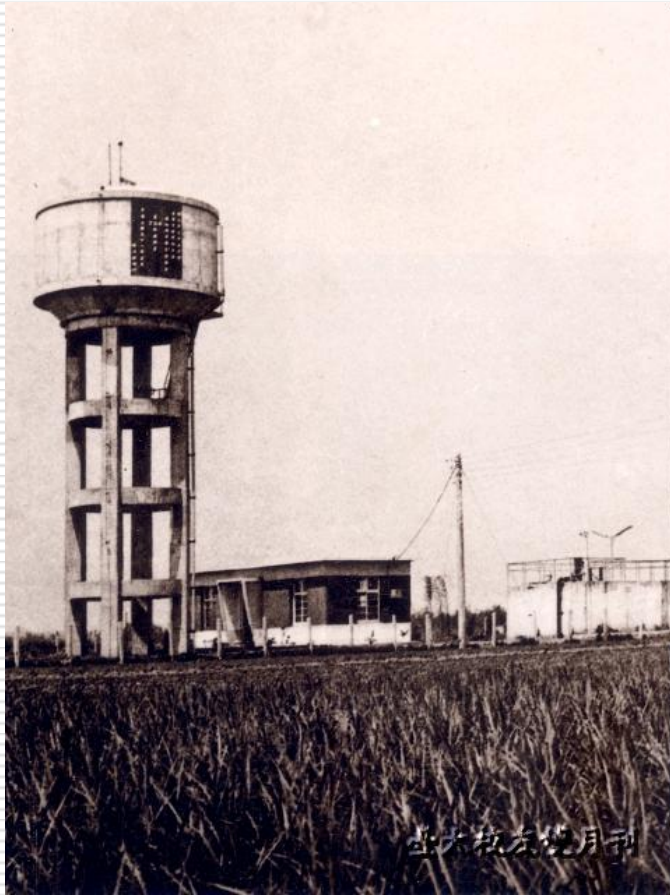
圖十 烏腳病盛行地區各村里之每千人口烏腳病盛行率
(黃色0，紅色0.1-4.9，綠黑條紋5.0-9.9，黑色>10.0)。



圖十一 北門、學甲、布袋、義竹四鄉鎮飲用不同水源之村里的每千人口烏腳病盛行率

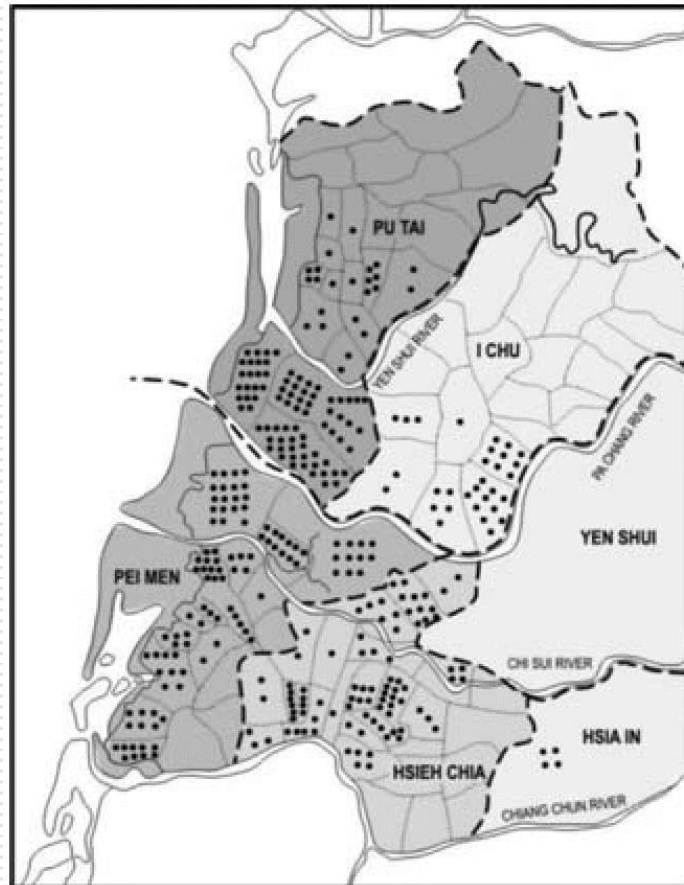
資料來源：陳建仁：環境與健康。高中高職環境教育課外讀物叢書11。教育部環境保護小組編纂，1992。

Improved Drinking Water



- In 1964, Funded by the Joint Commission on Rural Reconstruction (JCRR) and United Nations International Children's Emergency Fund (UNICEF)
- In 1974, Taiwanese government fund

Distribution of BFD Cases in the 1960s by Township (Ch'i and Blackwell, 1968)



BFD & Skin Cancer

圖八
烏腳病
飲用高含砷深井水引起的



圖九
烏腳病患者的手指壞疽



圖十二 飲用高含砷深井水引起的皮膚癌

Tseng WP, Chu HM, How SW, Fong JM, Lin CS, Yeh S. Prevalence of **skin cancer** in an endemic area of chronic arsenicism in Taiwan. J Natl Cancer Inst. 1968;40(3):453-462.

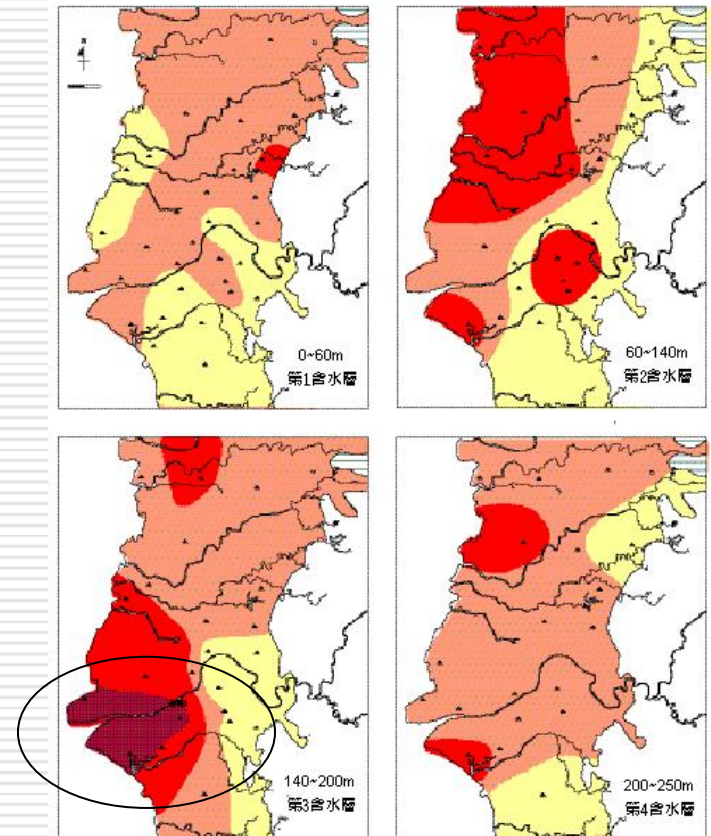
圖片資料來源：陳建仁：環境與健康。高中高職環境教育課外讀物叢書11。教育部環境保護小組編纂，1992。

Chen, CJ (陳建仁)

