particular aircraft at all events in taking off in a congested area, the nose should be pointed towards the people one wants to annoy least In connection with the foregoing figures and tables of external noise it will be useful to know what power was being produced in the various tests Table IV gives information on this as well as specifying the particular mark of helicopter concerned

What conclusions can we draw from our latest information ? On the whole, they are encouraging , at least, they are not as frightening as we might have imagined them to be You have seen the results and heard samples of the noise of the huge Westminster It is not all that bad No doubt there will still be a serious noise problem and we must do all we can about it, but we can be very hopeful about the whole thing Compared with the jets, I think we are well in the clear

I should like to express my grateful thanks to Westlands, not only for arranging the noise demonstration, but also for permission, given similarly by the Bristol Company, to present these results on their new helicopters It is very public-spirited of them to allow them to come out at this comparatively early stage

Discussion

The **Chairman** invited Dr G E Bell, of the Ministry of Transport and Civil Aviation, to open the discussion

Dr G E Bell (*Ministry of Transport and Civil Aviation*), who said that most of the points associated with the noise of helicopters had been at least touched upon by Mr Irving in the course of his talk, expressed his intention of underlining the extreme importance of the outside noise In the case of fixed-wing aircraft at airports, as everybody knew from correspondents all over the world, the problem had grown to be very acute and it was generally agreed that the aircraft that were now flying had just about the limit of noise level that the general public would endure This was the experience in certainly the United States, England, France, Australia, Germany and Holland There was a difference between the reactions to the fixed-wing aircraft, to which people were accustomed, and to helicopters, which were not yet fully operational in any real sense of the word

When London Airport was opened, in 1947, and for a few years thereafter, the predominating aircraft were the comparatively small DC 3s and Vikings and there was no serious measure of complaint Post-war developments had brought the bigger aircraft and ultimately, in 1952, the original Comet made its appearance, providing a rather sudden step from the comparatively small and quiet aircraft, apart from the Constellation 749 and the like At London Airport, the Comet was the instrument which began the campaign against noise Subsequently, other aircraft had come along and if the original Comet were to be introduced today, it was fairly certain that nobody would really worry, at least when the aircraft was in flight

It was important, if possible, to accustom the public to this sort of thing in a peaceful manner in gradual stages If the helicopter was to serve the purpose for which it was intended, it must operate from city centres or somewhere near city centres It also must have fairly few restrictions on its path It was no good making it fly by circuitous routes if that could possibly be avoided This meant that the noise must be cut down as much as was ever possible This raised the question, " It is all very well, but what should it be cut down to ? " For a brand new noise such as the helicopter represented, this was a difficult question to answer

It was a common and fallacious argument that cities were noisy and the addition of the helicopter was unimportant Even in a city like London, although the busy streets were noisy, as soon as one got away from the main streets London could be surprisingly quiet One of the quietest places he had ever measured, for example, was Queen Square, Bloomsbury If helicopter noises, which could be described as inaudible in the main streets, suddenly appeared in the residential areas where people had been living in comparative peace and quiet for a long time, it was certain that they would make a stir about it Therefore, as the Author had said, it was worth a very great deal and a considerable sacrifice to get these aircraft reasonably quiet, otherwise there was quite a growing risk that the public would not stand for them

Mr Irving said that the meeting was fortunate in having somebody like Dr Bell, who had experience of the public complaint end of the problem, to speak For his own part, he was rather inclined, perhaps, not to take public reaction as seriously as Dr Bell had to take it, and therefore it was very nice to have his views

Mr F B Greatrex (*Rolls-Royce Ltd*) said he had to admit that he had flown in an airliner in which he would have liked to have had a hood over his head, but surely it was not seriously suggested that passengers should be submitted to this kind of treatment inside a helicopter If so, it would be just as well to give up the whole idea of trying to get helicopters quiet enough inside

The Americans, however, seem to have managed it From an article concerning the Vertol aircraft, it appeared that the noise had been brought down to levels that were just as good as in ordinary commercial airliners In fact they had met quite a stringent specification which started from 105 db in the first octave and dropped to 58 db in the top octave, practically a straight line

The main interest of Mr Greatrex, however, was in the noise made outside the aircraft, noise that upset the people who probably had no intention of ever travelling by helicopter and who would do their utmost to stop them operating if they worried them It was people of this type who had to be looked after when considering the noise made by jet airliners around airports

