

Talk to Medical Directors, United Technologies, Hartford

12/15/77

Draft

I must apologize to you right at the outset of this talk. Being a foreigner I have been involved in something called FLEX - the Federal of Licensing Examinations Board or something and I just finished the exams last week. This is the second time I have taken it which indicates to you how much I know about basic sciences and biochemistry and all the things that have appeared on this scene since I graduated. The time I have had to prepare this talk has not been very great and I apologize to you because ~~what~~ I am going to ~~do~~ ^{"read"} ~~is~~ take a paper that was published this year in the British Journal of Industrial Medicine of which I was a co-author. I was only a co-author by virtue of the fact that I was ^{employed} ~~able to be~~ in a factory in the United Kingdom which has preserved its personnel records ^{since} ~~from~~ the/last century ^{turn of the} ~~onwards~~ and which has good medical records going ^{late} ~~back to the~~ 1940's-early 1950's. ^{These} ~~and which~~ had previously been studied by my predecessor, John Knox in association with Richard Doll who ^{now Regius} ~~is the~~ Professor of Medicine at Oxford University ^{and} whom I am sure ^{Sir} ~~you all~~ know of as a leading epidemiologist ~~in the field~~. It was Richard Doll who, in 1955 (based upon studies of the population I am about to describe to you), ~~was Richard Doll who~~ proved that there was indeed an association between lung cancer and exposure to asbestos. ~~Before we start~~, I think it ^{would be} ~~is always~~ worthwhile to ~~go through~~ ^{describe} ~~the old pot boiling mechanisms of telling you exactly~~ what asbestos is ^{and} ~~well not exactly but just giving~~ you some idea of ^{the material} ~~what~~ we are talking about. ~~Unlike the Chairman of Turner & Newall, the company which I worked for which was a large company with 30,000 employees in the United Kingdom and many subsidiaries throughout the world including mines in Canada,~~ ^{Your background data will then be better than that of} ~~and Southern Rhodesia and factories in many countries.~~ ^{The son of}

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of an international asbestos company,

Chairman, who went out to Rhodesia to see for himself where the asbestos came from and after breakfast said "Let's go and look at the plantation." ¹ "If we could just have the first slide and the lights

~~off then I could illustrate to you just briefly that~~ Asbestos is a

SLIDE 1.

fibrous mineral silicate and ~~that~~ there are a number of varieties that are of commercial importance. I am not going to go into ~~the~~ the arguments ~~and the details~~ about the differences in biological effects which exist between the various forms of asbestos. Chrysotile

asbestos which comes from Canada, Southern Rhodesia, the Soviet Union, ^{Swaziland and the} Cyprus, ^{is} ~~South Africa~~, United States, the type of fiber which composes

about 95% of the world's usage of this material. It is a hydrated ~~fibrous~~ magnesium silicate. Crocidolite, which is a blue ~~pellet~~ fiber, ^{is mined in} ~~comes~~ from South Africa at the present time ⁱⁿ ~~from~~ the Northwest Cape Province and ~~from~~ the Northeast ~~and~~ Transvaal. It ~~used~~ to be mined in

Australia but that ~~mining~~ no longer takes place and there was a disastrous experience there with regard to ^{the incidence} ~~accounts~~ of mesothelioma among the miners. Amosite is not ^{really} ~~an~~ acceptable mineralogical term ^a

because it ^{is} ~~merely~~ ^{an abbreviation} ~~stands~~ for "Asbestos Mines of South Africa"

^I ~~and that~~ ^a ~~is~~ ^{fiber} unique in that it only comes from ^{this} ~~one~~ part of the world i.e.

~~and that's from~~ the Northeast Transvaal. The amosite and crocidolite from the Northeast Transvaal ~~often~~ ^{rock} ~~occurred~~ in the same seam in the

~~rock~~ and therefore it is ~~always~~ possible ~~to say~~ that amosite ~~is~~ may be

~~not~~ contaminated with ~~some~~ crocidolite. ^{and vice versa.} ~~That is possible.~~ There are

deposits of amosite in India but I don't think they have been commercially exploited yet, ~~but there are some there of that type of fiber.~~ ~~Its~~ ^{belongs to} ~~Amosite~~

~~really is part of~~ the ^{cummingtonite-grunerite} ~~cummingtonite-grunerite~~ (2) series and just to

digress for a moment the importance of the CG series (or the fact that amosite is part of that series) became apparent when ^{the} Reserve

Mining Company ~~found~~ ^{embattled} itself ~~embattled~~ with EPA, the State of

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Minnesota and various others ^{people} regarding the dumping of ^{waste} tailings from its ^{taronite} mines in Silver Bay into Lake Superior, ^{early} and ~~Dr. Solikoff~~ ^{The fiber in the tailings} ~~waltzed into Minnesota and waltzed out again and really upset the whole apriest there and that battle is still going on with Reserve Mining.~~ I am sure you are familiar with that story. ~~That was CG~~

^{and the later} ~~which~~ ^{apparently} is similar to commercially used amosite. ~~Apart from the fact that a lot of the fibers initially discovered were Distimatic skeletons (?)~~

~~Anthophyllite~~ isn't very widely used in industry. It's one of the oldest ^{known} ~~used~~ asbestos fibers particularly ⁱⁿ Finland where for thousands of years it's been incorporated in the building of Sauna baths. ~~If you like to go into that sort of occupation. However, it isn't terribly important.~~ Biologically it is ^a very ~~very~~ interesting

^{Fiber} because no cases of mesothelioma have as yet been described ~~with the~~ association ^{with} of anthophyllite exposure, and we can forget about the ^{a fiber which is} other two except the bottom one Tremolite which is ^a often found in commercial talc or industrial talc. ~~Just to give you some idea of the fact that chrysotile crocidolite is blue amosite is sort of an in between color. Those are both iron containing fibers this is magnesium and various anthophyllite which is also an~~

