

**NASA ENVIRONMENTAL COMPATIBILITY  
WORKSHOP  
ATLANTA, MARCH 17-19, 1998**

**REDUCING THE IMPACT OF  
ROTORCRAFT NOISE  
AND DEVELOPMENT OF FUTURE  
NOISE REDUCTION TECHNOLOGY**

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**GKN Westland  
Helicopters**

# HELICOPTERS & CTRs

- NOISE IS THE CRITICAL ENVIRONMENTAL ISSUE?
- ... IS THIS TRUE?
  - ... NO, PUBLIC ACCEPTANCE IS THE MOST CRITICAL ISSUE!

NOTE: PUBLIC ACCEPTANCE IS OFTEN VOICED AS A DIRECT NOISE ISSUE BUT IT IS DEPENDENT ON WIDE RANGE OF FACTORS.

# PUBLIC ACCEPTANCE

- WHY ARE SMALL/MEDIUM HELICOPTERS LESS ACCEPTED THAN FIXED-WING AIRCRAFT?
- WILL LARGE PASSENGER ROTORCRAFT ( S92, EH101, BB609, FUTURE LARGE CTRs ) BE CONSIDERED LIKE CURRENT HELICOPTERS?
- HELICOPTER OPERATIONS CAN BE **ACCEPTABLE**
  - HELIJET COMMUTER: VANCOUVER-VICTORIA, B.C., CANADA
  - AIRSPUR (AFTER INITIAL PROBLEMS), LOS ANGELES 1982/84
  - 1960/70 NEW YORK, CHICAGO AND LOS ANGELES OPERATIONS
  - ABERDEEN 'NORTH SEA'(UK)
  - PENZANCE-SCILLY ISLAND (U.K.)