There were a number of questions to be dealt with The first was, as Dr Bell had said, the one of establishing what was the acceptable level of noise For people living around airports it had been possible to establish a level which appeared to be just about tolerable for the noise from the intermittent flying-over of aircraft, a noise which occurred only at intervals Outdoors this was a level of approximately 113 PNdb This same noise level corresponded to an indoor noise level of the order of 95 PNdb It might be possible to argue that these were numbers which would be tolerable for intermittent operation The only real experience, however, was around airports, and it was difficult to say what level would be tolerable inside a city

Secondly, how far away must one consider the people to be from the helicopter ? The Author had shown slides of the noise from aircraft flying overhead at 500 ft This, however, was probably not the worst condition, because the fly-over noise was quite quiet This corresponded to the technique adopted with jet airliners of throttling back as soon as they cross the community boundary, and flying at the minimum power at which they can safely climb away With helicopters, however, we must deal with the take-off noise itself, because the machine would be in a smaller, restricted space with, presumably, people all round it

Under these conditions we might use this same figure of 500 ft as a guess at the kind of distance at which it was necessary to take account of people in offices This figure clearly depends on the sort of site which would be used for helicopters Presumably, it would not be in a quiet residential area There were more likely to be offices, warehouses, railway stations or the like around it Obviously, schools or hospitals would not want to be in the immediate vicinity, but a department store would enjoy the trade of the airport and would therefore not object to the noise What were the Author's views on this ?

On a different subject, apart from the ordinary noise of the tip jets, which was a problem in itself, the Rotodyne had a variation of noise of the order of 10 db varying about ten times a second, the peak noise being probably 3 or 4 db above the R M S value What was the noise that mattered in a case like this ? Was it the mean R M S noise, was it the peak or was it even worse ? Was the flutter effect a singularly annoying one ? It would be interesting to hear the views of experts on these matters

Mr Irving expressed his agreement with most of what Mr Greatrex had said The curves shown rapidly at the end of the lecture, the information from which would appear in the printed paper, gave details concerning take-off noises, and it would be found that they were only a few decibels above the 500 ft fly-over figures which had been given Other members of the audience might have more to say on Mr Greatrex's remarks

Mr Purkis (*Building Research Station, Garston, Watford*) said that at the Building Research Station there had been no measurement of helicopters for a long time Recently, however, Mr Parkin, who was unable to be present this evening, had written a paper for publication in a suitable journal which tried to put into perspective something about the present state of knowledge on noise levels that would apply when large helicopters flew into and out of large cities Apart from the information given by the Author tonight on the noise from helicopters, particularly the turbine-driven helicopters, the published knowledge was mainly on piston-engined machines Although Mr Irving was of the opinion that piston-engined aircraft were on the way out, the information published so far related only to the noise levels for piston engines For the time being, therefore, these figures should be followed

From the published information, some of which was compiled by the Building Research Station and some in Australia, if the overall noise level of the aircraft was plotted against its weight, there would be found to be a surprisingly good correlation between noise level and weight In other words, the heavier the aircraft, the louder its noise Thus, at a distance of 125 ft , a 40-seater unsilenced helicopter weighing something like 20,000 lb , would be expected to make a noise level of 110 db This occurred for the normal fixed-wing aircraft and one would expect it also to occur for a piston-engined helicopter It was certainly true that the smaller helicopters followed this mass law

The only figures shown by the Author were mainly for turbine-driven machines, but that given for the Bristol 193, which, it was understood, was also turbine-driven, was an amazingly low noise level for its weight

By following the published figures on noise levels for piston-engined aircraft, it was possible to calculate the effects on buildings The propagation through the atmosphere was known provided that the aircraft was not too low on the horizon What was needed was a criterion for determining what noise level should be applicable inside the building For offices, about the only information to be published was Beranek's criterion, which had been confirmed by B R S experiments If one took the 80-phon level as the maximum tolerable, probably 70 phons would represent a more realistic view Certainly, telephone use was impossible in an average office at more than 80 phons It was, therefore, an important practical consideration that if noises of this sort were to occur with any frequency, 80 phons seemed to be the maximum level at which to aim

Assuming that an aircraft produced a noise level of 110 db at 125 ft , a maximum level of greater than 80 phons in offices would be achieved at distances of up to 6,000 ft if the office had open windows, or at 650 ft if the office had normal closed single windows, yet the corresponding distance was less than 125 ft with fully-sealed double windows of the best possible insulation obtainable The corresponding distance for an aircraft making 100 db at 125 ft —this corresponded probably either to a smaller unsilenced or a larger silenced type of aircraft—were 2,500 ft with open windows and 250 ft with single closed windows