^{SLIDE 2} ~~That's (a mine up in Canada) showing what has happened to the country side.~~ This is a composite slide ^{which shows} and ~~this is~~ what we did with asbestos in Rochdale in England. ^{The} ~~That's a rock, it was opened at the mine and the~~ ^{is crushed and graded} to some extent. ^{It is} ~~It was~~ further opened at the factory in the process ^{After} ~~of what we called fiberizing.~~ and carding it ^{is formed into} ~~was used as~~ a sliver and then ^{two of a} spun into a yarn, and that is the process and then ~~The yarn would be~~ ^{can} woven or sold to customers. Cloth ~~would~~ be used for various purposes. ^{Such} ~~as wrapping around insulation sections, laminating with resins for friction materials, safety curtains etc.~~ ~~Another think~~ I think you should appreciate if you will read in the paper if you have it or wish to read it ~~is~~ the fact that in the United Kingdom, ^{Regulations} were made in 1931 which took affect

in 1933, ~~which~~ ^P prior to the making of those regulations, which were called the Asbestos Industry Regulations, ~~and which therefore only apply to the asbestos industry and that also is important from the point of view of what happens subsequently however those regulations resulted after~~ a study which was conducted by ^{Meriwether} ~~Mary~~ whether and Price in 1929 and published in 1930 ^{and it became} which is ~~one of the most famous study in this field and is~~ a milestone in ~~the history of the~~ British asbestos industry.

What they found was that in people who had been employed for 20 or more years, ~~81%~~ - 81% had pulmonary fibrosis. We are talking about asbestosis, ~~and it's important to remember that asbestosis was a 20th Century disease.~~ The first case of asbestosis was not described until the beginning of the Century in London by Montague Murray.

~~and therefore this is a 20th Century occupational disease.~~ The first evidence that exposure to asbestos was going to cause a problem to the health of ~~the~~ workers was the finding of asbestosis and the regulations that were made in 1931 and that took effect in 1933 were designed to reduce the incidence of pulmonary fibrosis.

Lung cancer was not ^{then} associated with asbestos exposure apart from speculative case histories that first began appearing in 1935. No epidemiological study was done to confirm this suspected ~~association~~

association until the work of Richard Doll in 1955, ^α Although the same ^{Meriwether} ~~Mary~~ whether in 1947 had shown that 13% of asbestosis cases diagnosed in the United Kingdom were dying of lung cancer or had

died of lung cancer. That leads to another speculation, ~~again which~~

~~I don't intend to dwell upon and that~~ ^{the development of} ~~is where~~ asbestosis ~~is~~ a prerequisite for the development of lung cancer or ^{can} ~~that~~ lung cancer occur

in an asbestos worker without asbestosis, ~~is nevertheless an occupational disease and we would only enter in many arguments especially in view of the known~~ multiplicative effect which

cigarettes ~~xx~~ smoking has on lung cancer in asbestos workers

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However, I ~~show that simply to point out what the situation was~~
~~in 1930 with regard to asbestosis.~~ ^{In 1929} ~~This~~ Pulmonary fibrosis ~~was of~~
~~crippling and killing people and 81% of those~~ ^{workers} ~~with more than 20~~
~~years exposure, were suffering from this condition.~~ By comparison
 in 1975 only 0.77 or 0.8% of the ^{entire} ~~group~~ ^{in 1929} ~~were~~ compared with 26.2% ^{group} ~~were~~
 found to have asbestosis and the 20 year and over ^{the} ~~incidence were~~
 down to 5%. ^{This} ~~which~~ obviously is still ~~an~~ unacceptable but ~~what you~~
~~have to remember is that~~ some of ^{the} ~~these~~ cases ^{in this population} ~~were in fact exposed~~
^{the 1931} ~~before~~ regulations. They were still ^{employed} ~~working~~ and ^{as} ~~this was~~ ~~a~~
 table of prevalence not incidence ~~and consequently~~ they were there
^{were included} ~~and counted.~~ It does indicate quite dramatically that those regulations
~~in industry~~ had reduced the incidence of asbestosis. ~~If we go to the~~
~~paper know we will see that~~ ^{whose mortality experience} ~~This co-hort that we are describing in the~~
~~paper~~ has been the subject of 3 previous reports and the last of
 these ~~reports~~ was published in 1968. ~~the one prior to this and~~ ^{from} ~~They~~
 dealt particularly with mortality ~~of~~ lung cancer and respiratory
 disease in workers exposed to the high dust levels which preceded the
 1931 asbestos industry regulations. They attempted to examine the
 dependence of lung cancer incidence on ~~the~~ ^{age} and duration of ^{asbestos} ~~exposure.~~
~~The last one~~ ^{the paper} ~~In 1968~~ the cohort was divided into 6 groups. ~~with the~~
 Group 1 had more than 10 years of exposure ^{before 1933 but} ~~xxxxx~~ groups 1, 2, 3 and 4 had
^{total exposure} ~~all had more than 20 years but group 1 had greater than 10 years~~
~~exposure before 1933.~~ Group 2 had between 5 and 10 years exposure
 before 1933 when the regulations took affect. Group ³ ~~4~~ had less than
 5 years exposure and Group 4 had had no exposure before 1933. Group
 5 was all males and had had more than 10 years exposure but less
 than 20 with no exposure prior to 1933 and group 6 was all females and
 they ~~xxx~~ had all been exposed after 1933 for more than 10 years.
^{For} ~~When you look at~~ Cancer of the lung and pleura, ^{15 cases were observed where} ~~you see that the~~
~~observed was 15 and the expected 1.6~~ ^{were expected was} ~~so there is about an 11 times~~

excess incidence of lung cancer in ^{the} ~~that~~ group which ~~has~~ had the longest exposure prior to the improvements which came with regulations.