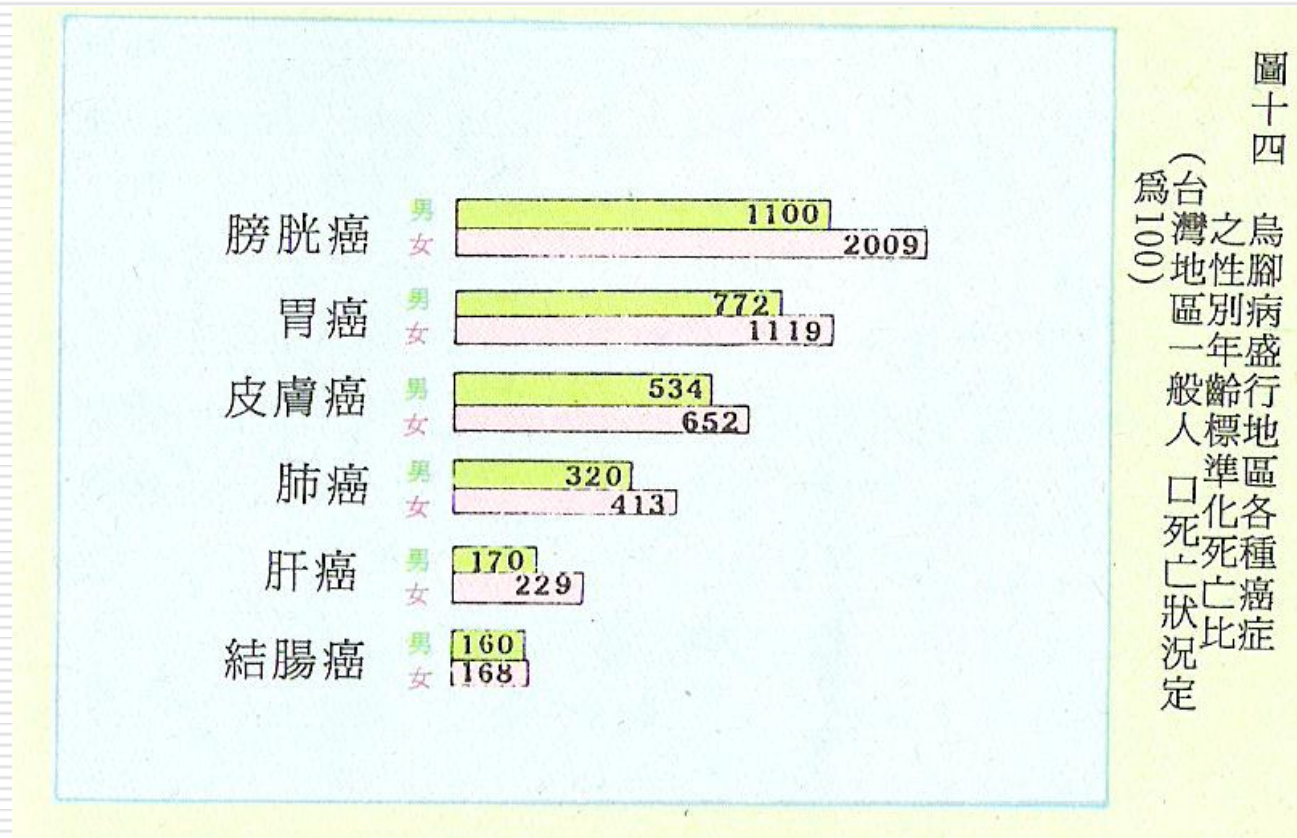
□ Arsenic and Cancer Epidemiology



1999年嘉南平原地下水之砷濃度分層分布

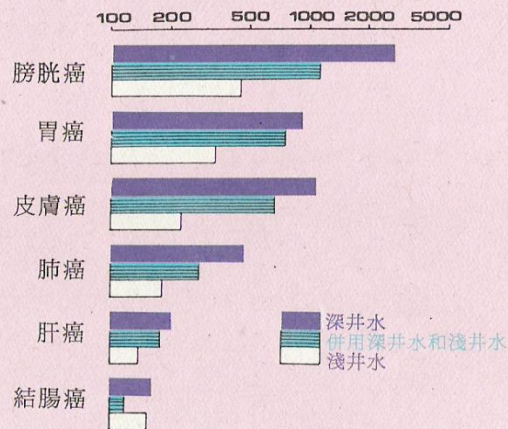


SMRs of Internal Cancers in BFD Endemic Area



資料來源：陳建仁：環境與健康。高中高職環境教育課外讀物叢書11。教育部環境保護小組編纂，1992。

Dose Response: Drinking Water and Cancers



圖十五 烏腳病盛行地區各種癌症之性別年齡標準化死亡率，按飲用水來源分。

表一 烏腳病盛行地區與台灣地區各癌症之年齡標準化死亡率，按性別及飲水含砷量(ppm)分

癌 症	性 別	烏腳病盛行地區飲水含砷量			台灣地區 一般人口
		≥ 0.60	0.30-0.59	< 0.30	
肝 癌	男	68.8	42.7	32.6	28.0
	女	31.8	18.8	14.2	8.9
肺 癌	男	87.9	64.7	35.1	19.4
	女	83.8	40.9	26.5	9.5
皮膚癌	男	28.0	10.7	1.6	0.8
	女	15.1	10.0	1.6	0.8
前列腺癌	男	8.4	5.8	0.5	1.5
膀胱癌	男	89.1	37.8	15.7	3.1
	女	91.5	35.1	16.7	1.4
腎 癌	男	21.6	13.1	5.4	1.1
	女	33.3	12.5	3.6	0.9
全癌症	男	434.7	258.9	154.0	128.1
	女	369.4	182.6	113.3	85.5

ARSENIC AND ARSENIC COMPOUNDS

IARC (1987),
Group 1 Carcinogen



Regulate Arsenic in Drinking Water

□ WHO & USEPA

EPA United States Environmental Protection Agency

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Water: Arsenic

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Arsenic in Drinking Water

[Arsenic iHome](#) | [Basic Information](#) | [Arsenic Rule](#) | [Compliance Help](#) | [State Guidance](#) | [Training](#) | [Funding](#)

[Publications](#)

Arsenic is a semi-metal element in the periodic table. It is odorless and tasteless. It enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practices.

Non-cancer effects can include thickening and discoloration of the skin, stomach pain, nausea, vomiting, diarrhea, numbness in hands and feet; partial paralysis; and blindness. Arsenic has been linked to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate.

EPA has set the arsenic standard for drinking water at .010 parts per million (10 parts per billion) to protect consumers served by public water systems from the effects of long-term, chronic exposure to arsenic. Water systems must comply with this standard by January 23, 2006, providing additional protection to an estimated 13 million Americans.

This web site is designed to provide you with information about arsenic in drinking water and provide guidance materials to help the states and water systems comply with the standard.

Arsenic Rule at a Glance

Maximum Contaminant Level
in parts per million (ppm)
MCL = 0.010 ppm

Maximum Contaminant Level Goal
MCLG = 0 ppm

Health Effects
Skin damage or problems with circulatory systems, and may have increased risk of getting cancer

Sources of contamination
Erosion of natural deposits; runoff from orchards, runoff from glass & electronic production wastes

For other contaminants and their MCLs, [visit this page](#).

World Health Organization

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International Programme on Chemical Safety

Arsenic

Soluble inorganic arsenic is acutely toxic. Intake of inorganic arsenic over a long period can lead to chronic arsenic poisoning (arsenicosis). Effects, which can take years to develop depending on the exposure level, include skin lesions, peripheral neuropathy, diabetes, cardiovascular diseases, and cancer.



Organic arsenic compounds, which are abundant in seafood, are less harmful to health, and are rapidly eliminated by the body. Human exposure to elevated levels of inorganic arsenic occurs mainly through the consumption of groundwater containing naturally high levels of inorganic arsenic, food prepared with this water, and food crops irrigated with high arsenic water sources. In one estimate, arsenic-contaminated drinking-water in Bangladesh alone was attributed 9,100 deaths and 125,000 Disability Adjusted Life Years (DALYs) in 2001.

Reduction in human exposure to arsenic can be achieved by screening of drinking-water supplies, clearly identifying those delivering water above the WHO guideline 10 micrograms arsenic per litre or national permissible limits, together with awareness-raising campaigns. Mitigation options include use of alternative groundwater sources, use of microbiologically safe surface water (e.g. rainwater harvesting), use of arsenic removal technologies, or dilution of high content arsenic source water with lower arsenic content source water that is microbially safe.

Radiation-Contaminated Buildings (RCB)

Radiation



New X-Ray Machine in a Dental Clinic in Taipei (1985)

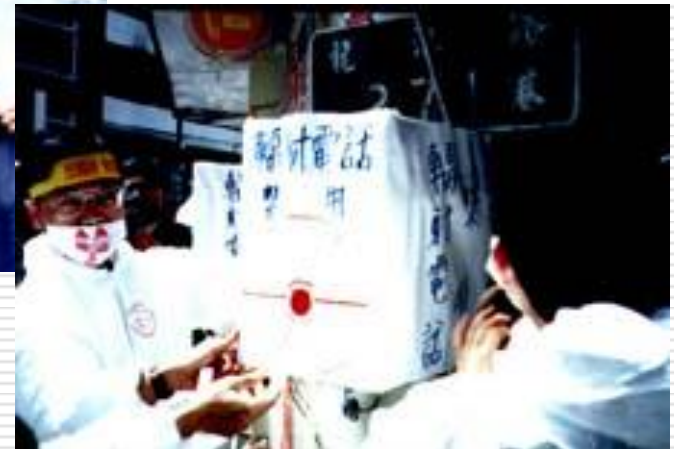


Radiation-Contaminated Buildings (RCB)

□ Reported in 1992



RCB Environmental Movement (1992)



RCB Exposure Assessment and Epidemiological Study



Granted by DOH in 1993



Chang WP (張武修)

Chronic Low-dose Radiation Exposure

- Chang WP, Kau J. Taiwan: exposure to high doses of radiation. *Lancet*. 1993;**341**: 750.
- Chang WP, Hwang BF, Wang D, Wang JD. Cytogenetic effect of chronic low-dose, low-dose-rate gamma-radiation in residents of irradiated buildings. *Lancet*. 1997;**350**(9074):330-3.

Cytogenetic effect

- ☐ Background radioactivity: 0.5-132mSV
- ☐ Subject
 - Exposed group (n=73)
 - ☐ Lived in MSV at least 1 year before study
 - ☐ Aged 2-46 years; had lived in building for 13-122 months
 - Control group (n=77)
 - ☐ Close relatives (39)
 - ☐ Residents from a non-contaminated building next door (38)
- ☐ Cumulative dose
 - Dose reconstruction program
- ☐ Micronucleus assay

RCB National Compensation

- ❑ RCB residents won the first trial in 1997, and the second trial in 2002
- ❑ AEC apologized and paid for the compensation in 2002



Epidemiologic Causation Theory

□ 疫學因果關係理論

➤ Minamata Disease Lawsuit in Japan



When Radiation Isn't the Real Risk?



The New York Times | <http://nyti.ms/1QUtXL5>

SCIENCE

When Radiation Isn't the Real Risk

SEPT. 21, 2015

George Johnson
RAW DATA

This spring, four years after the nuclear accident at Fukushima, a small group of scientists met in Tokyo to evaluate the deadly aftermath.

No one has been killed or sickened by the radiation — a point confirmed last month by the International Atomic Energy Agency. Even among Fukushima workers, the number of additional cancer cases in coming years is expected to be so low as to be undetectable, a blip impossible to discern against the statistical background noise.

One experiment, however, occurred inadvertently three decades ago in Taiwan after about 200 buildings housing 10,000 people were constructed from steel contaminated with radioactive cobalt. Over the years, residents were exposed to an average dose of about 10.5 millisieverts a year, more than double the estimated average for Fukushima.

Yet a study in 2006 found fewer cancer cases compared with the general public: 95, when 115 were expected.

Neither the abstract of the paper nor of a second one published two years later mention the overall decrease. (The authors speculated that the apartment dwellers may have been healthier than the population at large.) The focus instead was on weaker results suggesting a few excess leukemia and breast cancer cases — and on a parsing of the data showing an overall increased cancer risk for residents exposed before age 30.