In addition to offices, however, there was also the question of auditoria of various kinds which existed in many large cities This category included concert halls, theatres seating more than 500 people, opera houses, broadcasting studios and the like A suitable criterion[1] could be assumed for the maximum allowable noise level inside such an auditorium, not being the lowest noise level which could be achieved, but as the reasonable tolerable level which could be expected to be obtained for such an auditorium, assuming that it had (*a*) no windows and (*b*) a 5-inch concrete roof The area affected by a helicopter, on the same basis of producing 110 db at 125 ft , was shown as the light shaded area on the map of London in *Slide 1*, the centre of the circle being roughly the South Bank air terminal and the radius of the circle 6,000 ft The light-coloured circle showed the area in which any auditorium of the type described was affected even momentarily by an aircraft producing that order of noise

Such an auditorium was, of course, comparatively rare by existing building

1 Parkin & Humphreys, Acoustics Noise and Buildings Faber & Faber, London p 295

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standards Most theatres were fairly well protected against the noise of traffic There were foyers, and so on, and possibly shops and buildings forming the front to the street The walls were generally of fairly thick masonry and, consequently, there was fairly good protection against traffic noise The roofs, however, were usually of comparatively light-weight structure and were not normally expected to be exposed to fairly loud noises Thus the area that would actually be affected would be even larger than the area shown for type of theatre described The sort of theatre which had been postulated was a comparatively well-insulated one

That was roughly the sort of position that would be achieved if helicopters producing that order of noise level were allowed into and out of large cities If the sort of noise level shown tonight by Mr Irving was effectively quieter, everybody would be better off, but it was not likely that the orders of noise level would be much lower It might be possible to gain 5 db by going over to a turbine-driven aircraft, but, on the other hand, the result would certainly be 10 db worse by going over to a jet-driven rotor

Mr Irving, who thanked Mr Purkis for his contribution, said there was little doubt that at least 5 db would be gained by the change-over to the turbine It was too early to say definitely On the other hand, size and power were continually being increased, and, therefore, Mr Purkis's remarks must be taken seriously

As regards the jet-driven rotor it should not be forgotten that its adoption would probably lead to a great saving of tare weight In such a case the 10 db increase in noise mentioned by Mr Purkis would not apply for comparisons on a pay-load basis

Mr Purkis recalled that the Author's last slide showed the noise level from the Westminster at one particular angle to be 95 db at 500 ft This corresponded to about 106 db at 125 ft Therefore, it was not very much down on the sort of aircraft which Mr Purkis had postulated, for that particular angle at least

Mr Irving agreed and said that the size had outweighed the change-over to turbines On the question of windows, many would appreciate that in London there was a terrible noise in any event from traffic and a tremendous advantage would be gained if office buildings went over to double windows that were always closed and were air-conditioned There was, however, little likelihood of this in the foreseeable future Even on the fifth floor of Thames House, the noise on the river front was a bugbear when telephoning during the summer with a window open

Dr D B Leason (*Fairey Aviation Co Ltd*) suggested that what he was about to say might lead to considerable controversial discussion His intention was to give the current figures for the latest type of silencer The reason why Mr Irving had not been supplied with the figures was that as the silencer programme continued to develop, there was a progressive improvement in quietness The position had changed quite considerably from the limited circulation figures which Dr Bell and B E A possessed

The latest silencer, on prediction from Mr Greatrex's method of predicting the sort of attenuation that would be expected to be obtained from a corrugated silencer, should give about 11½ db attenuation Static tests showed that it gave about 10 db, though spot observations on a spinning rotor did not show quite such a large attenuation This was the first silencer which had given a drop in attenuation when it had started to spin As the tests were probably not as accurately measured on the spinning rig as one would have liked, it was possible that the 10 db was still being obtained

Taking the most pessimistic figures, there would be the following condition for the type of city take-off that one might visualise—*i e* a vertical climb of about 200 ft and then acceleration forward in a mild form of climb At the 500 ft point, 98 db overall Spectrum analysis-wise 85, 88, 89, 90, 90, 93, 91 and 84 db Statically, the eighth octave band was giving something of the order of 12–14 db attenuation

The eighth octave band was important because it determined the perceived noise level or PN value From these figures, the PN value worked out at 113, which should be compared with 108 given by the Author, for the Westminster doing a normal take-off For a town take-off there was a figure of 103 PN