In two ~~As you go down you see that that diminishes. When you get to this~~
 group ^{with} ~~here~~ no exposure before 1933 ^{but} ~~with~~ more than 20 years ^{service,} the difference is not statistically significant. That was ^a very ^{satisfying observation} interesting but the authors were wise and they pointed out that no ~~further~~ firm conclusions could be drawn because little carcinogenic effect ~~was~~ would be expected for 20 years after first exposure and some of the follow-up had not been for long enough. ~~If we just go through two more slides dealing with that cohort or with these figures~~
~~here were~~ ^{In} have the men and women all exposed ~~to~~ since 1933 and ~~you~~
~~can see that~~ ^{for} cancer of the lung and pleura ~~was~~ there was no statistically significance difference and ^{between observed and expected} ~~in~~ the women there ~~was this difference~~
~~and that was~~ ^{were} only 2 cases ^{but} and it was not possible to state what the meaning of that was ^{because of small numbers,} What we are dealing with here is men and women employed 10 years or longer since 1933. This is the ~~same~~ group with less than 20 years or 10 to 19 years and you see no difference in the observed to the expected ~~rate of incidence of lung cancer.~~
 In men employed 20 years ^{or more} those who worked before 1933 ~~as we have~~
~~said before~~ 11 to 0.8 ^{there were lung cancers observed} (11 to 1) and ^{for} all neoplasms 15 ^{observed} to 3 ^{expected.} and since 1933 ^{there were observed} 3 ^{expected} to 2.9 ~~and so~~ Therefore, it appeared from this information, that people who had worked since 1933 were ~~now~~ no longer at risk and, if you accepted this, that ^{because} the dust levels ~~that~~ had been brought down had been achieved a disappearance of the lung cancer. Furthermore this was against a diminishing background of incidence of asbestosis and as ~~you saw~~ in 1975 the prevalence of asbestosis was only 0.8% in the factory population studied, ^{compared with 26% in 1929.} The report published in 1977 is concerned with the ~~post 1933 population~~ the post-1932 population mainly, which, ^{to} as I said although exposed dust levels ~~which~~

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were higher than the present ~~xxxxxx~~ permitted levels, ~~this~~
~~population~~ was employed during the time of improving dust controls
 and plant modernization. The study is based on 1,106 men and women
 only (284 women) and the cohorts ^{have} ~~has~~ been roughly sub-divided in the
 same way except that you will see there are only 5 groups instead
 of 6. ~~and from the previous group 3 and 4 have been combined. If I~~
~~think that's what happened. I don't want to go into it too carefully.~~

Again we got years in asbestos areas 20 or more, 10 or more before
 1933 and than 20 or more less than 10 we have taken out the less than
 5 group from that and then we have ~~gone~~ gone on so that will be from
 _____ to 10 instead of just 5 to 10 and then we go on to 20 or more
 with no exposure after 1933 and that's the group we are particularly
~~xxxxx~~ interested in 10 to 19 and then females with 10 or more. Well
 there may be some ~~xxxxx~~ females who have done 20 years. We get
 1,106 with a total of 16,000 person years of observations.

Re-examination of our personnel records since the ~~xxx~~ last report
 in 1968 showed that a further 23 workers were eligible for inclusion
 in cohorts 1 and 2 and in addition 205 workers who ^{had} ~~have~~ completed
 10 years employment since June ~~16~~ 1966 were added to cohorts 3, 4
 and 5. So the study comprised 822 (men) and 284 women and the followup
 was until the 31st of December 1974 using the factory ~~xxxxx~~ personnel
 records and the National Health Service Central register. Only 2%
 of workers could not be traced and 13 ~~and that's~~ (1.2%) were
 recorded in the National Health Service Central registry as having
 immigrated or were not currently registered with ^a ~~the~~ GP. As you know
 everyone in the UK is registered with a GP, ~~you don't have to be, but~~
~~most people are.~~ From this you can see that a very small percentage
~~are not. Especially among the working population who are not able~~
~~to afford private treatment.~~ The remaining 1,071 (96.8%) have been

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followed-up to the end of 1974. The number of deaths in each group which have been attributed to lung cancer (and lung cancer includes deaths due to mesothelioma) ~~and these~~ ^{the} ~~The number of deaths in each group attributed to lung cancer~~ other cancers, respiratory disease and other causes are shown in the next slide and although it looks complicated it isn't really. If you simply look at ~~that~~ ^{the} column which ^{for} ~~is~~ the ~~xxx~~ cause of death, which ^{headed} ~~is~~ lung cancer and mesothelioma, other cancers, respiratory diseases and other causes, and if you will just look at the ones which ^{show} ~~is~~ statistically ~~significantly~~ significant ^{deaths} ~~there~~ you will see that ~~again~~ in Group 1 (which ~~we know before~~ ^{previously} ~~we had the 10 or 11~~ ^{15:0.8} observed to expected ratio) ~~xxx~~ in ~~xxxxx~~ the respiratory diseases again there is a 3.6 observed to expected ratio and all causes the ratio is about 2 to 1 so there is an excess mortality in this population which is largely attributable to lung cancer but some of which is attributable to other respiratory diseases which might reflect a ~~xxxx~~ residue of asbestosis in ~~xxx~~ this population. The expected numbers ~~for those of you who are interested~~ were calculated from National death rates by 5 year periods and 5 year age groups. To insure that the expected ^{number} ~~members~~ are not underestimated, immigrants and those lost to follow up were assumed to be alive on December 1, 1974. Deaths before the 1st of January 1931 or after the ~~xxxx~~ age of 85 are ignored and expected members are calculated accordingly. In Rochdale itself lung cancer mortality was lower than the national average ^{for males} ~~among the men~~ which is interesting, ~~in that~~ This is the ~~xxxx~~ largest asbestos textile factory in the world. Rochdale ^{with} ~~has~~ a population of about 80,000 people ~~and it~~ had a lower than average lung cancer mortality. It doesn't prove anything but ~~you~~ ~~we know for those who say that~~ ^{if} asbestos is an environmental pollutant which is going to cause an excess incidence of lung cancer in the general population ~~*~~, this doesn't seem to make sense. The A00910