"New Approach Needed in Radiation Protection"

Dose-Response, 5:63–75, 2007
Formerly *Nonlinearity in Biology, Toxicology, and Medicine*
Copyright © 2007 University of Massachusetts
ISSN: 1539-3028
DOI: 10.2203/dose-response.06-105.Chen

International Hormesis Society
www.internationalhormesis.org

EFFECTS OF COBALT-60 EXPOSURE ON HEALTH OF TAIWAN RESIDENTS SUGGEST NEW APPROACH NEEDED IN RADIATION PROTECTION

W.L. Chen □ National Yang-Ming University, 155 Li-Nong Street, Sec. 2, Pei-tou, 112 Taipei, Taiwan

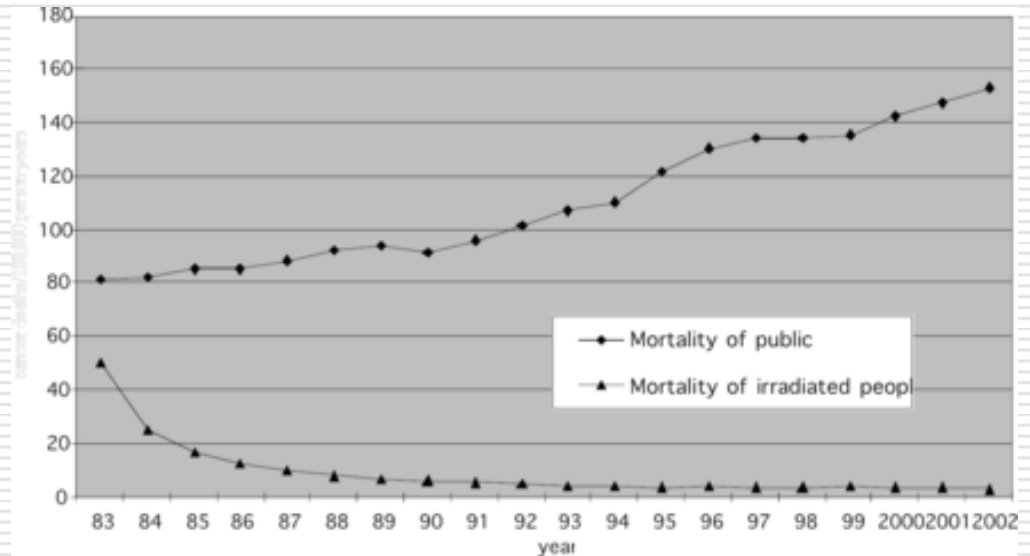
Y.C. Luan, M.C. Shieh, S.T. Chen, H.T. Kung, K.L. Soong, Y.C. Yeh □ Nuclear Science & Technology Association, 8F, No. 182, Sec. 2, Beisin Road, Sindian City, Taiwan

T.S. Chou, S.H. Mong, J.T. Wu, C.P. Sun □ Nuclear, Biological and Chemical Protection Society, 11F-5, 110 Cheng-Tu Road, Taipei, Taiwan

W.P. Deng □ Institute of Biological Materials, Taipei Medical University, 250 Wu-Hsing Street, Taipei, Taiwan

M.F. Wu, M.L. Shen □ National Taiwan University, Taipei, Taiwan 10764

□ The conventional approach for radiation protection is based on the ICRP's linear, no threshold (LNT) model of radiation carcinogenesis, which implies that ionizing radiation is always harmful, no matter how small the dose. But a different approach can be derived from the observed health effects of the serendipitous contamination of 1700 apartments in Taiwan with cobalt-60 ($T_{1/2} = 5.3$ y). This experience indicates that chronic exposure of the whole body to low-dose-rate radiation, even accumulated to a high annual dose, may be beneficial to human health. Approximately 10,000 people occupied these buildings and received an average radiation dose of 0.4 Sv, unknowingly, during a 9-20 year period. They did not suffer a higher incidence of cancer mortality, as the LNT theory would predict. On the contrary, the incidence of cancer deaths in this population was greatly reduced—to about 3 per cent of the incidence of spontaneous cancer death in the general Taiwan public. In addition, the incidence of congenital malformations was also reduced—to about 7 per cent of the incidence in the general public. These observations appear to be compatible with the radiation hormesis model. Information about this Taiwan experience should be communicated to the public worldwide to help allay its fear of radiation and create a positive impression about important radiation applications. Expenditures of many billions of dollars in nuclear reactor operation could be saved and expansion of nuclear electricity generation could be facilitated. In addition, this knowledge would encourage further investigation and implementation of very important applications of total-body, low-dose irradiation to treat and cure many illnesses, including cancer. The findings of this study are such a departure from expectations, based on ICRP criteria, that we believe that they ought to be carefully reviewed by other, independent organizations and that population data not available to the authors be provided, so that a fully qualified epidemiologically-valid analysis can be made. Many of the confounding factors that limit other studies used to date, such as the A-bomb survivors, the Mayak workers and the Chernobyl evacuees, are not present in this population exposure. It should be one of the most important events on which to base radiation protection standards.



*The medical evidence from this exposure clearly suggests that **current radiation protection policies and standards are inappropriate**. We therefore recommend that the radiation protection authorities change them to accurately reflect **the actual benefits and hazards of exposures to radiation**.*

Radio Corporation of American (RCA)

Organic Solvents



We Won! (2015/4/17)



Former Workers vs. RCA, GE & Technicolor (Thomson)



RCAT (Taiwan), 1967-92

RCA

1967-86



1986-88

THOMSON

1988-92

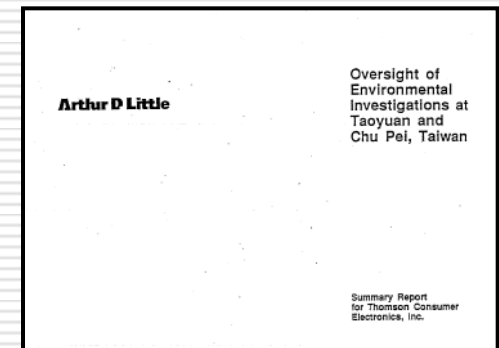
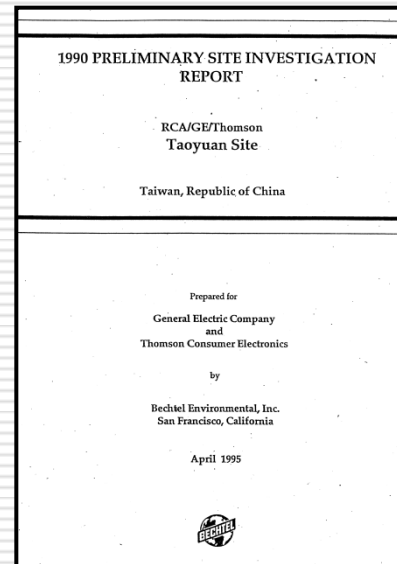
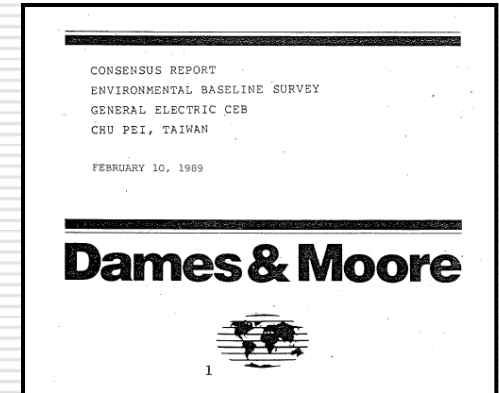
2010

technicolor



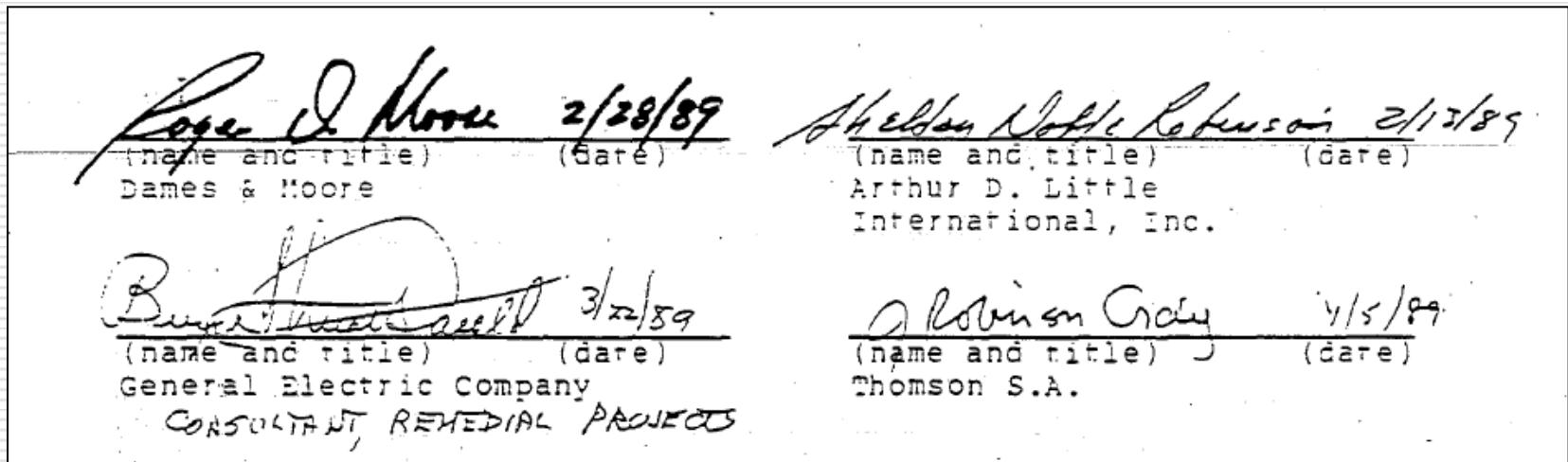
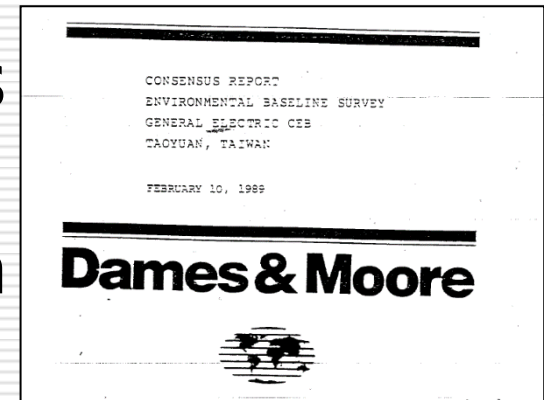
GE/Thomson (1989-90)

- Dames & Moore (D&M)
 - General Electric Company
- Arthur D Little (ADL)
 - Thomson, SA
- Bechtel
 - Arthur D Little