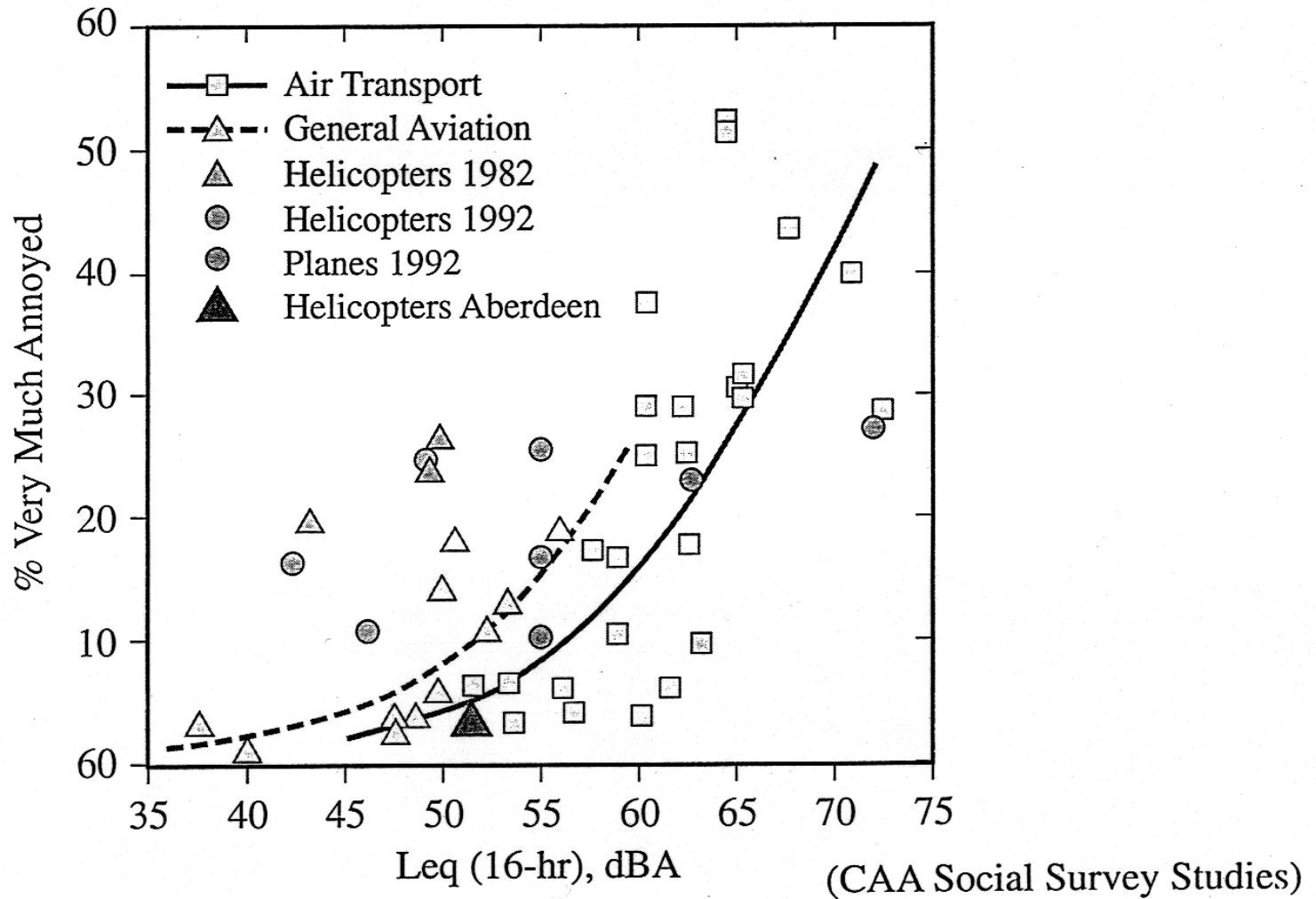




# — ANNOYANCE REACTIONS

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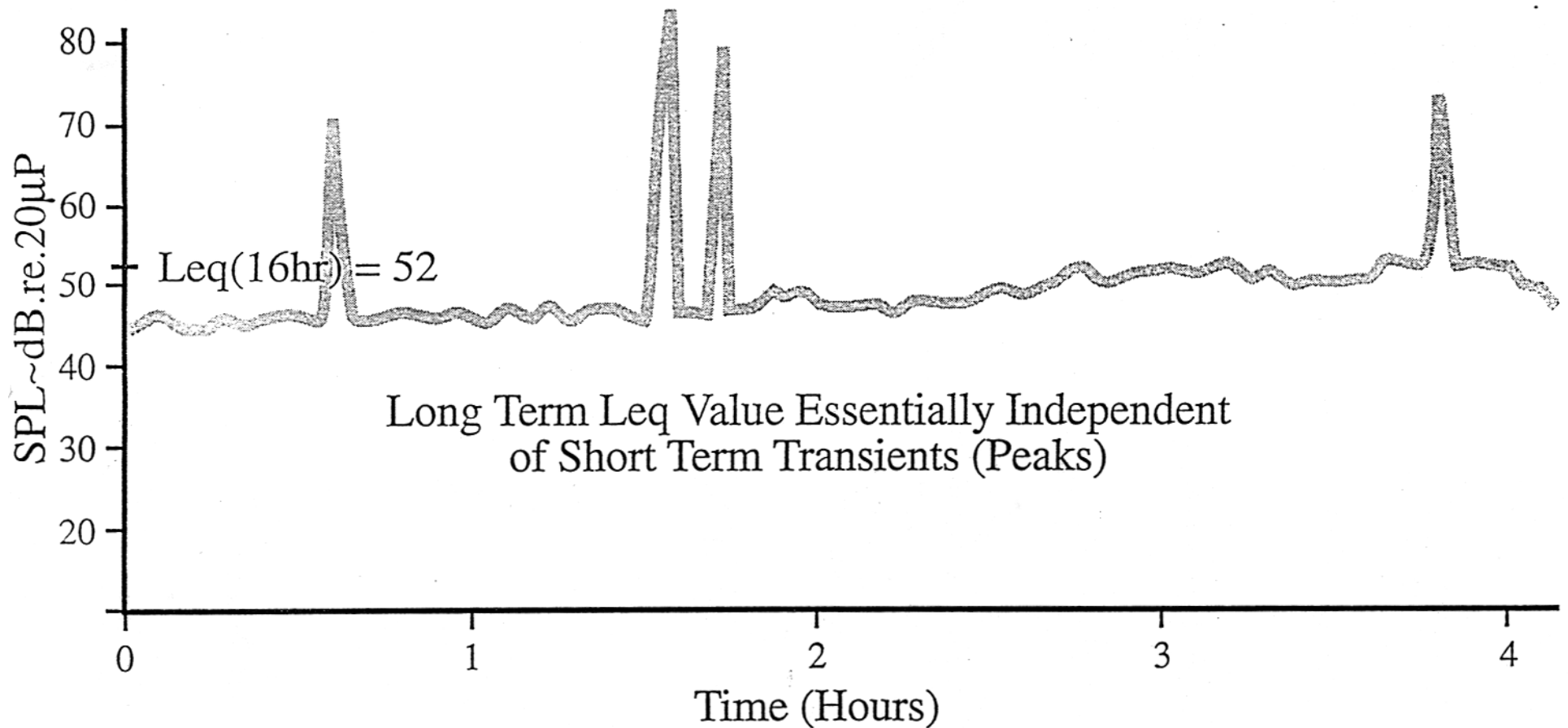