Table II

standardized mortality ratio ~~is~~ in Rochdale is 87^{for men} and ~~similar~~ for women 104 ~~that's~~ (1959 to 1963 Register^{ray} General 1971.) Workers first exposed before 1933 ~~that's for~~ ^{i.e.} cohorts 1 and 2, suffered from ^{an} excess ^{incidence} of lung cancer and respiratory disease, ~~xxxx~~. Particularly those with 10 or more years exposure prior to ¹⁹33. ~~and~~ There is also some excess mortality ^{from} lung cancer and mesothelioma (36 observed and 19.3 expected, the P ~~is less than~~ [<] 0.01) and respiratory disease (35 observed, 25 expected, P ~~equals~~ ⁼ 0.03) in those who entered after the 1st of January 1933 ~~that's~~ (cohorts 3, ~~and~~ 4 and 5 combined). ~~You combine these 3 cohorts.~~ This excess is very much less than in the first two cohorts. ~~What it indicates is that in even~~ In those people ~~with longer follow up now these people~~ who were first exposed after 1933, the longer follow up indicates that there is still an excess mortality from lung cancer, mesothelioma and respiratory diseases. In the 1968 study there was a slight excess of circulatory disease in cohorts 3 and that hasn't increased (27 observed 20.6 were expected). In cohorts 4 and 5 there was a matching deficit (50 observed, 60.10 expected). The ^{inference} ~~incidence~~ that this was probably a chance observation seemed confirmed. There were 16 deaths attributable to gastro-intestinal cancer compared with 15.7 expected. This cohort, ever since it has been formed and ~~it has been~~ followed, has not yielded an excess incidence of ~~g~~ deaths from gastro-intestinal carcinoma. It is also interesting that in a paper published in the same issue of the British Journal of Industrial Medicine, Elmes in Belfast, following up his insulation workers finds the incidence of gastro-intestinal carcinoma is declining as the ~~xxxx~~ time goes by and ~~that he~~ thinks that this might be due to improvements in earlier years. ~~now that he is following the population further ahead in time.~~ However this excess incidence of gastro-intestinal carcinoma in asbestos workers appears to be something that is related to the most heavily

^{worked}
 exposed ~~in~~ groups. ~~and~~ ^A Although this group of textile workers
 in the earlier years was probably as heavily exposed as any, it has
 progressively been getting less and less exposure and ^{an} ~~this~~ excess
 of gastro-intestinal carcinoma has ~~never~~ been found ~~in Rochdale~~
~~I~~ ^{we} think ~~it~~ ~~you~~ will ~~only~~ find that gastro-intestinal carcinoma
 is associated ^{only} with ~~it in some way with~~ very severe exposures.
 That is just my personal opinion. No excess, ^{incidence} for ~~any of those that is~~
 statistical
 gastro-intestinal carcinoma approached/significant in any cohorts
 and no peritone^{al} mesothelioma was reported. To distinguish exposure
 immediately after 1933 from that under present conditions cohorts
 3, 4 and 5 were divided into those first entering or first ~~being~~
 exposed from 1933 to 1950 and those starting later. The reason
 we took 1950 was because ~~in 1951~~ we regarded ¹⁹⁵¹ ~~it~~ as the start of the
 modern period in that factory. ~~because~~ ^{It} was the year in which
~~the~~ routine dust sampling was initiated. Although ^{Merrill} ~~Merry~~ whether had,
 way back in the 1930's, ~~had~~ tried to give some indication as to what
 he considered to be an unacceptable ^{dust level,} ~~dusty~~ the instrumentation and
 the techniques were not available to assess dustiness ~~numerically~~
~~and to assess~~ accurately. It was only in 1951 when the thermal
^{precipitator}
 percipitator came into use in that factory, ~~and~~ ~~then~~ subsequently
 was followed by the long-running thermal ^{ie} percipitator and then, in
 1961, by the membrane filter method, that it was possible to attempt
 to measure ~~what~~ the exposure ~~was~~ of these people and to control the
 environment ^{using} ~~according to~~ measurable
 dust levels rather than ~~according to~~
^{visible}
 best achievable results, ~~visibly~~. Observed and ~~expected~~ deaths for
 those first exposed between 1933 and 1950 are shown in Table ~~18~~ ¹⁹ but
 I think before we get there, no we got there, ^{men} ~~Men and women~~ first
 exposed 1933 to 1950 ~~there were 616 Men and women first exposed~~
 1951 or later lung cancer 33 to 50 ~~of~~ observed 30 expected 16
 with a 2 to 1 ratio. Here we find that the 1968 authors were

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wise to add a word of caution about the length of follow up. It had only been 20 years and 20 years may not be long enough because here we ^{have} ~~had~~ emerging ~~now~~ something they didn't find ^{and} that is a slight excess ~~of it by no means the significant excess of 11 to 1 that we have had previously~~ but there is still a slight excess of lung cancer in those persons exposed between 1933 and 1950. What ^{there first exposed after} about 1951? Well we have it again. We ~~have~~ have a ratio of 1.9, ^{observed to expected lung cancer deaths is} that is only 6 cases ~~to~~ ^{are} observed to 3.2 ~~3~~ expected. The numbers ~~might~~ ^{are} at this stage ~~be~~ small and therefore this has to be followed up ~~and we~~ have to increase the numbers and ~~the length of we have to~~ lengthen the follow-up, ^{but in this group of} ~~but even~~ people who first entered since 1951 ~~up to 1974 which gives you~~ (24 years ^{follow-up}) still show this slight excess. Again the statistical significance is not as great as for the ^{remainder} ~~other half~~ of the cohorts ~~not exactly the half other~~ ~~2/3 approximately of the cohorts~~, but here we have evidence that the lung cancer has not been totally eliminated in this population. There have been very few deaths among those first exposed in 1951 ~~or~~ subsequently and if we look at table 4, one of the things that is going to crop ~~up~~ about those 6 cases after 1951 is whether they smoked or not. ~~It is as important for the others but we~~ ^{all the} don't have the information available in ~~their~~ medical records but we do ~~for~~ ^{since} ~~cases who died after~~ a certain period of time ~~when~~ smoking histories were added. In fact, the lack of information on cigarette smoking in the earlier studies was a serious omission, but there were no smoking ^{details recorded} records kept in the medical records ~~of cigarette smoking~~ until I went there in 1966. I then started meticulous ~~making recording~~ smoking habits. ~~From that one could see that~~ ^{divided} In 1976 if you ~~broke~~ the population into age groups smokers, ex-smokers and non-smokers ~~I went go into how these are defined just suffice to say~~ 0 9 1 3 that that's the way they were at the time. There were 22% who were ~~non-smokers~~ non-smokers, 13% who had given up smoking and ~~they~~ ~~there~~ there were