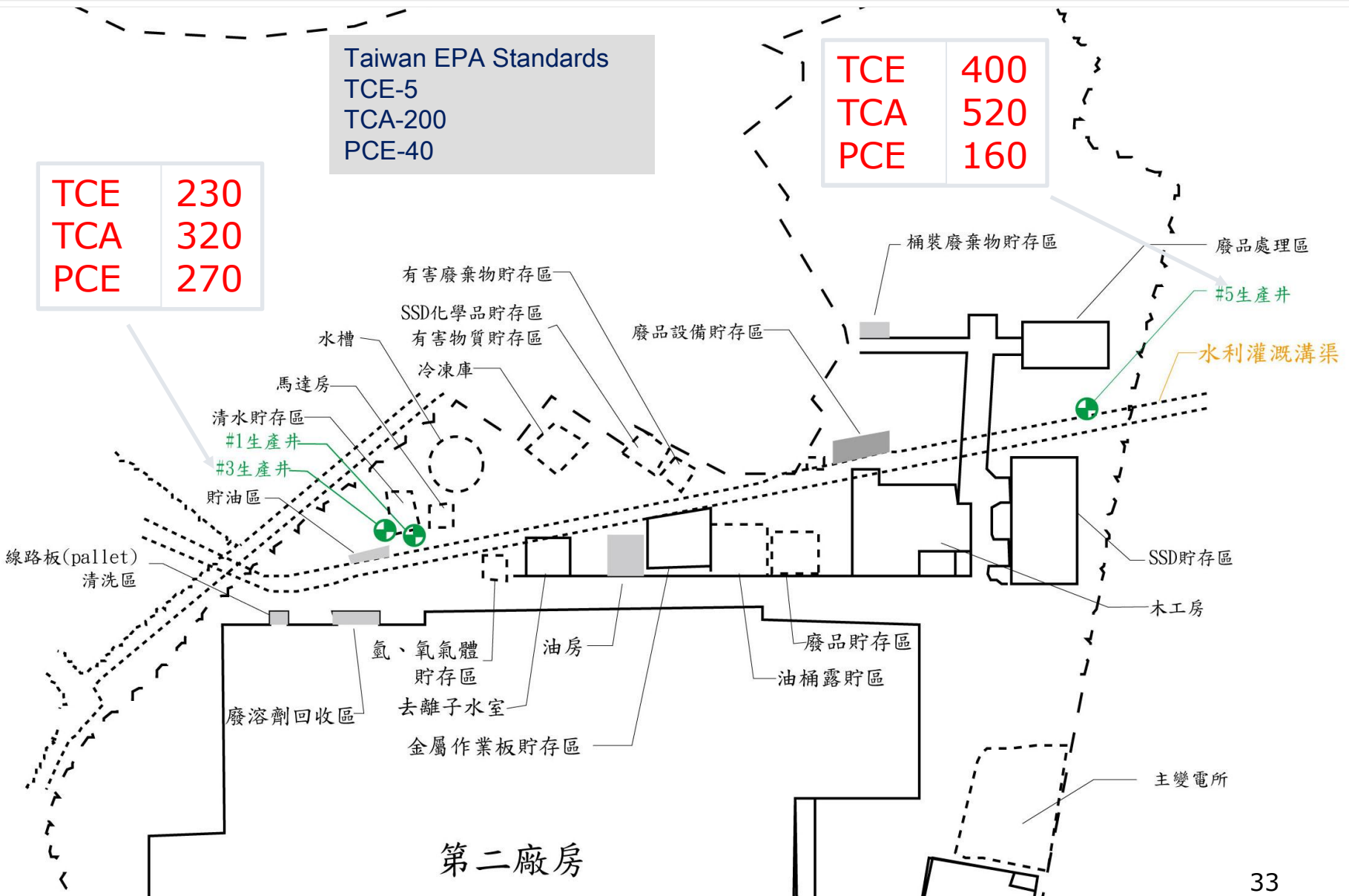


GE & Thomson Consensus Report (1989/2)

- Hidden from the Workers
 - Rediscovered in the Taiwan EPA Storage Room in 2013



RCAT Production Wells (Bechtel, 1990. unit: ppb)



RCAT Monitoring Wells (Bechtel, 1990. unit: ppb)

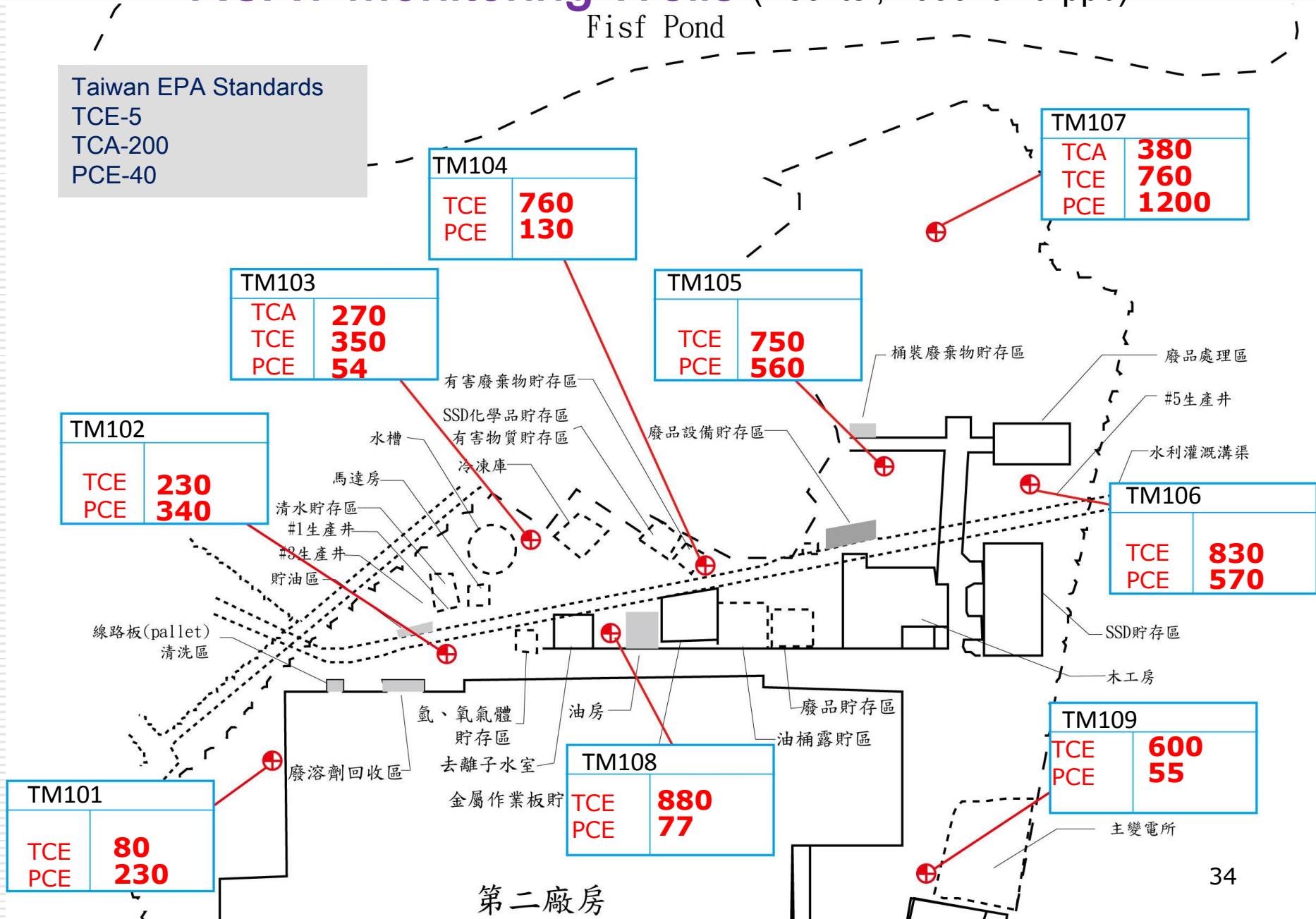
Fisf Pond

Taiwan EPA Standards

TCE-5

TCA-200

PCE-40



Hidden Evidence (Taiwan EPA, 1996)

- ❑ Deserted Well #1, Cement-Filled Well #3, and Missing Well #5
- ❑ Asphalt-covered Monitoring Wells



Production Well #3.



TECHNICAL MEMORANDUM 008
RCA/GE/THOMSON TAOYUAN SITE

A-6

5/3/96

Cement-Filled Well #3

Asphalt-covered Monitoring Wells
TM-101 & TM-201

Toxic Water Pollution (1994-06-03)

害公造製料廢毒有倒傾井挖 RCA 商美 委立揭

區業商區宅住為做擬日地更變正地土批該且 染污重嚴遭均水下地及壤土廠兩北竹、園桃指康少趙

【記者呂理達台北報導】立委趙少康二日舉行記者會，揭發美國無線電公司(RCA)在竹北、桃園兩廠，均遭地下水及土壤嚴重污染，且該地土地變更擬作為住宅區，要求環保署立即採取行動，並要求環保署立即採取行動，並要求環保署立即採取行動。

趙少康表示，美國無線電公司於五十九年在台灣桃園、竹北兩地設立工廠，生產電子、電器用品，民國七十五年桃園及竹北二個工廠與奇異公司G.E.合併，民國七十七年又被法國施耐德公司併購。他指出，目前桃園廠佔地二萬九千坪，因處於鐵路旁，不久將以每坪八萬元價格賣給立基集團及建仁建設，目前正由該兩家集團進行土地開發，增建更為商業區及住宅區。竹北廠土地約一萬坪，目前已經賣給中國電器(即聯益保社公司)。

趙少康強調，在過去二十年中，RCA公司一直將有毒的有機溶劑VOC，倒入廠區所挖的地下水井中，污染嚴重，污染土壤及地下水。由於該兩廠公司規定只買工廠，不買污染，也就是污染必須由奇異公司清理。

他說，湯姆生公司在併購工廠之後，即委託美國環境公司進行調查，結果發現污染問題相當嚴重，湯姆生公司乃計劃對此一事，但由於當地居民一直飲用地下水，湯姆生公司擔心居民抗爭及賠償金額可能過高，最後就決定不公開，且不敢放實情於世。

趙少康表示，奇異、湯姆生及美國無線電公司都是世界著名的公司，居然如此污染我國土地，在大陸污染嚴重，其心可謂。因此政府必須向美國及法國政府表達嚴厲的抗議，同時向國際法庭及聯合國環境組織投訴該公司。

環署成立專案小組調查真相

【記者呂理達台北報導】針對立委趙少康檢舉美國無線電公司污染案，環保署二日表示，本案事關重大，廠商故意隱瞞污染事實，心懷可謂，環保署將成立專案小組進行調查，並要求廠商立即公開，且不敢放實情於世。

