Havarikommissionen
Luftfartsenheden

Rapport
HCLJ510-000811

Lufttrafikhændelse med
Canadair CRJ-900 og CRJ-200
Københavns Lufthavn, Kastrup (EKCH)
Den 26. november 2010

Indholdsfortegnelse

RAPPORT

HCLJ510-000811	**Hændelse**		
Luftfartøj A:	Canadair CRJ900	Registrering:	OY-KFK
Motor(er):	2 – CF34-8C5	Flyvning:	Ruteflyvning, IFR
Besætning:	4 - ingen tilskadekomne	Passagerer:	82 – ingen tilskadekomne
Luftfartøj B:	Canadair CRJ200	Registrering:	OY-RJB
Motor(er):	2 - CF34-3B1	Flyvning:	Ruteflyvning, IFR
Besætning:	3 – ingen tilskadekomne	Passagerer:	38 – ingen tilskadekomne
Sted:	Købehavns Lufthavn, Kastrup (EKCH)	Dato og tidspunkt:	26.11.2010 kl. 2239 UTC

Alle tidsangivelser er UTC.

Synopsis

Luftfartsenheden i Havarikommissionen (HCLJ) modtog meddelelse om lufttrafikhændelsen fra Flyvesikringstjenesten d. 27.11.2010 kl. 0015.

The International Civil Aviation Organisation (ICAO), The Canadian Transport Safety Board Canada (TSB), The European Aviation Safety Agency (EASA) og den svenske havarikommission (SHK) blev notificeret d. 30.11.2010 kl. 1213.

Luftfartøj A krydsede utilsigtet over stoplinjen til bane 04L på rullevej A7 og kom ind i banens sikkerhedsområde, mens luftfartøj B var under start. Den mindste horisontale og vertikale afstand mellem luftfartøjerne var henholdsvis 19,5 meter og 175 fod (bilag 2). Trafikbelastningen på hændelsestidspunktet var skønnet til at være medium til høj.

Hændelsen indtraf i mørke, under snefald og fygning.

Klassifikation:
A) Risiko for kollision.

Sammenfatning.
Bane 04L i Københavns Lufthavn, Kastrup (EKCH) blev brugt til afvikling af både startende og landende trafik.

Det er Havarikommissionens opfattelse, at de involverede piloters beslutningsproces under hændelsesforløbet var påvirket af forskellige operationelle faktorer, hvilket kumulativt bevirkede, at flere af de tilgængelige forsvarsbarrierer blev svækket.

Medvirkende forhold:

1. Ressourcekrævende foregående tur for en af piloterne.
2. Skift i vejrforhold.
3. TODC beregninger skabte et mentalt trafikbillede fokuseret på start fra bane 04R.
4. Skift af banesystem.
5. ”Hjemmebanesyndrom”
6. Programmering af Flight Management System (FMS) under udkørsel.
7. Snedækkede rulleveje.
8. Svært identificerbar rullevejsbelysning.
9. Design af rullevejssystem.
10. Stopbarre ved A7 var slukket (manglende forsvarsbarriere).

De tilgængelige forsvarsbarrierer som Runway Guard Lights (RGL) og rullevejsbelysning – om end sværere at definere – forhindrede ikke udviklingen af hændelsesforløbet.

Havde en tændt stopbarre ved A7 været tilgængelig som forsvarsbarriere, var piloterne med stor sandsynlighed blevet opmærksomme på, at de var på vej ind i et område uden klarering.

Hændelsen skete under marginale baneforhold og på et tidspunkt umiddelbart efter baneskift fra bane 04R til bane 04L. Bane 04R blev anvendt primært til afvikling af startende trafik og 04L til afvikling af landende trafik.

Undersøgelsen har ledt til fremsættelse af en rekommandation.

1. Faktuelle oplysninger

1.1 Flyvningens forløb

Luftfartøj A udførte en ruteflyvning fra Københavns Lufthavn, Kastrup (EKCH) til Vilnius Lufthavn (EYVI). Piloterne havde tidligere på dagen fløjet andre sektorer, henholdsvis EKCH - Hamborg Lufthavn (EDDH) - EKCH for fartøjschefen og Düsseldorf Lufthavn (EDDL)-EKCH for styrmanden, begge med andre besætningsmedlemmer. Fartøjschefen var på første dagen af en fem dages sling og landede fra den foregående sektor kl. 21:18:00 og havde derved 37 minutter ”turnaround”. Styrmanden var på dag to af et fem dages sling og landede fra den foregående sektor kl. 19:57:00 og havde derved 1 time og 58 minutter “turnaround”.

Luftfartøj B udførte en ruteflyvning fra EKCH til Norrköping Lufthavn (ESSP). Piloterne var tidligere på dagen landet efter overnatning i ESSP og havde derefter en ”split duty” indtil flyvningen, hvorunder hændelsen indtræf.

På luftfartøj A var fartøjschefen pilot flying (PF), og styrmanden var pilot not flying (PNF).