On a decibel basis, for comparison under these conditions of a town take-off, the Westminster figures were about 93, whereas in a normal take-off it would give about the same value as Rotodyne, *i e* 98 It might be pointed out that this indicated a noisier trend and that the fluctuation to which Mr Greatrex had referred existed It was not known how this would affect people When something flew directly overhead, however, there was no fluctuation It was coming virtually from a noise disc

The Tyne-powered version of the Rotodyne was, of course, the 50,000 lb aircraft It was a big aircraft and, consequently, its tip jet units would be bigger This would send the frequency down The power required would increase and overall db value might go up, not very much, but to some extent

The curve of PN against frequency shows a characteristic negative slope Thus' if the frequency is shifted downwards, a higher db value is allowable for the same PN value Thus the stage is reached when it appears that one can say that at least the PN value may remain unchanged It might possibly go down a little, but it would probably remain unchanged, so that the current figure of 113 would be the sort of level obtained with a 50,000 lb aircraft if everybody decided to sit back and do no further work on silencers More work would, of course, be done and the noise level would continue to be brought down Now that PN values were regarded as being the important thing, there would be concentration on the high frequency end, which was not too difficult In recent discussions and exchange of information, Rolls-Royce had agreed that with the present size of nozzle, corrugated nozzles would have most effect in the high frequency

This was not by any means the end of the story, because with the Tyne-powered aircraft there was a goodly power in hand on twin engines It was necessary to meet the safety requirements of landing safely on one engine Consequently, in an emergency case, the rotor must, on one engine only, be able to let the aircraft down safely To do this, one would obviously operate that half-rotor at the maximum possible amount of fuel/air ratio, and it should be noted that the existing silencers were already developed to take stoichiometric burning Thus for the emergency case the aircraft would be working on a fairly high temperature jet However, for the normal twin-engined take-off it would operate at a much cooler jet temperature By operating with a cooler jet there would be a marked attenuation, possibly of about 5 db

Mr Irving replied that he was very interested to hear of Fairey's efforts and wished them all the best luck in the very difficult problem Possibly he had gathered the wrong idea about the effect of spinning , he thought that a reduction in the effectiveness of the noise-suppressing nozzle in the spinning condition was expected

Dr Leason added that there was an attentuation as a result of spinning, but this was obtained with a plain jet anyway When a silencer was applied, one would like to get the same basic level of reduction In this one particular case, the measurements which had been obtained were not quite so good as one would expect They were being studied to discover the exact reason , aerodynamic causes were suspected but this was surprising because it was a very low drag unit as it was

Mr C E P Jackson (*Westland Aircraft Ltd*) said that he wished to make one or two small points The first was the question of judging subjective noise levels It seemed to be becoming more and more common nowadays that when reading about these things in the papers, one would see contradictions such as that in the current issue of the *Daily Telegraph* concerning the Tu 104 Whilst the Russian Air Attache considered that the inside of the cabin of this aircraft was superior because it was so much quieter than the Comet, the correspondent writing the note stated that he found the inside of the Tu 104 to be very noisy, particularly near the engines It obviously depended upon where one was sitting

Mr Greatrex had raised a point concerning peak versus R M S values and Mr Jackson wondered whether anyone present was doing work on peak noise , this might be of importance Although there was not much difference in people's objective noise measurements of turbine versus piston-engined helicopters, it might be that the piston-engined types had their different frequencies combined in the bang-bang-bang of the exhaust and it might be the peak value of this process that was so noticeable This was why the impression which one obtained of a turbine helicopter as being much more quiet than a piston-engined one, relative to size, might be due to lower peak values

The turbine helicopters gave a maximum octave band analysis in about the fifth octave band The piston-engined ones were in about the second band Indoors,

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the higher octave bands would be suppressed better by whatever windows there were and, therefore, indoors the turbine ones would be much more acceptable than the piston-engined machines

Mr Irving replied that he agreed with all that Mr Jackson had said The point about the peak was an important one and the question about the external and internal noise was also quite important

An Englishman he knew who had flown in the Tu 104 only a few days ago had stated how quiet and comfortable it was

Mr Irving added that he wished to record his grateful thanks to Westlands, not only for arranging the noise demonstration which had been given this evening, but also, together with the Bristol Company, for permitting the presentation of the results of measurements of the noise of their new helicopters It was very public-spirited of them to allow these results to come out at this comparatively early stage

Westlands had also gone to the trouble of displaying at the meeting the various items of noise measuring equipment that were currently in use by the Firm

Mr Purkis asked what would be a reasonable angle at which a helicopter would be expected to take off in a town centre For purely arbitrary reasons and for the purposes of the paper to be published, an angle of 30 degrees had been decided upon Was this too steep, or was it not steep enough ?