對於該廠知名公司在台灣製造污染一事，張隆盛說，如果查明確實之後，環保署不排除依立憲趙少康建議，向國際法庭及聯合國環境規劃署投訴該公司行徑。

張隆盛同時建議都市計畫主管機關內政部，在整個可調查未告一段落之前，暫時停止有關土地變更事宜。

張隆盛是在環保署二日所召開臨時記者會上作上述表示。他同時強調，由於本案可能不是單純的污染問題，而涉及土地變更，今後國內工業區廠商申請變更土地時，都市計畫主管機關應由土地所有權人提出土地報告，確定未有污染後，始得進行變更。

他同時表示，由於現行法令並沒有追償既往的規定，對於土壤污染者可溯及既往規定，因此希望立法院儘速通過該項法案，俾資適用。

趙少康於立委趙少康二日就向外界透露將在二日舉行記者會，揭發此案，因此環保署在二日上午據悉此一消息，立即派員前往RCA桃園廠，實地了解問題。

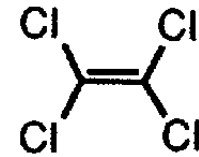
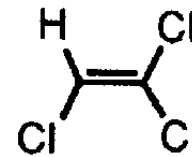
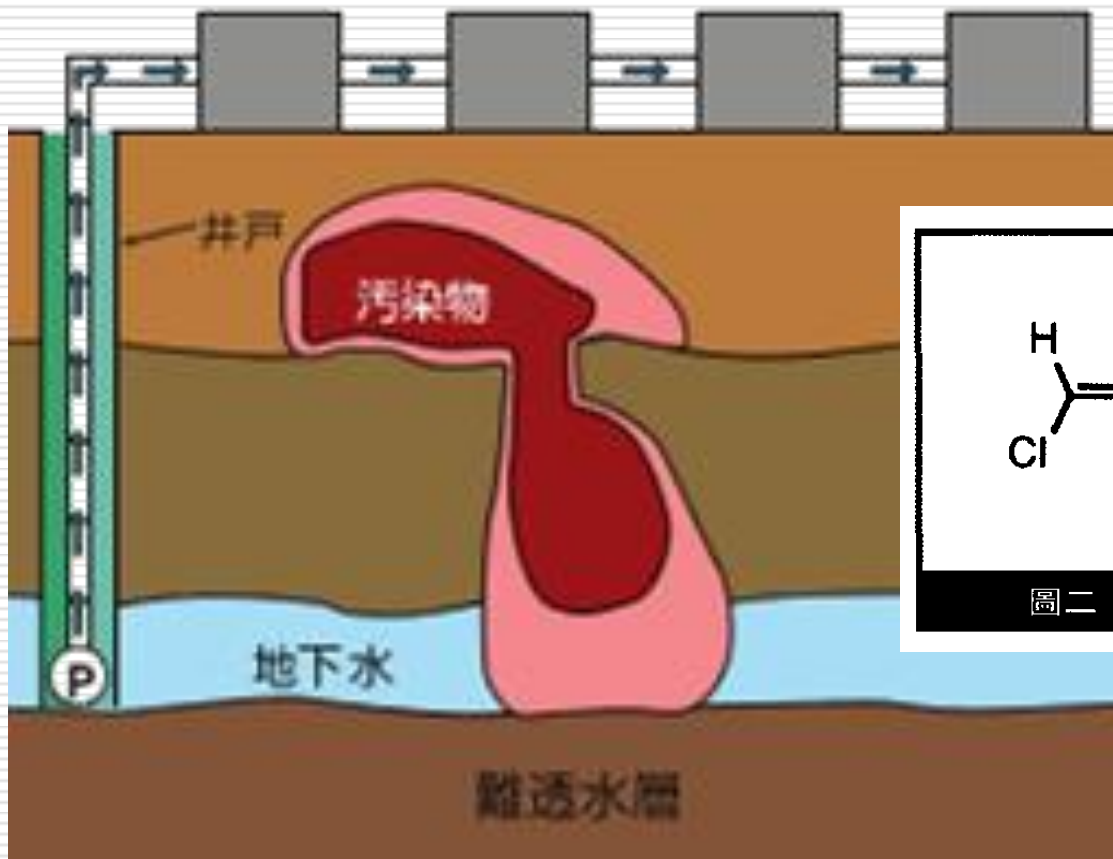


被立委趙少康指名為長期污染傾倒廢水井的桃園無線電廠目前大門深鎖(右)，廠區長滿雜草，附近則為一個新興的社區。(左)

(圖 環保署提供)

Environmental Clean-up of Trichloroethylene and Tetrachloroethylene

Paid by GE & Thomson



圖二：三氯乙烯（左）及四氯乙烯

Health Risk Assessment

- Otto Wong, 1995
 - “The health effects of TCE and PCE contaminated ground water to the local residents and former workers were **neglectible**”

說 明 稿

桃園與竹北地區附近地下水所含化學物質對人體健康影響研究

經環境及公共衛生科學家們對桃園及竹北二地前電視裝配場址附近，進行地下水所含化學物質調查與完成之環境暴露評估報告(該報告已於日前提報行政院環境保護署)中指出，此地下水所含化學物質危害附近居民及員工健康的可能性微乎其微。

科學家們做成上述的結論，是經過比較場址附近地下水井所含化學物質之濃度與為數眾多的科學文獻所報導有危害人體健康之化學物質濃度。這些科學家們是由從事本項研究工作多年經驗且國際知名之毒物學及流行病理學專家所組成。

在本研究中所引用的地下水井化學物質分析數據是來自民國 83 年所完成的採樣分析的工作，該採樣結果亦在民國 84 年 1 月間分發給當地居民了解。

為了確保嚴謹地評估安全的考量，科學家們採用非常保守的假設進行評估。

例如：

- 雖然在不同水井中發現不同濃度的化學物質，但為安全起見，科學家們於暴露量計算時假設每一口水井中含有化學物質濃度為本調查區域內所測得最大濃度。

- 在不同水井中發現不同類別的化學物質，同樣的為安全起見，科學家們於暴露量計算時假設每一口水井含有的化學物質種類包含本調查區域內所有測得內之化學物質種類。

以上述保守的假設經計算後將導致大約 10 倍或更大倍數於每一口水井真正化學物質的暴露量。然而以如此保守的推估，本研究發現這些地下水井中所含化學物質仍遠低於可能造成人體危害健康影響的濃度。

本人體健康影響研究乃應中華民國環境保護署要求而完成，為湯姆生與奇異公司調查及解決有關桃園及竹北兩地前電子裝配廠的環境議題持續工作的一部份。

湯姆生與奇異公司正免費為桃園及竹北二場址附近居民安裝自來水管，預計自來水接管工作將於民國八十四年七月完成。在此同時，該公司將持續供應包裝水給尚未完成接管住戶居民。

1998-02-24

Clean-up FAILED

地下水污染 無藥可救 RCA場址 環署宣判死刑

成為國內首處永久污染區 二萬九千坪土地將無法開發為住宅區 地主已打國際官司討公道

【記者呂俊合北報專訊】根據美國奇異公司及法國南錫公司六個月污染調查報告指出，RCA場址地下水的污染程度，已無法改善，RCA場址將因此宣佈為永久污染區，成為國內首例。據了解，RCA場址污染如果無法改善，由宏德及長昌公司提出的二萬九千坪的土地，將變更為住宅區，將無法進行。地主宏德及長昌將成為直接受害者，當時購買該土地的金額超過十億元，也可謂面臨無法挽回的損失。

（Technical Intractability）技術上給個案的處理作業會議。C.A.公司提議以抽取受污染地下水的方式進行污染改善，整個工作已進行了半年之久，經過實際檢驗，証明受污染地下水並無改善。

交大環工所教授陳弘德及台大地質系教授曾國平表示，從監測資料來看，地下水污染整治工作並無效果。根據民國八十二年環保調查RCA的地下水污染數據，三氯乙烷濃度為九百ppb，與飲用水容許的標準五ppb相比較，高出數百倍，但經過半年整治後，有的樣品竟然比原先污染濃度還高，顯示整治工作幾乎完全無效。

中央大學地質系教授陳家洵說，三氯乙烷及四氯乙烯等有機污染物質，科學上稱之為DNAPL，密度比水大，所以會沉積在底部，根本無法失效。目前的抽提方式解決污染的做法，美國無聲公司（RCA）於九十九年在台灣桃園設廠，生產電子、電腦用品，民國七十七年又成立桃園奇異公司，生產佔地二萬九千坪，因生產廢料，由宏德及長昌公司合併，八萬五萬餘，都市計劃通盤檢討時，準備遷至商業區及住宅區。

但污染事件在民國八十三年曝光後，土地變更案就被擱置。據了解，過去二十年中，RCA公司一直將有毒的有機廢料VOC與A類廢物堆積在地下水中，長期嚴重污染土壤及地下水。

【記者呂俊合北報專訊】目前為桃園RCA土地地主的宏德及長昌公司，因無法改善污染，他們是無辜的受害者，美國奇異及法國南錫公司應負污染責任，讓他們買到污染土地，目前他們已接受地主委託，委託律師何宗賢說，該處土地有污染，只有待商榷，並非全無。但環保署昨日開有開會，討論地主有特權，應通知他們與會，但環保署卻忽略了他們的權利。做法他強調，長昌、宏德在工廠廢料的經費，卻買到了污染土地，所以他們已向國際法律訴訟，討回公道。

1998-07-06

會救自立成者害受RCA

檢健助協府政籲 償追開展司公向決

【本報記者陳曉雲台北報導】近二百名疑似RCA污染受害者，昨日向RCA公司提出訴訟，要求該公司對其污染行為負責，並對受害者進行賠償。RCA公司則表示，將全力配合政府調查，並對受害者提供必要的醫療援助。



Cancer cases reported

百破例案救求癌致 件事RCA

87.6.28 人六卅達者亡死 工員職離是數多 人三〇一有己者害受似疑

【本報記者陳曉雲台北報導】RCA公司污染事件，昨日已進入第十個年头。據悉，已有超過一百名受害者向法院提起訴訟，要求RCA公司對其污染行為負責。RCA公司則表示，將全力配合政府調查，並對受害者提供必要的醫療援助。

污染受害者
罹癌致死已達五十三例
要求RCA公司賠償

【本報記者陳曉雲台北報導】RCA公司污染事件，昨日已進入第十個年头。據悉，已有超過一百名受害者向法院提起訴訟，要求RCA公司對其污染行為負責。RCA公司則表示，將全力配合政府調查，並對受害者提供必要的醫療援助。

Former RCA Employees' Mutual Aid Association (MAA)

- Taiwan Association of Victims of Occupational Injuries (TAVOI)

**Taiwan workers plead cancer case
Link RCA plant to disease**

Friday, May 24, 2002

San Francisco Chronicle
CHRONICLE SECTIONS

Matthew Yi, Chronicle Staff Writer



[Printer-friendly version](#)

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MORE BIZ | TECH

Deserted RCA Site (1998)



RCA Environmental Health Studies

- ❑ Wang FI, Kuo ML, Shun CT, et al. Chronic toxicity of a mixture of chlorinated alkanes and alkenes in ICR mice. J Toxicol Environ Health A 2002;65:279-91.
- ❑ Lee LJ, Chan CC, Chung CW, et al. Health risk assessment on residents exposed to chlorinated hydrocarbons contaminated in groundwater of a hazardous waste site. J Toxicol Environ Health A 2002;65:219-35.
- ❑ Lee LJ, Chung CW, Ma YC, et al. Increased mortality odds ratio of male liver cancer in a community contaminated by chlorinated hydrocarbons in groundwater. Occup Environ Med 2003;60:36.