65% who still smoked. ~~and these~~ ^{therefore} were comparable to the national figures, ~~in a way~~. This population was no different ~~xxx xx~~ in its smoking habits from the general population. ~~What do you do about smoking? I don't know.~~ Table ^{IV} shows deaths ^{from} of lung cancer (including ~~peritineo~~ mesothelioma) in the men and women first exposed 1933 to 1950 and men and women first exposed 1951 or later. They are distributed according to ~~the day by day first~~ ^{date of exposure} and time since first exposure. ~~If you look at that 10 to 14 years since first exposure 15 to 19, 20 years or more~~ In the the 20 years or more ^{group} ~~xxx~~ the ~~observed~~ ratio is 2 to 1. ~~In these two groups it probably is not significant.~~

In Men and women first exposed 1951 ~~or later 20 years or more if you take xxxixyxxxixx~~ that group 15 to 19 because one of them was just about 19 years which is close enough to 20 makes it 5 instead of 3 and 2 ^{there are} you get 5 observed, 1.8 expected (2.7 ^{the} as ~~your~~ ratio of observed to expected.) The 6 employees who were first exposed after 1950 who died of lung cancer were all men and they were all smokers. 5 worked in areas where dust levels were high in 1951 and one of them may have been exposed to asbestos dust from 1925 to 1930 in a previous occupation. He was a welder in a shipyard. No case of mesothelioma has occurred in the population first exposed after 1950 but that may not be long enough for follow up, ^a although in view of the long latent ^{none} period, ~~not~~ would yet be expected. ~~An approximately~~

A multiplicative effect of asbestos exposure and cigarette smoking ~~x~~ ^{incidence} on lung cancer/has been suggested. As you know, Selikoff has suggested that an asbestos worker who smokes has a 92 times greater chance of dying from lung cancer than a non-smoking non-asbestos worker. ~~or to put it another way, that an asbestos worker who smokes has x~~ an 8 times greater chance of dying from lung cancer than ^{a nonexposed person} ~~an asbestos worker, who does not smoke.~~ But without detailed smoking histories which have been collected for the future, we can't quantify what the effect of smoking were in this particular study. Asbestosis was

found by the Pneumoconiosis Medical ^{al} Board ⁱⁿ at ~~examinations of~~ three of the six cases. They all came to post-mortem. All asbestos workers in Rochdale ~~x~~ who die ^{to the coroner} have their ~~x~~ deaths reported either by their doctors, ~~to the coroner or the hospital, report to the coroner~~ or by the ~~xixxxx~~ ^{Register} of marriages and deaths. This has been done since 1930. The post mortem rate when I once looked into it was ^{nearly} ~~merely~~ 70%, ~~of our ex-employees~~ which is pretty high, and I used to go ^{nearly} to every post mortem that took place. ~~XXXXXX~~

There is a lot of interesting work which will come out of the post mortem ^e work which was done in Rochdale. The numbers ~~of~~ are too small for the magnitude of excess of lung cancer in those first employed after 1950 to be estimated with any precision. The implementation of the asbestos industry regulations started a drive to improve dust levels and as I explained to you the ~~xxxxxxx~~ process ^{of} were fiberizing ^{was} where the fiber came from the mines, ~~xxx~~ was opened, mixed and ^{involved} there were certain operations such as mixing, opening, bag-slitting, mechanical bagging. Then they went ^{followed} on ~~the to~~ the carding ~~xx~~ process, and if you are familiar with the textile industry the carding is simply a matter of teasing out the fibers, layering them all in one direction and you do this by passing them through two rollers moving in opposite directions with ^{sharp} ~~chopped~~ needles projecting from ~~them so you~~ ^{to} tease them out, and you get a fine web, ^{is formed which subdivided and spun (or twisted)} and then you take that web and you spin it and there are different grades of yarn, ^{medium} ~~fine or whatever~~ and then you ~~beaming~~ (?) ~~x~~ is a winding is the _____ and if you ever get confused with the weaving loom as to what the whaft and the wharp are the whaft goes from whaft to white and the wharp goes whap and down and you ~~x~~ can't forget it that way and that's how you weave.

^{Plaiting} ~~Plaiting~~ is obviously used for packings. You do things with ^{plaiting} ~~plaiting~~ ^{can be impregnated} ~~like impregnating~~ with ~~xxxxx~~ grease or graphite and this ~~got xxxxx~~ ^{is used in} ~~stuck into valves.~~ ^{valves for packing.} ~~xx~~ You can see here years 52, ~~xxxx~~ 60, 61 66, 71