Mr Irving invited Mr Jackson, who had been present at the various take-offs, to reply

Mr Jackson said that he could not quote the actual angle, but the main readings were taken during a standard take-off as normally used by Westland pilots Take-offs which were referred to as town take-offs were done at the minimum safe forward speed, in most cases 30 knots In every case it was at a safe speed, as proved by actual tests which showed that at any point with engine failure of a single-engined aircraft it was possible to come down safely and land

Mr Irving added that for two take-offs by the town technique, altitudes of 280 and 180 ft had been attained at 500 ft from the pad There was a considerable difference between the two There was, however, a very great difference between the normal technique and the town technique

Mr Purkis remarked that under those conditions, his angle of 30 degrees was very optimistic, but the area of city affected by the noise would vary considerably with the angle of take-off

Dr Leason pointed out that in a very congested site, one would have to do a vertical take-off to, say, about 200 ft , before moving into forward flight

Captain J A Cameron (*B E A*) (*Founder Member*) stated that he was in agreement with Dr Leason Having attended various I A T A Conferences at which this matter was discussed, it could be categorically stated that helicopters must be able, power-wise, to make vertical take-offs at maximum all-up weight Take-offs could be vertical or slightly over the vertical, thus enabling pilots to keep the heliports in view during take-off

Mr Greatrex asked whether in helicopter take-offs a minimum clearance round the machine was necessitated for airworthiness safety requirements—in effect defining a minimum size of " heliport "

Mr D L Hollis Williams (*Westland Aircraft Ltd*) (*Member*) suggested that it depended upon the installed power of the particular helicopter If it was proposed to do a towering take-off, it would have to be demonstrated in continuous flight with one engine failed

Dr Leason replied that that implied a certain clearance for buildings of, he thought, 1 in 8

Mr F N R Ballam (*Westland Aircraft Ltd*) (*Member*) said that from the viewpoint of noise, a vertical climb might not be the best solution

Dr Leason agreed Sometime one might have to do a vertical take-off and then accelerate in forward flight

Mr Ballam suggested that there was a connexion between the power used and the amount of noise In other words, was it possible to compromise with the rate of climb ? (If a vertical climb were inevitable, not use maximum power, if possible reduce power to point where noise is tolerable and accept attendant lower climb rate and longer time in presence of aircraft)

Dr Leason replied that it depended on the size of the site

Mr Greatrex said that the answer was probably in the sort of compromise which had had to be made on the Boeing 707 All-up weight must be limited when space is restricted

Mr Wilson (*Boscombe Down*) remarked that there had been no reference, in the lecture, to the Acoustical Comfort Index method of evaluating noise levels As a result of numerous flight measurements, the method seemed to give quite realistic results Did its absence mean that the Author had lost faith in this method ?

Mr Irving recalled his statement at the beginning of his lecture that helicopters fell a long way short of the R A E standard, as regards internal noise

Mr Wilson said that the principle of quoting noise levels as an acoustical comfort index figure was useful in that a high numerical value would be obtained for a noisy condition of flight whereas a low value would be obtained for a less noisy condition even though this was not very apparent from results quoted in decibels

Mr Irving said he was not clear as to what was implied

Mr Wilson explained that there was a simple method of working out this index of comfort, for any condition of flight, from the results plotted on the octave band scale

The Acoustical Comfort Index method seemed to be a fairly reliable method of judging an aircraft's noise properties He understood that this method was used quite extensively in the United States (*Ref* A method for Evaluating Aircraft Acoustical Comfort By Stanley Lippert and Matha M Miller *The Journal of Aviation Medicine*, Vol 23, February, 1952)

Mr Irving replied that he agreed It was necessary to have some such figure He did not know which particular index of comfort was being referred to, but he would be inclined now to work out the results as perceived noise levels in decibels and take that as his index of comfort Did Dr Bell agree ?

Dr Bell said that he would want notice of that question !