RCA Occupational Health Studies

- ❑ Chang YM, Tai CF, Lin RS, et al. A **proportionate cancer morbidity ratio** study of workers exposed to chlorinated organic solvents in Taiwan. Ind Health 2003;41:77-87.
- ❑ Chang YM, Tai CF, Yang SC, et al. A cohort **mortality** study of workers exposed to chlorinated organic solvents in Taiwan. Ann Epidemiol 2003;13:652-60.
- ❑ Chang YM, Tai CF, Yang SC, et al. **Cancer incidence** among workers potentially exposed to chlorinated solvents in an electronics factory. J Occup Health. 2005;47:171-80.



Further Occupational Epidemiological Studies

- ❑ Sung TI, Chen PC, Lee LJH, Lin YP, Hsieh GY, Wang JD. Increased standardized incidence ratio of **breast cancer in female electronics workers**. *BMC Public Health* 2007;7:102.
- ❑ Sung TI, Wang JD, Chen PC. Increased risk of cancer in the offspring of **female electronics workers**. *Reprod Toxicol* 2008;25(1):115-9.
- ❑ Sung TI, Wang JD, Chen PC. Increased risks of infant mortality and of deaths due to congenital malformation in the offspring of **male electronics workers**. *Birth Defects Res A Clin Mol Teratol* 2008.



RCA Class Action Lawsuit (2004-)

- Compensation for Mental Distress
- ❑ Former RCA Employees' Mutual Aid Association
 - 529 members
 - ❑ Group A: Family member of the death (47)
 - ❑ Group B: Cancers and other disease (249)
 - ❑ Group C: Currently healthy (141)
- ❑ 8 Witness and 6 Experts appeared at court
 - Environmental engineers, epidemiologists, toxicologist, industrial hygienists, occupational physicians
- ❑ 4 Groups of Judges
 - 58 court hearings



First Witness at Court (2009/11/11)



RCA Consultants

Plaintiff, Activists, Lawyers, Scholars



RCA Student Volunteers

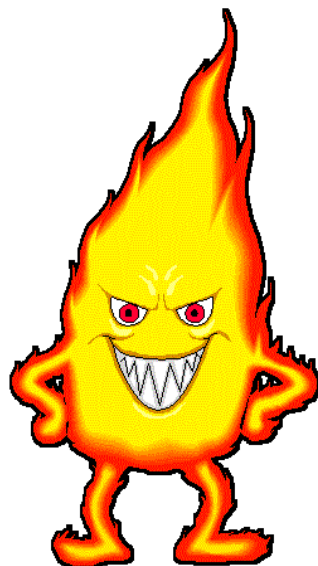


**RCA工殤案
志工培訓營**

- 時間：2011年4月23日(六)-4月24日(日)
- 地點：台大社科院（徐州路21號）第16講堂
- 主辦：RCA員工關懷協會（自救會）
工作傷害受害人協會法律扶助基金會
教育部連結科技與風險社會的公共衛生目標計畫辦公室
世新大學社會發展研究所、陽明大學科技與社會研究所



Burnt RCA Company Files (1970-92)



Flooded Government Files (-1985)

❑ Labor Insurance, Mortality, Morbidity

台灣RCA電子廠營運：1967-1992

1965 1970 1975 1980 1985 1990 1995 2000 2005 2010

勞保紙本：1950-1977

勞保電腦：1978-

死因電腦：1985-

癌症登記：1979-

勞保就醫：
1985-1994

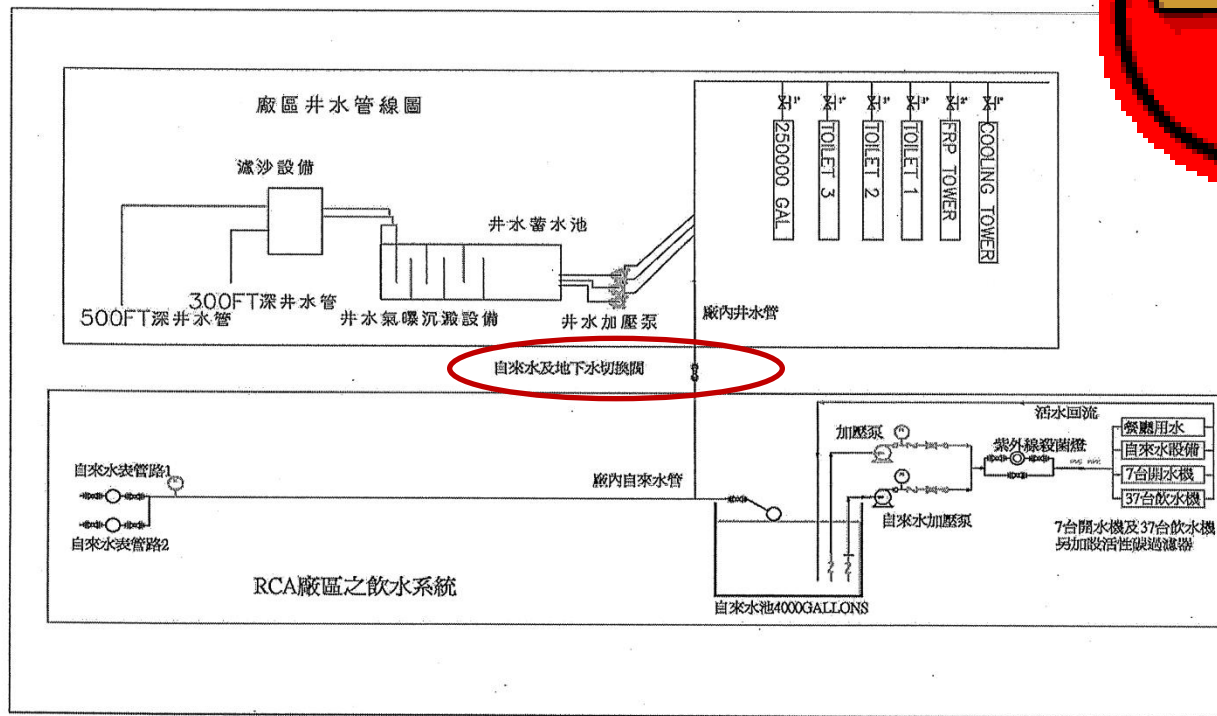
健保就醫：1995-

出生登記：1978-

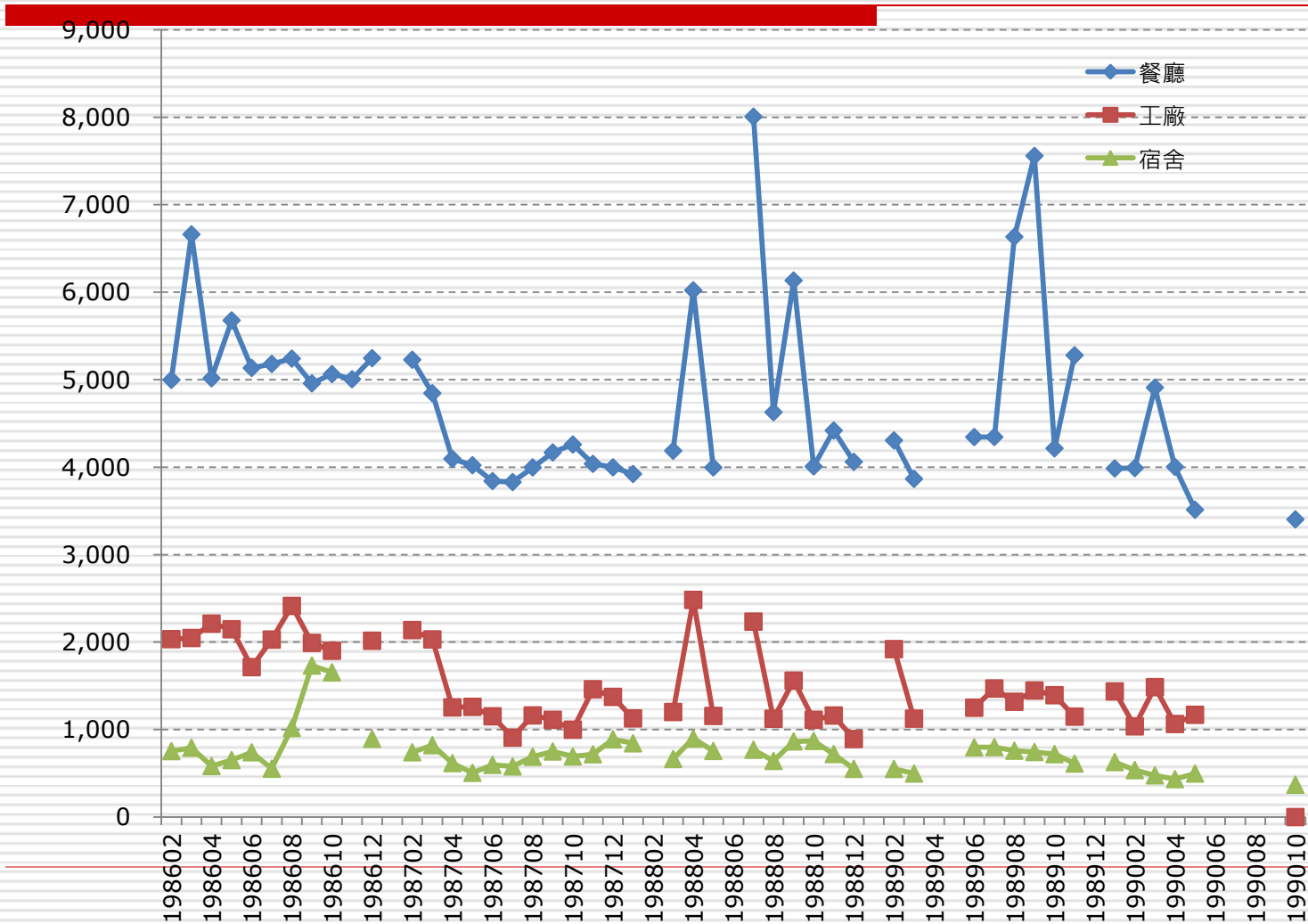


Well Water or Tap Water?