~~I think these are average levels and in those are particles per cc and~~
~~after 61 you got the membrane filter technique and you are getting down to~~
~~fiber per cc.~~ ^{The} That operation, I'll show you in a moment, is totally closed.
 Of course that is the way to deal with ~~it anything~~ ^{anything dusty} ~~anything~~ ^{ever} If you close it you got
 no dust. ~~But these gradually went down 6 fiber in 1961 to 3 in 74.~~ ~~Q~~
 This factory population was used and studied by the British Occupational
 Hygiene & Society in 1966 ~~and~~ and on the morbidity study which was done at
 that time ~~not a mortality but a morbidity study~~ ^{hygiene} the present standard
 for asbestos ~~fiber~~ fiber was developed, ~~and to the dismay~~ ^{the dismay} of the people who
 developed it ^{it} became widely accepted throughout the world and ^{is} now the
 current ^{US} standard ^{for} (or threshold limit values) ^{for} in asbestos of ~~2~~ 2 fiber/cc.
 Originally it was a cumulative standard of 100 fibers ~~per~~ years/cc. ~~so~~ If
 a man worked for 50 year in 2 fiber/cc he stood a 1% risk of ~~getting~~
 asbestosis. The standard was not designed for lung cancer. Although there
~~is~~ ^{is} some indication, ^{as} that I have shown you, if ~~you reduce~~ ^{that the incidence of} asbestosis ^{is reduced} you
~~also reduce~~ the incidence of lung cancer ^{is also reduced} ~~but you~~ may have to reduce the
 exposure levels further still below 2 fiber/cc if we are going to eliminate
 the lung cancer. However no population in the world has been followed for
 long enough which has been purely ~~exposed~~ ^{for long enough} exposed to 2 fiber/cc or less.
 No population has been followed ^{for long enough} to say that 2 fiber/cc is or is not a
 no effect level for lung cancer, ~~and as you know~~ There is a lot of
 controversy about whether there is or isn't either a safe or no effect
 level for any carcinogen. As you can see, in certain operations dust
 levels came down dramatically ^{and} by 1974 in the whole weaving operation
~~there were less than 1.~~ ^{There} ~~There have been less than 1 for a long time.~~
 In that weaving ^{shed} there has never been a case of lung cancer associated with
^{asbestos} exposure that ~~we~~ ^I know of and asbestosis doesn't occur in that weaving shed.
~~and that's why~~ The old timers, people who were involved in reporting the
 data to the British Occupational Hygiene Society in 1966 (and some of them
 had been at the factory for a long time) ^{using} ~~using~~ their "gut feeling" felt
 that 2 fibers/cc was a reasonably level because of the health experience

of that weaving shed. No single population in the world has ^{been} followed-up for long enough at a 2 fiber/cc or ~~any~~ less level to ^{enable us to see which} ~~say~~, based upon human experience, ~~whether~~ this is an adequate level or not. Let's look at Table ^{II} ~~which is~~ ^{showing} the mean dust ^{levels} ~~table~~ and the number of men exposed to them. From 1936 to ^{over the period of observation} ~~1951~~ obviously I told you we ^{did not} ~~didn't~~ have dust counts. ^{were not routinely done} In 1936 they didn't ~~start having~~ dust counts until 51. that is ~~based on calculations made by the~~ ^{but it is} Based on calculations made by the committee of the British Occupational Hygiene Society ^{and the} ~~status~~ ^{statistician} ~~station~~ involved was Geoffrey Berry of the Medical Research Council's Pneumonociosis Unit in Penarth) and they arrived at a ^{means} ~~monas~~ of ^{calculating} ~~calculating~~ ~~based upon present~~ levels ^{that} ~~what~~ would be a reasonable estimate of exposure in those years when dust counts were not available. ~~So you can see as the years go by the dust counts come down not much until 1952. Again, 1952 was also~~ ^{period of} ~~is~~ the beginning of a modernization of the factory ^{and was} ~~which was~~ completed in about 1954, ^{engineering} ~~and~~ a lot of work was done, ^{many} ~~a lot of~~ jobs were changed, ^{altered} ~~a lot of~~ many processes were ^{it all} ~~altered~~ and ^{working} ~~that~~ resulted in a better environment. In 1969 new Regulations were made. Those ~~x~~ new regulations were ~~called the~~ ^{called} no longer ~~x~~ the "Asbestos Industry Regulations" but the "Asbestos Regulations" and they applied not only to the asbestos industry, but to anybody using asbestos where ~~xxxx~~ asbestos dust was ^{given} ~~giving~~ off in ^{such} ~~excess~~ concentrations as ^{was} ~~is~~ liable to be harmful to the health of the exposed person. As opposed to the American method of doing it, the British ~~xxx~~ have not put a figure in the asbestos ~~standard in the regulations~~ ^{to} ~~there is~~ no legally enforceable figure. The way it has been done is ~~by publishing~~ ^{to} as an addendum to the standard, ~~if you like~~ guidelines for the benefit of those people ^{who} ~~xxx to whom~~ ^{have to apply the standard}. The guidelines ~~the standard applies which~~ indicate what the current thinking of the factory inspectorate is ~~at the present time~~ ^{dust} with regard to the levels ^{to be achieved}. ~~they are going to enforce~~. That means that ^{they} ~~if~~ they want to ^{vary} ~~change~~ those ^{this} levels ~~to modify~~ tomorrow (and they have already changed them once since 1969), all they have to do is ^{amend the published guidelines} ~~pull that piece of paper out of circulation~~ and publish another. It ~~does~~ doesn't require an act of Parliament or any