# COMMUNITY NOISE LEVELS

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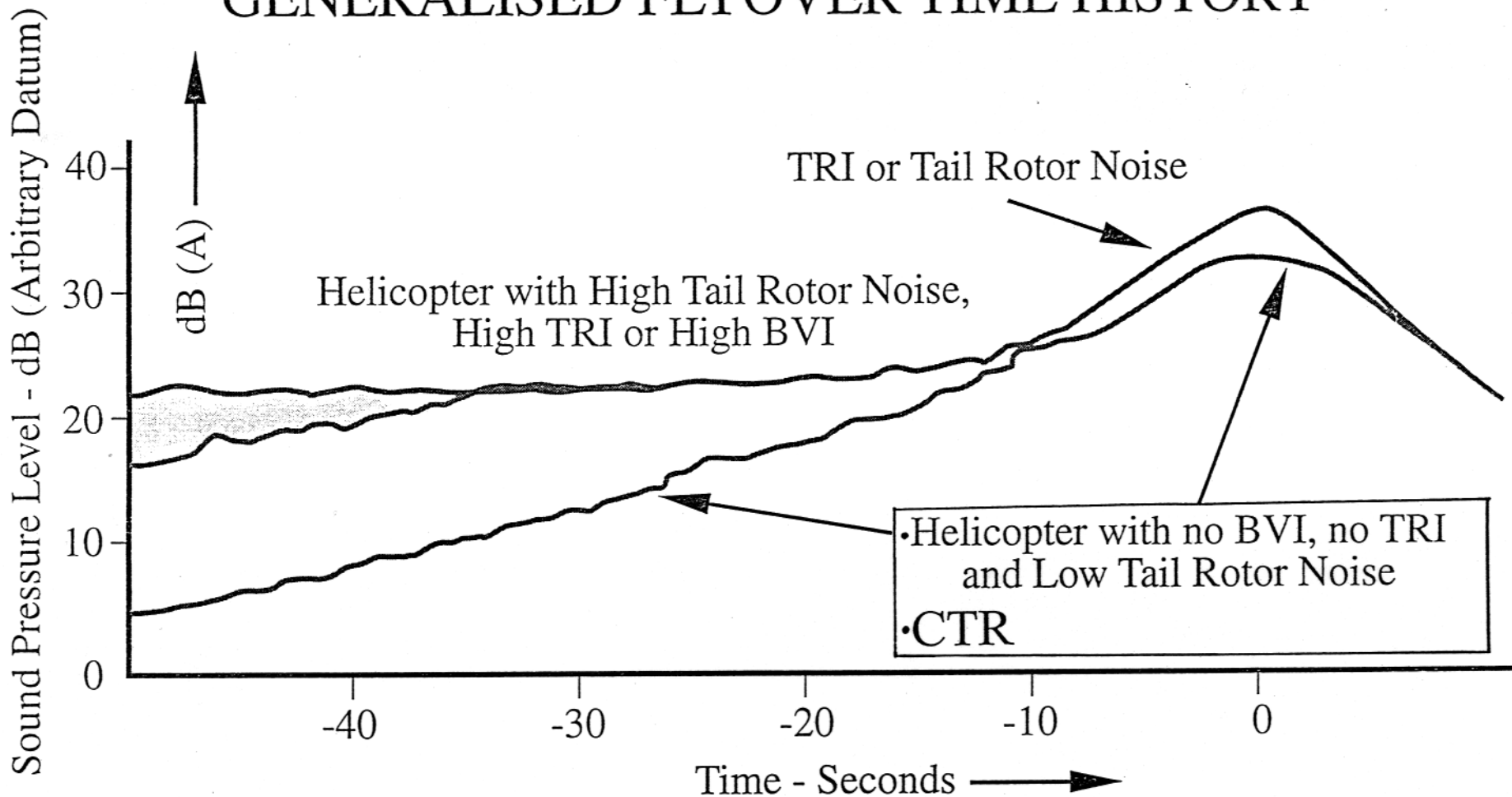
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# HELICOPTER NOISE