自來水井水切換圖說



RCA Water Bills (1986-90)



Records of Ventilation Violations at RCAT (1970-92)

臺灣省政府 北區勞工檢查所勞工檢查(有機溶劑)結果通知書

事業單位名稱: 台灣美國無線電股份有限公司

事業單位地址: 桃園縣桃園市龍岡路新街(電話) (03) 367-181

代表: 柏恩斯

檢査員: 沈育南

檢査日期: 80年5月31日

勞工人數: 男100人 女15人 合計115人

項次	違反條款	違反規定事實	文則違反日期
1	有機溶劑中毒預防規則第5條	僱用勞工從事有機溶劑作業, 未於該作業場所設置局部設備、局部排氣裝置或整體排氣裝置。	90日、45日
2	有機溶劑中毒預防規則第6條	以噴霧方式之塗裝、清洗、塗料作業, 未設置局部設備或局部排氣裝置。	90日、45日
3	有機溶劑中毒預防規則第10條第1、2款	局部排氣裝置之風罩, 未置於有機溶劑發生源位置並適當調整風罩與發生源。	60日、30日
4	有機溶劑中毒預防規則第10條第4款	設置之局部排氣裝置, 未於適當位置, 開設清洗及定期檢點。	30日、15日
5	有機溶劑中毒預防規則第11條第2款	設有空氣清淨裝置之局部排氣裝置, 其排氣機未置於空氣清淨裝置之位置。	60日、30日
6	有機溶劑中毒預防規則第11條第3款	設置之整體排氣裝置之送風機、制風機、導管開口等未適當檢點有機溶劑洩漏發生源。	90日、45日
7	有機溶劑中毒預防規則第12條	設置之局部排氣裝置, 未依風罩之型式及風速檢點或風罩之檢點, 具有規定之控制風速(每分鐘0.4公尺以上)。(註: 檢點結果合格)	90日、45日
8	有機溶劑中毒預防規則第13條	設置之整體排氣裝置, 未依有機溶劑或其混合物之種類, 具有規定之排氣能力(每分鐘1立方公尺以上)。	90日、45日
9	有機溶劑中毒預防規則第14條第1款	設置之局部排氣裝置, 整體排氣裝置於有機溶劑作業時應內保保持有效運作。	即日
10	有機溶劑中毒預防規則第14條第2款	局部排氣裝置或整體排氣裝置, 未置於使排氣或排氣不致洩漏之處。	30日、15日
11	有機溶劑中毒預防規則第15條第1、2款	未每週檢點有機溶劑作業場所有關風速設備狀況, 檢點作業情形, 空氣流通效果或有機溶劑使用情形等紀錄之。	30日、15日
12	有機溶劑中毒預防規則第15條第3款	未將預防發生有機溶劑中毒之必要注意事項通告全體勞工周知。	30日、15日
13	有機溶劑中毒預防規則第16條	設置之局部排氣裝置, 未依有機溶劑中毒預防規則第16條之規定, 每年定期實施有動檢點一次以上, 並依規定記錄及保存三年。	30日、15日

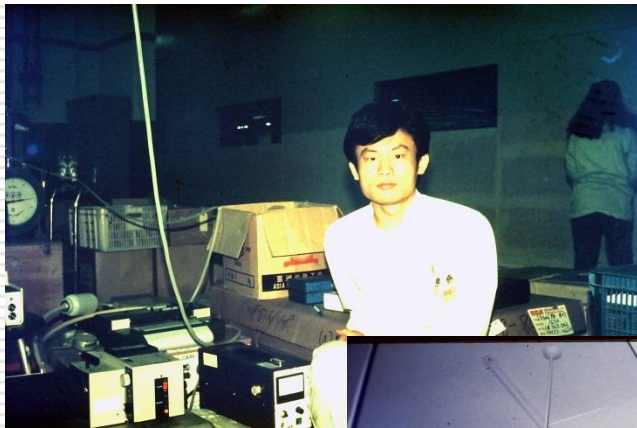
本通知書共計二頁, 本頁為第一頁。

8	7	通風測定	6	安全衛生指示制等
80.5.31	74.5.17	77.8.10	71.4.15	67.7.10
異丙醇 三氯乙烷	丙酮 甲苯 三氯乙烷	丙酮 二氯乙烷 三氯乙烷 異丙醇 丁酮 四氯乙烷 正己烷	異丙醇 丙酮 二氯乙烷 三氯乙烷	無一般使用資料記載
12	5	(本次未實施通風測定)	12	18
15-1/3	12		18	19
16	16			27
17	17			12
18-1	29			18
18-2				(資料不全, 未檢點)
22				18
29				18
沈育民	陳金昌	林進基	林國毅	何慶松
"	"	"	"	"
"	"	"	"	"
80.6.10	74.5.17	77.8.10	71.4.15	67.7.10
10000	10000	10000	10000	10000

5	4	3	2	1	檢査次數
69.11.28	69.6.29	68.5.3	68.11.4	64.6.4	檢査日期
異丙醇 丙酮 丁酮 二氯乙烷	異丙醇 丙酮 二氯乙烷 三氯乙烷		異丙醇 石油精 正己烷 丙酮 正丁醇 乙醚 丁酮	異丙醇 丙酮 二氯乙烷 甲苯 石油精	使用之有機溶劑
15-3	12	16	5/12	12.13.5	違反條款
16	22	17	6	6	(有機溶劑中毒預防規則)
17	29	18	12	12	
22		15-1/3	15-2	333	
29		16	18-2	345	
		18-1	18-1	15-2	
		22	18-2	15-1	
		健12	18-1	18-1	
			22	22	
			23	23	
			29	29	
劉國文	吳慶男	何慶松		林進基	檢査員
"	"	通知改善	通知改善	通知改善	處理情形
"	"	通知改善	通知改善	通知改善	
80.6.10	74.5.17	77.8.10	71.4.15	67.7.10	檢査日期
10000	10000	10000	10000	10000	

Environmental Monitoring at RCA (Geng-Hui Chang, 1988)

□ Master's Thesis at NTU



"Recirculation"



High concentration of organic solvents

Expert Witness for the Plaintiff

□ Environmental Engineering

■ Chang GH (張良輝)

□ Epidemiology

■ Chen PC (陳保中)

□ Toxicology

■ Ueng TH (翁祖輝)

□ Environmental Engineering

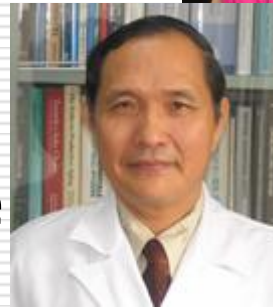
■ Ding LL (丁力行)

□ Industrial Hygiene

■ Chen CC (陳志傑)

□ Occupational Medicine

■ Wang JD (王榮德)



Expert Witness for the Defendant

□ Radiation Oncology

- Lee S (李百勳)

● Former RCA Manager

- Hu (胡忠仁)

➤ Occupational Medicine/Epidemiology

- Tao X (陶旭光)

➤ Risk Assessment

- Liu (劉碧芳)

➤ Geology

- Zeng CM (鄭春苗)

➤ Epidemiology

- Wong O (黃遠邦)

➤ Industrial Hygiene

- Frank Rover



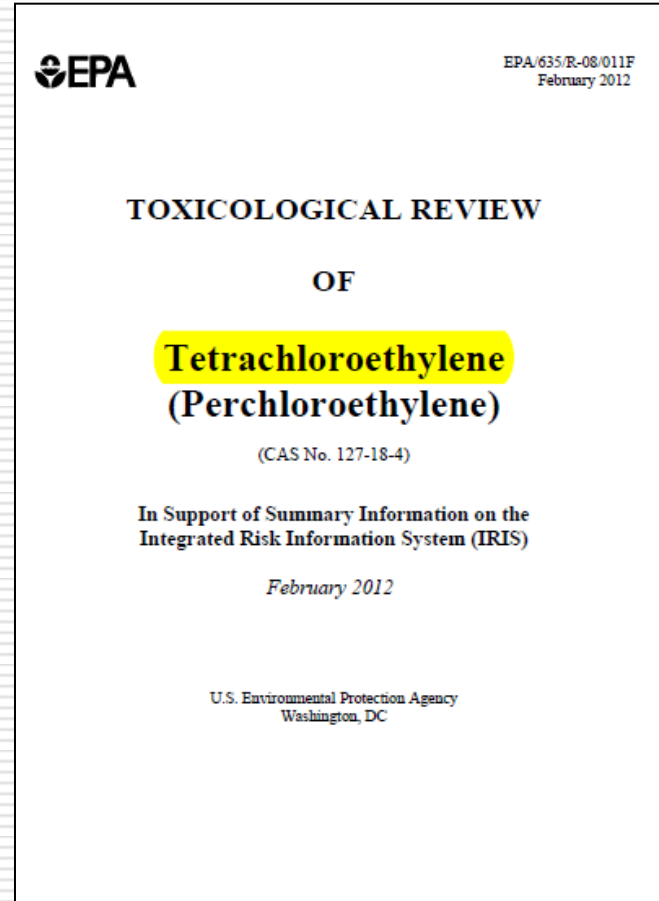
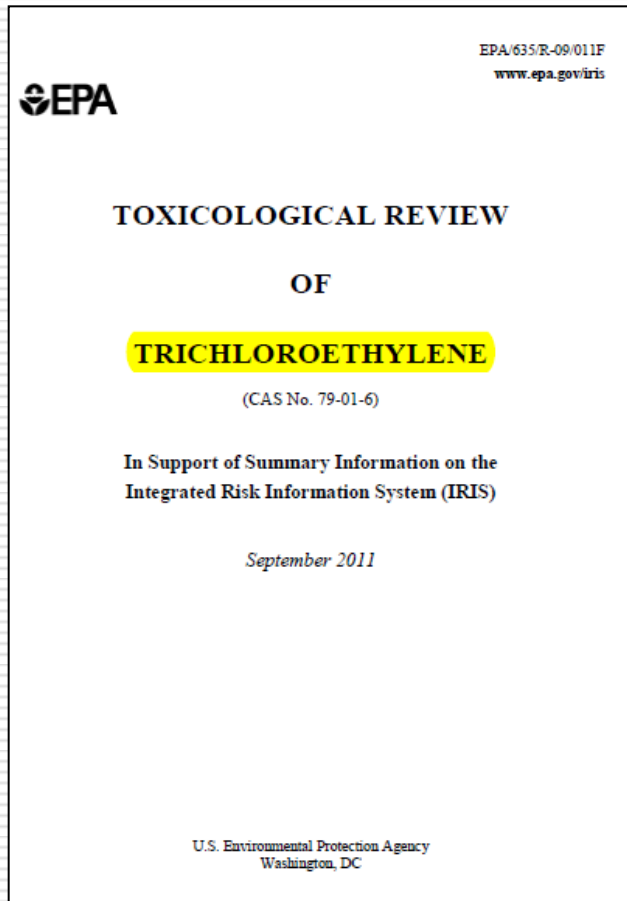
Steve Lee M.D.
UCLA radiation oncology