^{forms' consultative}
~~sort of consulted~~ mechanisms to do this, although ~~xx~~ obviously ~~they~~ would
^{with all exposed}
~~consult before~~ ^{the guidelines} It really makes it very much simpler to operate the
^{don't have to play the "numbers game" and}
~~regulations when you haven't got a number which you could be punished for~~
~~if you go .1 below or .1 above~~ ^{this} which is the difference ~~xxx~~ between the
 OSHA standard ~~xxx~~ and the British standard. However, that ~~xx~~ just shows
^{In Table VI}
~~you the changes that took place.~~ You will see that the number of men
~~goes on increasing and then it starts declining and so this is obviously~~
~~because the cohort we are going to begin to~~ ^{losing} ~~xxx~~ people out of the cohort
^{people}
~~now and there are obviously fewer~~ in 1972 who have been exposed for ^a long
 period of time than there were in 1960 because we are losing them. ~~As you~~
~~can see that~~ ^{we've} In 1972, 32% ~~are~~ exposed at less than 2 fiber/cc. In ~~1976~~ 1936
 100% were exposed to ~~greater~~ greater than 5 fiber/cc and only 3% now remain
~~in it~~ ~~1972~~ in 1972 who ~~are~~ exposed ~~who~~ ~~xxx~~ ~~exposed~~ to greater than 5
^{demonstrates}
 fiber/cc. What this is ~~really showing you~~ is that with time the number
 of people ~~being~~ exposed to high concentrations is declining. It is just
 interesting to present it that way. ~~There are a number of~~
~~always in this type of thing.~~ World War took place and ^{Second World War} ~~During the war~~
 the regulations were relaxed. Factory inspector's didn't care too much
 about what the levels were. The government wanted production, asbestos
^{and} was essential ^{produced} it had to be ~~made~~. ^{was} Overtime worked, ~~xxx~~ women were brought
^{of}
 in to work instead of men and long hours ^{of} blackout restrictions made
 it impossible to ~~operate ventilations and all sorts of things.~~ ^{systems adaptations} You have
~~this period in World War which I don't know what effect~~ ^{this} ~~that~~ is going
^{have} to ~~be~~ on the follow up ^{in years to come.} // It is difficult to interpret the relevance of
^{present day}
 the results which I have reported to you to ~~modern~~ conditions. What
^{the result}
 we are looking at is a ~~hypothesis~~ of bad conditions in the past and
 a continued exposure of the same population to changing conditions. What
 we need is a long term follow up of people exposed ~~eventually at this~~
^{to}
~~level here~~ less than 2 fiber/cc for 20 or 30 years. // Dust levels don't come
 down in a day. It takes a long time to get down to less than 2 fibers/cc
^{The next slide}
~~and that is just a plot of~~ ^{graph showing} in the way in which the levels in the factory

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have been coming down. Even people exposed after 1950 ^{were} ~~are~~ having substantially higher levels of exposure than are at the present time permitted by law.

The thing to remember is that what we are interested in is diseases with an ^{incidence and} excess mortality. ~~That your factory may be build here and start producing~~

~~here and that is when you start fire the shot. You ~~didn't~~ ^{usually} begin to~~

see any difference in mortality experience, ~~you may see a slight~~ ^{until a latent period of} difference after 20 years but you may have to ^{follow up people for} go 30, 40 or 50 years ^{an} with occupational cancers before ~~that~~ ^{from occupational cancer} excess mortality becomes apparent.

This is why it is important ~~that you~~ ^{to} keep records of medical findings, ~~you~~ ^{to} keep personnel records which are accurate with regard to ~~data~~ date

of employment and types of employment and if possible the type of materials ~~to~~ ^{were} to which people are exposed, ~~which are hazardous or which~~ ^{may be considered hazardous in the future and that you} maintain a strict

control of your environmental monitoring and dust sampling and ~~that you~~ ^{bearing} record these meticulously ~~varying~~ in mind that some time they will have

to be related to the health experience of a group of people. It is only if you are meticulous about all that, that in the future we will clear up a lot of the arguments and lot of the mess which we are in at the present

time, simply because our ~~predecessors~~ predecessors had no concept of this type of approach ~~to~~ occupational medicine. Occupational medicine ~~in the past~~ for many years was the transfer of general practice into the factory ~~at~~ with

a captive population ~~and you could treat them. What it is~~ ^{is} In my opinion ~~is~~ that ~~part of it~~ ^{that's} a fringe benefit. ~~what is~~ ^{to enable me to} more important to me

is to establish a system of keeping records, abstract from these records ^{and} ^{to} ~~certain~~ information ^{analyze it statistically and obtain an idea as to how} ^{this} population compares with another population ^{with} or the general population.

~~If you so that~~ ^{can do all this} ^{will find out} you have an idea whether ^{your industry is} ~~you are~~ ⁱⁿ in any way ~~in~~ ^{impeding} or ^{impairing} the health of ^{persons} the employed ^{by it.} person ~~and~~ I promised ^{would} that I show you that improvement had taken place ^{at Rockdale} ~~and~~ ^{but} that doesn't show up ^{holding is} very well, that's a man and those are his legs and what he ~~has~~ ^{is} is a pitchfork.

There is a hole in the ^{floor}~~ground~~ and he is standing on a big wooden drum.

This is asbestos and he is ~~mixing~~ using his pitchfork to blend it on a open floor throwing it up in the air and letting it settle. ^{It's blowing} ~~and throwing it~~ about all over the place. That was ^{taking} ~~taken~~ place in ^{the} ~~a~~ factory that I ~~was~~ just ~~showing~~ talked about until 1954 and in some American factories that I visited in 1970 I saw that ~~still~~ ^{then} taking place and in some American factories that I visited in 1976 something very similar ~~to~~ was still taking place. And therefore that is another caveat. You have got to be very careful when you read the world literature because working conditions in different countries vary and ~~when~~ ^{when} some ~~of~~ people ~~are~~ ~~describing~~ ~~as~~ describe the horror and the disease associated with asbestos, ~~and their findings~~ ^{they} conditions under which those people worked have to be taken into account. I could show you lots of horror slides. I have been around the world and ~~seen~~ ^{have} seen conditions and I ^{got} slides to demonstrate the differences between the U.S., somewhere like South Africa, ^{Nam} ~~Mon~~ ^{basin} ~~basin~~, India, ⁺ Britain, ~~and~~ ^{It} depends upon the degree of sophistication of ^{Regulation} ~~and~~ of dust control as to what is going to happen to those people but authors of papers describing the effects seldom pay attention to that, and they ~~will~~ will talk about asbestos or asbestos textiles or asbestos cement and never show the pictures of the factory or tell you what the conditions ~~are~~ were like. ~~and that was 1954~~ and ^{So, for} OSHA or NIOSH to say that the Rochdale population was always exposed to 2 fiber/cc and hence the 2 fiber/cc standard is no good because they are still getting lung cancer is a lot of well there are ladies present. ^{That's} ~~That's~~ what happened to ^{this} ~~the~~ job-it was totally enclosed. The drum is now ^{enclosed} ~~in there~~ and ^{and mixes the fibre} ~~It~~ revolves and ^{There is a} ~~There is a~~ bag opening procedure ^{whereby} ~~the bags~~ are fed on ^{to} a conveyor belt and ~~go~~ ^{fiber} into the drum, ^{After mixing it} ~~and~~ tips it into another bin down on the floor ^{which} ~~and that is also~~ all enclosed and there ~~is~~ ^{should be} no dust. ~~That's the way it was in 1954~~. When I walked into that factory in 1966 I was taken on a tour and ~~they~~ ^{A00920}