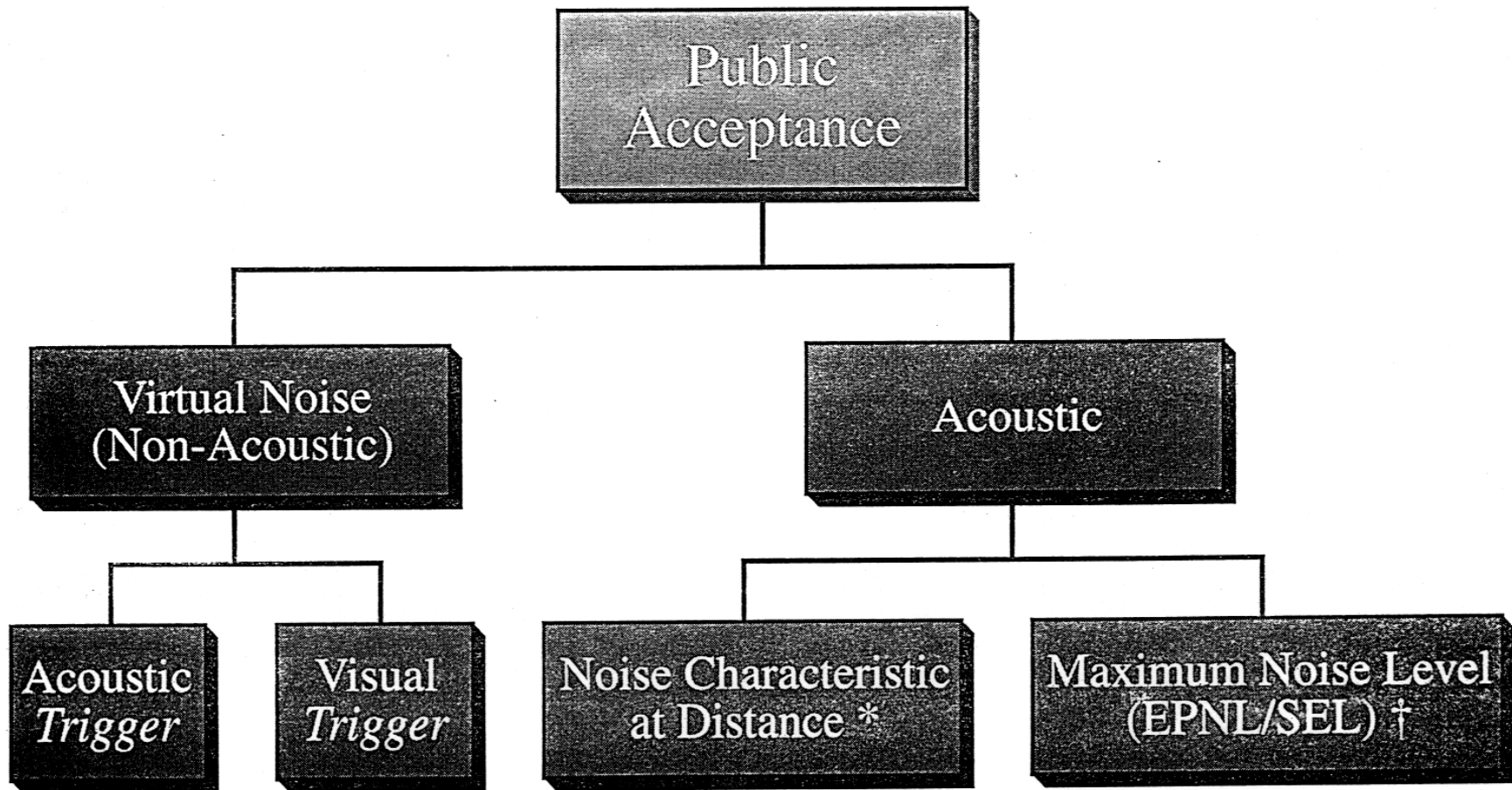
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## GENERALISED FLYOVER TIME HISTORY