Xuguang (Grant) Tao, MD
Associate Professor and Research
Director, Division of Occupational and
Environmental Medicine, JHSOM



Toxicological Review of TCE & PCE (USEPA, 2011/2012)



TCE: Carcinogenic to humans (Group 1) (IARC, 2012)

□ Target Organ: **Kidney**



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For more on the IARC
Monographs see <http://monographs.iarc.fr/>

Upcoming meetings

Feb 12-19, 2013

Volume 107: Polychlorinated
biphenyls and polybrominated
biphenyls

June 4-11, 2013

Volume 108: Some drugs and
herbal medicines

Monograph Working Group
Members

A. Birkbø (IARC), C. B. L. F. (IARC)

Carcinogenicity of trichloroethylene, tetrachloroethylene, some other chlorinated solvents, and their metabolites

In October, 2012, 18 experts from seven countries reassessed the carcinogenicity of several chlorinated solvents and some of their metabolites at the International Agency for Research on Cancer (IARC), Lyon, France (table). These assessments will be published as volume 106 of the IARC Monographs.²

Trichloroethylene (TCE) was used for degreasing metal parts in the 1990s, and in dry cleaning the 1930s to 1950s. It is still used for stain removal, but its main use is for chlorinated chemical production. In the early 1990s,³ although occupational exposure levels are decreasing, the general population is exposed to consumer products—including and contaminated water.

genotoxic, particularly in kidney cells in which in-situ metabolism occurs.

Case-control studies provide convincing evidence for a positive association between exposure to TCE and renal-cell carcinoma. Two studies^{5,6} have evaluated confounding for several kidney cancer risk

Danish study of workers in industries using TCE have reported modestly increased relative risks (RRs) of kidney cancer, with indications of an exposure-response relationship.⁷⁻⁹ Three small, independent cohorts of Nordic workers who were monitored biologically by TCA in urine show little

Uses and exposures		Evidence for carcinogenicity in humans	Evidence for carcinogenicity in animals	Group*
Trichloroethylene	Chemical intermediate; metal degreasing	Sufficient	Sufficient	1
Tetrachloroethylene	Dry cleaning solvent; metal degreasing; chemical intermediate	Limited	Sufficient	2A
1,1,1,2-tetrachloroethane	Solvent in pesticides, cleaning, degreasing, and extracting processes; chemical intermediate for chlorinated solvents	Inadequate	Sufficient	2B
1,1,2,2-tetrachloroethane	Solvent; metal degreasing; chemical intermediate for chlorinated solvents	Inadequate	Sufficient	2B
Dichloroacetic acid	Water disinfection byproduct; cauterising and therapeutic agent; chemical intermediate	Inadequate	Sufficient	2B
Trichloroacetic acid	Water disinfection byproduct; herbicide; treatment for skin conditions; urinary biomarker of exposure to trichloroethylene and other chlorinated solvents	Inadequate	Sufficient	2B
Chloral and chloral hydrate†	Sedative; water disinfection byproduct	Inadequate	Sufficient	2A

*See IARC preamble¹ for explanation of classification system. †Exist in equilibrium in aqueous solution.

Table: Agents assessed by the Monograph 106 Working Group

Semper Fi: Always Faithful

❑ Camp Lejeune, NC



TCE, PCE, Benzene, VC

 **ATSDR**
Agency for Toxic Substances & Disease Registry

[A-Z Index](#) [A](#) [B](#) [C](#) [D](#) [E](#) [F](#) [G](#) [H](#) [I](#) [J](#) [K](#) [L](#) [M](#) [N](#) [O](#) [P](#) [Q](#) [R](#) [S](#) [T](#) [U](#) [V](#) [W](#) [X](#) [Y](#) [Z](#) <#>

 **USA.gov**
Government Made Easy

Camp Lejeune, North Carolina

Camp Lejeune
Background
Calendar of Events
Chemicals Involved
Community Resources
News Releases
Public Health Activities
Water Modeling
Health Concerns

[Camp Lejeune](#)
Reported health effects linked with trichloroethylene (TCE), tetrachloroethylene (PCE), benzene, and vinyl chloride (VC) exposure
Reported health effects linked with TCE, PCE, benzene, and VC exposure in people
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- [Reported health effects linked with TCE, PCE, benzene, and VC exposure in people](#)
- [Reported health effects linked with TCE, PCE, benzene, and VC exposure in animals](#)
- [Reported health effects linked with TCE, PCE, benzene, and VC exposure in both people and animals](#)
- [References](#)

Janey Ensminger Act (2012/8/6)



Filmmakers Tony Hardmon & Rachel Libert look on with Jerry Ensminger as President Obama signs The Janey Ensminger Act.

TITLE I—HEALTH CARE MATTERS

SEC. 101. SHORT TITLE.

This title may be cited as the “Janey Ensminger Act”.

SEC. 102. HOSPITAL CARE AND MEDICAL SERVICES FOR VETERANS STATIONED AT CAMP LEJEUNE, NORTH CAROLINA.

(a) HOSPITAL CARE AND MEDICAL SERVICES FOR VETERANS.—

(1) **IN GENERAL.**—Paragraph (1) of section 1710(e) is amended by adding at the end the following new subparagraph:
“(F) Subject to paragraph (2), a veteran who served on active duty in the Armed Forces at Camp Lejeune, North Carolina, for not fewer than 30 days during the period beginning on January 1, 1957, and ending on December 31, 1987, is eligible for hospital care and medical services under subsection (a)(2)(F) for any of the following illnesses or conditions, notwithstanding that there is insufficient medical evidence to conclude that such illnesses or conditions are attributable to such service:

- “(i) Esophageal cancer.
- “(ii) Lung cancer.
- “(iii) Breast cancer.
- “(iv) Bladder cancer.
- “(v) Kidney cancer.
- “(vi) Leukemia.
- “(vii) Multiple myeloma.
- “(viii) Myelodysplastic syndromes.
- “(ix) Renal toxicity.
- “(x) Hepatic steatosis.
- “(xi) Female infertility.
- “(xii) Miscarriage.
- “(xiii) Scleroderma.
- “(xiv) Neurobehavioral effects.
- “(xv) Non-Hodgkin’s lymphoma.”

(2) **LIMITATION.**—Paragraph (2)(B) of such section is amended by striking “or (E)” and inserting “(E), or (F)”.

Health Effects?

Cocktail of 31 organic solvents



TCE: IARC, USEPA, CDC & RCA (Cancer)

名稱	IARC	US EPA	Camp Lejeune	RCA
三氯乙烯	分類： •確定人類致癌物 (Group 1) (Monographs 106) •很可能人類致癌物 (Group 2A)— (Monographs 63) 人類致癌性： ✓證據有限 •肝癌 •膽道癌 •非何杰金氏淋巴瘤 ✓證據不充足 •子宮頸癌 •膀胱癌 動物致癌性： •肝癌、腎細胞瘤、間質細胞睪丸瘤(大鼠) •淋巴瘤、肝癌、肺癌(小鼠)	分類： •人類致癌物 相關癌症： •腎細胞癌(有信服力) •非何杰金氏淋巴瘤(強力但較少信服力) •肝癌(有限) •膀胱癌、前列腺癌、食道癌、子宮頸癌、乳腺癌與兒童白血病(支持性)	分類： •美國衛生和人類服務部(The U.S. Department of Health and Human Services, DHHS)目前正在審查三氯乙烯的分類 •美國NIEHS主導的國家毒物計畫(National Toxicology Program, NTP)已建議將其列為合理預期的人類致癌物 •國際癌症研究機構確定為很可能人類致癌物質(2A)	PCMR (-6%) 女性癌症(vs電子廠對照組)未去除 •胃癌 1.64 (1.04-2.44) •肝癌 1.74 (1.04-2.84) •肺癌 1.64 (1.04-2.44) •子宮癌 4.34 (2.74-6.54) <u>去除就業≤3個月</u> •乳癌 2.24 (1.74-2.74) •結腸癌 2.74 (1.64-4.34) •消化器官 2.24 (1.24-3.84) <u>去除就業≤3個月及潛伏期≤5年</u> - 乳癌 1.84 (1.44-2.34) - 結腸癌 2.14 (1.24-3.44) - 消化器官 1.84 (1.04-3.14) 女性癌症(vs紡織廠對照組)未去除 •子宮癌 3.14 (1.94-4.74) <u>去除就業≤3個月</u> - 其他 1.74 (1.24-2.34) <u>去除就業≤3個月及潛伏期≤5年</u> - 乳癌 1.44 (1.14-1.84) - 其他 1.44 (1.04-1.94) <u>去除就業≤3個月及潛伏期≤10年</u> - 乳癌 1.54 (1.14-1.94) - 其他 2.04 (1.44-2.84) - 肺癌 2.94 (1.64-4.94)

To Be Continued...

- ❑ RCA case moves on to the High Court