me and asked' I wanted
looked at ~~the~~ and ~~I said~~ where ~~do you want~~ to start, and I said ~~I'll start~~
at the beginning where the fiber comes in, ~~and I found~~ I found ~~can I~~
~~take my camera~~ and I took my camera and that's what I found. This of
course is very good fiber, ~~that~~ ^{It} is the best fiber in the world ⁺ it comes
from Rhodesia. Turner & Newall owned the mines in kRhodesia and since
UDI they have not had any of that fiber. They have ^{not} had any of the profits
and they have been cut off from their mines because of ~~the British~~ sanctions.
~~I~~ I ~~wasn't~~ wasn't allowed to visit Rhodesia while I worked for Turner
& Newall. However in ~~the~~ ^{American} Raybestos' factories there is plenty of this stuff.
The United States hasn't bothered about sanctions. Anyway this was 1966
these were ^{burlap} ~~rolled up~~ bags. Every now and then you could see holes
in them. Shippers used to love this stuff because it ^{made} ~~was~~ beautiful
^{Ballast.} ~~balanced.~~ They could put a few bags in a corner here and a few bags ~~and~~
~~a corner~~ in a hole there and they could trim their ships ^{with it} ~~and~~ That's the
way it ~~just~~ used to arrive ⁱⁿ loose bags. The dockers had no respect
for these bags. ~~They~~ ^{They} had big hooks and the way they lifted ~~that~~ ^{them} is to
plunge a hook into the bags swinging over their sholders ~~and~~ ^{through} ~~it~~ over
the side to someone else, ~~and have~~ ^{used to result} a horrible mess ^{bags} and these things used
to arrive at the factory ^{where} and the chaps in the warehouse ~~they~~ did not have
quite as big hooks ^{theirs} so the little holes are ~~there~~ ^{and} ~~they used to pull~~
~~these things off and what you found was a stack like that and that~~
~~represented about~~ You can't imagine the size of this warehouse, ^{It was a} huge warehouse
full of ~~of~~ fiber stacked to the ceiling. It ~~was~~ ^{held} 18 months supply because
they knew ^{UDI} ~~it~~ was coming and so they brought ~~it~~ as much as they could
and as much as they could stuff into the warehouse. There were bags
bursting, there was fiber all over the place, ~~that's~~ that's what you
found. ^{It} was an impossible situation and it was very very bad. That's the
^{way it is} ~~what you find~~ today. The bags are now ^{made of} polypropylene or polyethylene ~~and~~
they are pressure-packed at the mines. ^{They} ~~These~~ are all ^{solid} ~~hard~~ they are like
bricks, they are palletized and very often they are covered with an
additional plastic cover. ^{is an example of fiber} ~~And that comes~~ from Cassiar up in Canada.

There are

~~in the~~ 2 mines; there is one in North British Columbia and one in ~~the Yukon~~ ^{at} ~~Clinton~~ ^{Creek.} Territory. ~~It's~~ ^{and} a nice part of the world to go to in January. ^{What we have} ~~is~~ ^{herefore} a story that is unfolding, ~~and~~ ^{and} this is rather an old slide ~~and~~ it tells you about asbestosis beginning at the beginning of the century. The incidence declining ^{at} in textile workers from 1930 onwards. I haven't mentioned insulation workers at all but the lung cancer incidence noted to be increasing in the late 50's early 60's ~~affected~~ ^{insulation workers to a large extent} ~~Asbestosis and lung cancer overall increasing this is~~ ^{as in occupation} in the U.K. while it was declining among textile workers. Mesothelial tumors ~~being~~ ^{were} recognized in association with asbestos in the late 1950's-early 1960's, ~~and work production taken off like that~~ ^{Asbestos use increased markedly} during the War and ~~accelerating~~ ^{accelerated} afterwards so that asbestos became a ~~universally~~ ^{utilised} widely used material. It was cheap, ~~and~~ easy to find and not expensive to mine and it was used in just about everything you could think of. With regard to mesothelioma in case you think we haven't had any in that factory, we have, ~~and~~ I don't want to get into a long argument about it but that factory did also process crocidolite fiber and in my opinion crocidolite fiber is the most hazardous type of fiber and the one mostly associated with mesothelioma, ~~and~~ ^{while} I was there I collected ~~30~~ 27 cases of mesothelioma, ~~and~~ ^{people} I hadn't seen any in ~~anybody~~ exposed after 1950. The average lapsed interval was long. At the present time Prof. Doll is initiating a study of mesothelioma incidence at TBA. Just before I left we completed going through our personnel record cards back to ¹⁹ 1918 and collected something like ~~nearly~~ ^{records of} 30,000 people who had ever been employed. The group in Oxford are now going to check through those. They will probably take a random sample to start with and ~~face~~ trace them to see what they can find with regard to mesothelioma. ~~whether we~~ ^{Have we} underestimated our experience? ~~or whether just to try and see what they can find,~~ ^{so} That is the next study which is going to emerge from this particular ~~group in Oxford.~~ ^{Factory.} I have taken up a lot of your time. I think it's over the hour and I must apologize. That is all I have to say.

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