Piloterne på luftfartøj A mødte hinanden direkte ved flyet, hvor briefing og planlægning blev færdiggjort i fællesskab. Piloterne var allerede ved ankomsten til luftfartøjet sene i forhold til det

planlagte afgangstidspunkt men har forklaret, at planlægning og udførelse af briefinger og tjeklister blev foretaget uden unødigt stress. Allerede før push-back havde piloterne planlagt, anmodet og modtaget Take-Off Data Calculation (TODC) for bane 04R tre gange. Briefingerne og udførelse af start var alle planlagt fra bane 04R. Grundet de hurtigt ændrende vejr- og baneforhold blev der anmodet om TODC tre gange.

Efter push-back blev luftfartøjet klareret til afisningsområde V uden forsinkelser. Under og umiddelbart efter afisningen ajourførte piloterne sig med vejr- og baneforhold, og der blev anmodet om Automatic Terminal Information Service (ATIS) to gange via Aircraft Communications Addressing and Reporting System (ACARS). Udkørslen fra afisningsområdet var via W, W1, R, R2, B, og luftfartøj A holdt klar af bane 12/30 efter en Boeing 737. På grund af igangværende snerydning af bane 04R blev luftfartøjet holdt ventende på videre klarering i 15 minutter. Ventetiden blev brugt til en konstruktiv dialog vedrørende baneforhold, herunder bremseværdier og vind. Piloterne konkluderede, at bremseværdierne og sidevindskomponenten ikke længere var egnet til start på bane 04R. Baneforholdene på bane 04L var tilstrækkelige og acceptable, hvorfor der blev anmodet om start fra denne bane.

Videre kørselsinstruktion var ad rulleveje D og A til venteposition bane 04L. Rullevejene var dækket af sne, og piloterne bemærkede, at rullevejsbelysningen var svær at identificere. Rullevejsbelysningen på rullevej D og A var grøn og kunne ses fra 360 grader (omnidirectional). Fartøjschefen havde aldrig foretaget kørsel til og start fra bane 04L og styrmanden kun ganske få gange. Piloterne briefede om kørslen og bemærkede, at rullevej A først drejede lidt til venstre og derfra til højre ved brandstationen. PF kørte luftfartøjet imens PNF anmodede om ny TODC for bane 04L A10. KL. 22:35:44 modtog piloterne en ny TODC, hvor luftfartøjet befandt sig under kørsel på rullevej D umiddelbart før rullevej A.

Informationerne fra TODC blev verificeret af PNF og nødvendige ændringer til luftfartøjets Flight Management Computer (FMC) blev ligeledes udført af PNF. Under kørslen på rullevej A foretog PNF en del - head down - arbejde inde i cockpittet, hvilket betød, at PF til tider var alene om at kigge ud og frem.

Da luftfartøjet nærmede sig krydset A og A7 fokuserede PF på at følge rullevej A som briefet mellem piloterne. PF observerede ikke rullevejs A´s svage højredrejning og fortsatte derfor ad A7. Umiddelbart efter og på A7 udbrød PNF *"du er ved at køre ind på banen"*. PF aktiverede øjeblikkeligt bremserne og luftfartøjet gled og stoppede umiddelbart på banebegrænsningen. Næsten simultant med, at luftfartøj A var stoppet, kaldte tårnflyvelederen, at de skulle stoppe. Et sekund senere passerede luftfartøj B luftfartøj A med en afstand på 19,5 meter horisontalt og 175 fod vertikalt.

Piloterne i et tredje luftfartøj, der kørte til start ad rullevej A umiddelbart efter hændelsen indtraf, havde en oplevelse af at måtte bruge mange ressourcer på at sikre korrekt udkørsel. Piloterne i det tredje luftfartøj bemærkede endvidere, at de ved rullevejskryds A/A7 var ved at køre fejlagtigt ad A7.

Nedenstående er en beskrivelse af hændelsesforløbet:

tt:mm:ss	Luftfartøj A	Luftfartøj B
20:55:26	ATIS vejroplysning modtaget via ACARS	
20:59:28	TODC (take-off data) anmodning via ACARS (datalink) for start bane (04R B1**)**	
20:59:53	TODC modtaget via ACARS for start på bane (04R B1)	
21:34:31	ATIS vejroplysning modtaget via ACARS	
21:44:32	ATIS vejroplysning modtaget via ACARS	
21:48:50	TODC anmodning via ACARS for start bane (04R B1)	
21:49:14	TODC modtaget via ACARS for start på bane **(**04R B1)	
21:51:49	ATIS vejroplysning modtaget via ACARS	
21:53:17	TODC anmodning via ACARS for start bane (04R B1)	
21:53:40	TODC modtaget via ACARS for start på bane **(**04R B1)	
21:58:19	Push back fra standplads D4	
22:00:00	Holdt klar til kørsel fra standplads D4 på rullevej S.	Holdt klar til start ved venteposition B1 til bane 04R. Snerydning af bane 04 R var i gang.