# PUBLIC ACCEPTANCE

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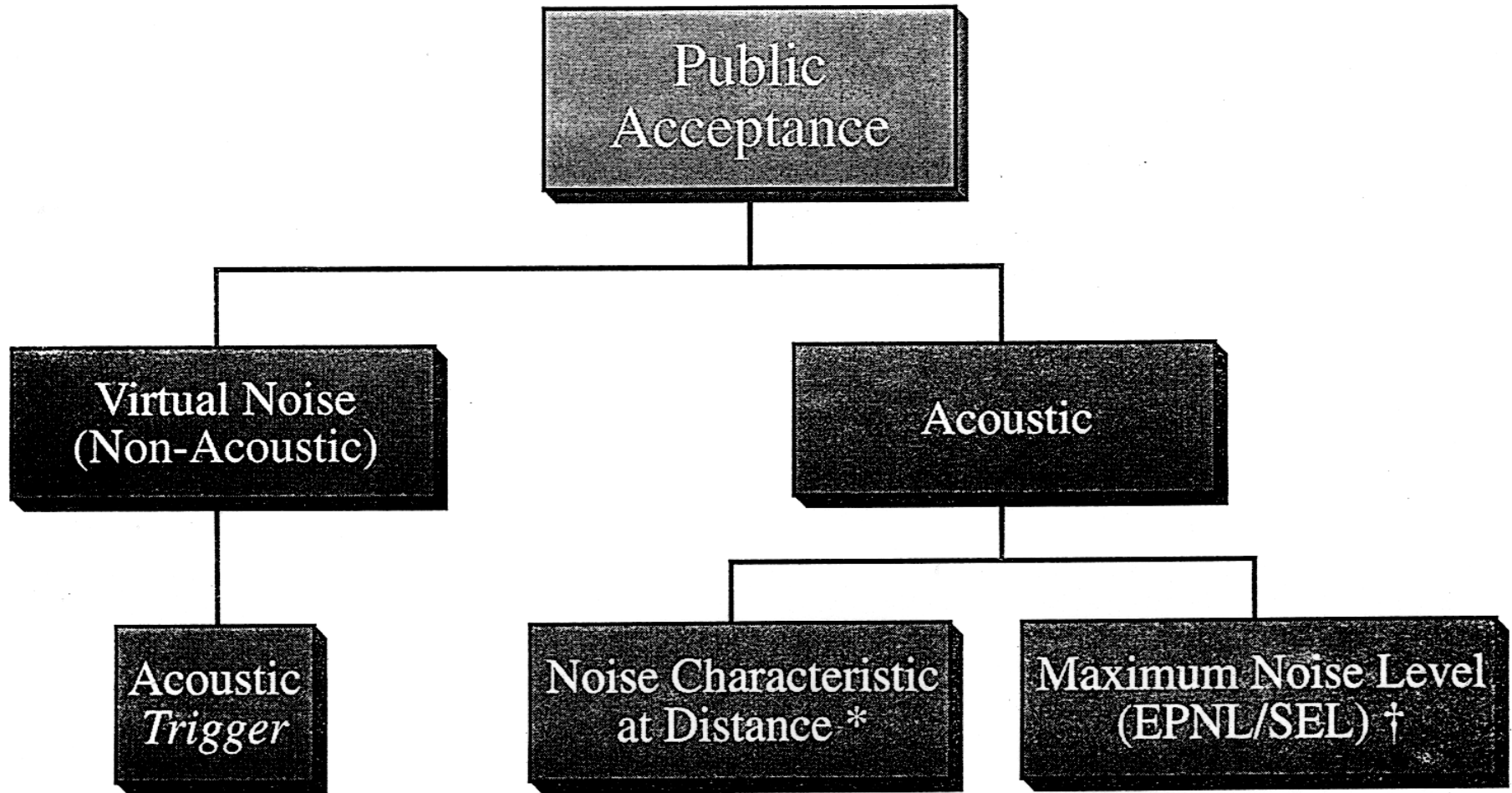