The Chairman said that one reason why development of the tip-turbine system had been retarded a little in America was because the Air Transportation Corps had stated that, even if such a system were fully developed, the noise level would not be acceptable This was in spite of the fact that in America the acceptable noise level was not so low as in Britain There was no suggestion that ears were more delicate in Britain, but, as pointed out recently by Professor Richards, it was due to the fact that is was easier in America to take legal action against people for making a noise Thus the acceptable standard had to be raised

He had been wondering whether the Author had thought of mentioning possible applications of the jet flap for propulsion of rotor blades and whether such a system would give a reasonable noise level eventually Another related feature was the Rolls-Royce idea of using a battery of small engines for jet lift Were these small engines likely to have a fairly low noise level, or, like the jet flap, have a high frequency content owing to their small dimensions, thereby resulting in noise attentuation ? Possibly these questions, however, were beyond the scope of the lecture

Mr Chowns (*B E A*) asked whether the Author could give any information on ground-to-ground and air-to-ground atmospheric attenuation as against the pure distance effect

Looking at Beranek's work for the Port of New York Authority, the air-to-ground atmospheric attenuation for a Comet appeared to be 2 db per 1,000 lb and, on the same basis, for a Viscount about ½ db per 1,000 lb He was sure that Parkin and Purkis had done some work on ground-to-ground noise attenuation and this seemed to be something like four times that for air-to-ground attenuation The nature of the terrain makes a vast difference, of course

His own office was at the end of runway 10R at London Airport and it was possible to make comparisons between the noise of the Boeing 707 and that of the Comet At this point the Comet, after a steep initial climb, is a good deal higher than the 707 and his own impression was that the Comet sounded noisier than the 707, in spite of the fact that recordings seem to indicate that at the same altitude the reverse is the case Could this be explained by this difference in atmospheric attenuation ?

Following the Author's comments about soundproofing on the Whirlwind, he thought this was an easy way of putting a lot of weight into the aeroplane without doing much to the noise level in the cabin When Convairs were building the model 440 they carried out detailed noise measurements inside the cabin of the 340 and then they graded the thickness and density of the soundproofing along the side walls of the fuselage according to the noise level in the particular area, going from its thickest in the region of the propeller plane and thinning out towards the rear of the cabin

In measurements on the Viscount, it was found that noise level contours seemed to run down the length of the cabin from "point" sources in the propeller plane, showing that there was this "thinning" out of noise towards the rear end of the aeroplane

Perhaps Dr Bell would, after all, give an answer on the PNdb question, although one did not blame him for wanting written notice Could a convincing case be made to show that measurements in PNdb gave a result that made it worth while to change from the phon ? The PNdb was not backed up by so much controlled experimental work as was the phon Furthermore, had not Beranek and company assumed that the noisiness of each octave band had the same effect upon the neighbouring octave band as Stevens had done when dealing with loudness ? In the calculation for noys and PNdb the same equation was used as for the sone and the phon One wondered whether this was justified and whether too much weight was being placed upon PNdb when it would be as well to stop at the phon

Mr Irving suggested that Mr Purkis could give a better reply As regards transmission along the ground, while the position concerning vertical or nearly vertical transmission was fairly clear, there was a great lack of information about transmission either right along the ground or at very fine angles to the ground It was generally agreed that there was much room for further research in this direction The various results which recently had been examined showed very big differences and evidently the transmission along the ground depended very much on the nature of the surface of the ground, temperature gradient and all kinds of things which had not yet been sorted out but which ought to be sorted out It certainly was an important aspect and one about which Mr Purkis was better informed than himself

He agreed that the grading of soundproofing was important and that there were possibilities of saving quite a lot of weight by proper grading Lockheed, for example, had taken tremendous trouble to find out the levels of sound all round the cabin of the Electra aircraft and to adjust the noise absorption or suppression accordingly It was said that they had obtained a very good result

Mr Purkis said that given a further twelve months, it would probably be possible to give some sort of an answer concerning ground-to-ground attenuation At long last, he and his colleagues had obtained a jet aircraft to do measurements of ground-to-ground attenuation, and it was hoped to be able to get some results in twelve months

Mr Irving asked whether the jet engine was the best and most realistic source of noise for the work

Mr Purkis replied that such an engine was a reasonable source of noise which could produce measurable levels over distances of the order of $\frac{1}{2}$ to 1 mile

The Chairman, in closing the meeting, said that he would like to propose a hearty vote of thanks to Mr Irving for his excellent paper on this important subject

The vote of thanks was accorded by acclamation and the meeting then ended