\* Trigger for Non-Acoustic

† Certification Value

# PUBLIC ACCEPTANCE

FEA120-07



\* Trigger for Non-Acoustic

† Certification Value





*PUBLIC ACCEPTANCE*

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# Reaction to Helicopter Noise Acoustic and Virtual Noise<sup>†</sup>

<sup>†</sup>Virtual (Non-acoustic) Factors Equal OR more  
Important

# — ACOUSTIC FACTORS

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## Helicopters

Noise Character at Distance\*

Duration

Maximum Noise Level (Certification Level)

## Community

Background (Ambient) Noise Level

Variations in Level with Time

- \*Level of - BVI (Blade Vortex Interaction : Impulsive Main Rotor Noise)
- TRI (Tail Rotor Interaction : Main Rotor Wake/Tail Rotor Interaction)
- Tail Rotor (Tail Rotor 'Whine')
- Engine (Not a Major Issue)

# — VIRTUAL NOISE FACTORS

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- Helicopters

- Safety/Fear of Accidents

- Low Flying/Low Altitudes

- Type of Flying (Public less Tolerant to Leisure or Perceived Leisure Travel)

## Community

- Heliport (or Airport) Environmental History

- Quality of Life

- Satisfaction with Area, Employment, Work Travel Distance etc.



# HELICOPTER NOISE

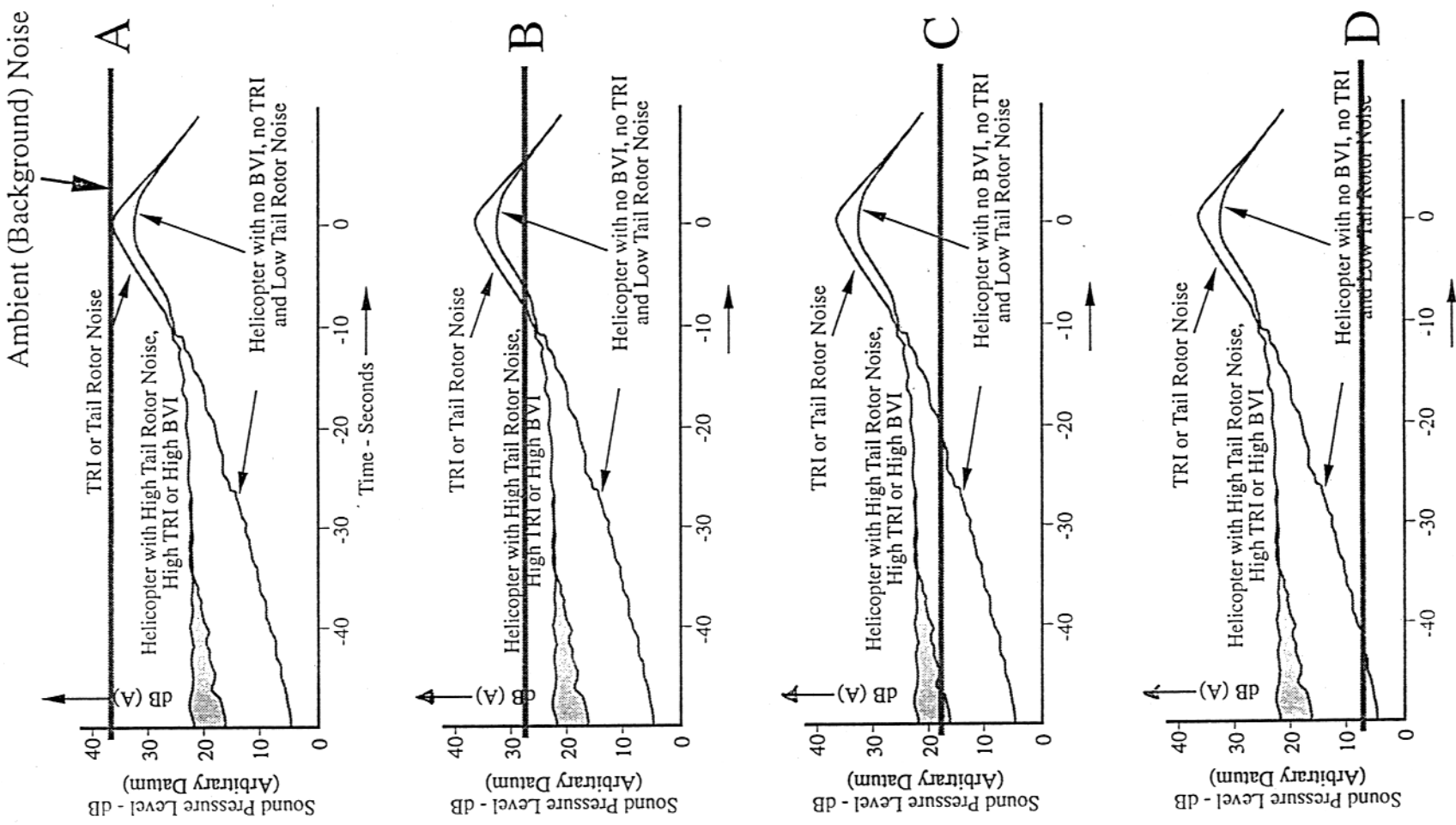
FEA120-10

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GENERALISED

Zero  
Acoustic  
Annoyance



# PUBLIC ACCEPTANCE STUDY CONCLUSIONS

- PUBLIC ACCEPTANCE NOT DIRECTLY RELATED TO ABSOLUTE LEVEL: IE. NOT DIRECTLY RELATED TO CERTIFICATION LEVELS OR VALUES USED FOR RATING COMMUNITY RESPONSE.
- REDUCTION IN NOISE CERTIFICATION LIMITS AND/OR “ACCEPTABLE” COMMUNITY RATING STANDARDS (LIMITS) CANNOT BE EXPECTED TO INCREASE PUBLIC ACCEPTANCE

# VIRTUAL NOISE REDUCTION

- CONTROL OF NOISE TRIGGER IE. CHARACTER AND LEVEL. IMPACT ON OPERATIONAL FLIGHT PROCEDURE AND FLYOVER HEIGHT.
- EDUCATION OF THE PUBLIC\*: ISSUES
  - SAFETY
  - NEED FOR ROTORCRAFT
  - IMPACT ON NATIONAL AND LOCAL ECONOMY
  - OPERATIONAL CONTROL<sup>+</sup>

\*WHO SHOULD TAKE LEAD . . . NASA, FAA, OR INDUSTRY? WILL REQUIRE MAJOR INTERNATIONAL AND DOMESTIC PROGRAM. . . HENCE ALL WILL NEED TO BE INVOLVED IN A PUBLIC/PRIVATE PARTNERSHIP

+OPERATORS WILL HAVE TO ACCEPT FLIGHT PATH AND HELIPORT/VERTIPOINT ATC CONTROL FOR NORMAL OPERATIONS IN URBAN ENVIRONMENTS TO GAIN PUBLIC ACCEPTANCE

# CURRENT RESEARCH

- MAINLY AIMED AT REDUCTION OF ABSOLUTE (OVERALL) NOISE
- FOCUSED ON MAIN ROTOR AND BVI
- BVI (BLADE VORTEX INTERACTION) NOISE REDUCTION WILL LOWER ABSOLUTE (OVERALL) NOISE AND DECREASE IMPULSIVE CONTENT (IE. IMPROVE CHARACTER)
- . . . BVI UNFORTUNATELY FOCUSED MOSTLY ON REDUCTIONS AT NOISE CERTIFICATION APPROACH TEST CONDITION OF  $6^\circ/V_y$  AND NOT NECESSARILY APPLICABLE TO NORMAL OPERATIONS
- . . . LITTLE EMPHASIS ON COMPLETE HELICOPTER NOISE REDUCTION (CONFIGURATION, DESIGN, INTERACTION EFFECTS): PERFORMANCE (OPERATING COST) IMPLICATIONS OFTEN NOT CONSIDERED
- . . . TAIL ROTOR AND TRI NOISE IS MAIN SOURCE AFTER BVI: IMPACTS BOTH ABSOLUTE LEVEL AND CHARACTER

# RESEARCH AIMS

- MINIMUM ANNOYANCE/MAXIMUM PUBLIC ACCEPTANCE ROTORCRAFT: NOT NECESSARILY A “*QUIET HELICOPTER*” IN TERMS OF ABSOLUTE LEVEL
- MINIMUM ANNOYANCE AT MINIMUM COST IMPACT (LOWER COST CRITICAL TO GROWTH OF ROTORCRAFT INDUSTRY)
- BOTH DESIGN AND OPERATION PROCEDURES MUST BE CONSIDERED: MINIMUM NOISE FLIGHT PROCEDURES CAN BE PRE-PROGRAMMED INTO AUTOMATIC FLIGHT CONTROL SYSTEMS



# RESEARCH - COMMUNITY RESPONSE

- CONFIRM IMPORTANCE OF 'NOISE CHARACTER'
- CONFIRM / ESTABLISH FACTORS WHICH CONTROL '*VIRTUAL NOISE*' FOR CURRENT HELICOPTERS
- STUDY COMMUNITY RESPONSE TO LARGE PASSENGER HELICOPTERS AND CTRS OPERATING FROM LARGE HELIPORTS / VERTIPOINTS
- ... ESTABLISH DESIGN FEATURES AND PUBLIC EDUCATION TO MINIMISE COMMUNITY IMPACT

# RESEARCH REQUIRED

- UNDERSTANDING/RATING IMPACT OF NOISE CHARACTER ON APPROACH AT LEVEL WELL BELOW THE MAXIMUM NOISE LEVEL
- FURTHER UNDERSTANDING OF TRI AND TAIL ROTOR NOISE GENERATION
- STUDY OF OVERALL DESIGN IMPLICATIONS: CONTROL OF NOISE WHILE RETAINING PERFORMANCE AND LOW COSTS
- DEVELOPMENT OF MINIMUM NOISE LANDING PROCEDURES. . . FUTURE AUTOMATIC FLIGHT CONTROL.

# RESEARCH AREAS

- NOISE LEVEL/CHARACTER IS DEPENDENT ON TIP SPEED: ADVANCED BLADE PROFILES WHICH PROVIDE “*HIGH LIFE*” AT LOWER SPEEDS REQUIRED
- BVI: HIGHER HARMONIC CONTROL (HHC) AND INDIVIDUAL BLADE CONTROL (IBC) OFFER POTENTIAL TO CONTROL BVI - MAJOR CERTIFICATION AND SAFETY ISSUES STILL NEED TO BE RESOLVED. TIP SHAPES (VANE/”*STUB WING*:) ALSO APPEAR TO OFFER POTENTIAL WITH NO REAL CERTIFICATION ISSUES
- ENGINE NOISE SIGNIFICANT FACTOR ON MANY HELICOPTERS - WILL BECOME MORE OF A PROBLEM AS OVERALL NOISE LEVELS ARE REDUCED. LITTLE OR NO SMALL ROTORCRAFT ENGINE NOISE CONTROL RESEARCH. SPACE AND WEIGHT ARE CRITICAL FACTORS FOR HELICOPTER

# RESEARCH/DESIGN

- OVERALL ROTORCRAFT DESIGN:  
CONFIGURATION AND DETAILED DESIGN ISSUES  
- NOISE/PERFORMANCE/COST MUST BE  
CONSIDERED IN CONCERT
- NOISE ABATEMENT APPROACH PROCEDURES\*
- INCREASED ROUTE HEIGHTS: ATC  
IMPLICATIONS: RE-EVALUATION OF “*AIRPORT  
AIRSPACE*” REQUIREMENTS

\*6°/Vy APPROACH PROCEDURES GENERATE MAXIMUM  
NOISE LEVELS YET IFR PROCEDURES BASED ON 6° ARE  
BEING PROPOSED/DEVELOPED - IS THIS LOGICAL??

# CONCLUSIONS

## – IF ...

- VIRTUAL NOISE MINIMIZED (CRITICAL FACTOR)
- BVI, TR, TRI REDUCED/NOISE CHARACTER IMPROVED
- MINIMUM “*ENVIRONMENTAL IMPACT*” (NOT JUST LOW NOISE) DESIGNS DEVELOPED
  - ...THEN ROTORCRAFT INDUSTRY CAN GROW AS MAJOR AVIATION SEGMENT

## – AND IF ...

- ENGINE NOISE CONTROLLED
- IMPROVED BLADE DESIGN (IMPROVED PERFORMANCE AT LOW TIP SPEEDS)
- LOWER COST ROTORCRAFT DEVELOPED
  - ...THEN INDUSTRY POTENTIAL WILL BE FURTHER ENHANCED