tt:mm:ss	Luftfartøj A	Luftfartøj B
22:03:10	Begyndte udkørsel til bane 04R via afisningsområde V ad rulleveje R og V. *Fartøjschefen styrede luftfartøjet under kørsel på jorden*	
22:06:00	Ankom til afisningsområde V og begyndte afisning af luftfartøjet.	
22:07:34	ATIS vejroplysning modtaget via ACARS	
22:13:10		Begyndte kørsel til bane 04L via afisningsområde A ad 04R, rulleveje C og D.
22:13:15	Begyndte udkørsel til planlagt start på bane 04R ad rullevej V, T, W, R2 og B.	
22:18:00	Holdt kort af bane 12/30 og afventede nye og bedre bremseværdier for bane 04R.	
22:19:55		Begyndte afisning af luftfartøjet ved rullevej A.
22:27:00		Begyndte kørsel til bane 04L af rullevej A.
22:29:29	ATIS vejroplysning modtaget via ACARS	
22:33:30	Begyndte kørsel til start fra bane 04L ad bane 30, rulleveje D og A.	
22:34:22	TODC anmodning via ACARS for start bane (04L A9)	

tt:mm:ss	Luftfartøj A	Luftfartøj B
22:34:24	TODC anmodning fejlede *(fejl: kunne ikke finde banebetegnelse)* *Mulige baner var:* *04L 04LA10 04LE4 04R* *04RB1 04R21 04RB3 04RB4* *04RNS 12 12L 12K2 12K3* *12D 12NS 22L 22LV1 22LV2* *22R 22RA1 22RA2 22RA3* *22RA4 22RA5 30 30G1*	
22:35:21	TODC anmodning via ACARS for start bane (04L A10)	
22:35:44	TODC modtaget via ACARS for start på bane **(**04L A10)	
22:37:50		Ankom til venteposition A10 ved bane 04L.
22:38:04		Kørte ind på bane 04L.
22:38:48	Befandt sig umiddelbart før ”intersection” A/A7.	Begyndte start fra A10 på bane 04L.
22:39:04	Passerede stoplinje og inaktiv ”stopbarre” på A7.	Havde passeret A9 under start.
22:39:17	*Styrmanden advarede fartøjschefen, at de var på vej ud på bane 04L*	
22:39:19	Luftfartøjet stoppede på banekant-begrænsningen. Simultant meddelte tårnflyvelederen via tårnfrekvensen (118,575 MHz): ”STOP luftfartøj A”	
22:39:20	Tæt horisontal passage mellem luftfartøjerne.	Tæt horisontal passage mellem luftfartøjerne.

1.2 Tilskadekomst af personer

1.2.1 Luftfartøj A

Tilskadekomst	Besætning	Passagerer	Andre
Omkomne	-	-	-
Alvorlig	-	-	-
Mindre/ingen	4	82	-

1.2.2 Luftfartøj B

Tilskadekomst	Besætning	Passagerer	Andre
Omkomne	-	-	-
Alvorlig	-	-	-
Mindre/ingen	3	38	-

1.3 Skade på luftfartøjet

Ingen

1.4 Andre skader

Ingen

1.5 Oplysninger om personel

1.5.1 Luftfartøj A

1.5.1.1 Fartøjschef.

Fartøjschefen var indehaver at et gyldigt dansk Airline Transport Pilot License (ATPL) med udløbsdato d. 29.4.2014. Den helbredsmæssige godkendelse var gyldig indtil d. 1.6.2011. JAR-FCL 1 rettigheden til CRJ 100 var gyldig indtil d. 30.4.2011.

Fartøjschefens planlagte og aktuelle flyve- og tjenestetid lå inden for begrænsningerne fastsat af Trafikstyrelsen (EU-OPS Subpart Q).

Fartøjschefens flyvetidsopgørelse jf. udskrift fra operatøren.

	Sidste 24 timer	Sidste 30 dage	Sidste 90 dage	Total
Type CRJ	2:33	46:58	159:20	808:36
Alle typer		46:58	159:20	5548:00
Landinger	1	19	67	1508

1.5.1.2 Styrmand.

Styrmanden var indehaver af et gyldigt dansk Airline Transport Pilot License (ATPL) med udløbsdato d. 9.3.2014. Den helbredsmæssige godkendelse var gyldig indtil d. 6.7.2011. JAR-FCL 1 rettigheden til CRJ 100 var gyldig indtil d. 28.2.2011.

Styrmandens planlagte og aktuelle flyve- og tjenestetid lå inden for begrænsningerne fastsat af Trafikstyrelsen (EU-OPS Subpart Q)

Styrmanden bestred stillingen hos operatøren som fartøjschef på typen men fløj på hændelsestidspunktet som styrmand (”lower”).
Styrmandens flyvetidsopgørelse jf. udskrift fra operatøren.

	Sidste 24 timer	Sidste 30 dage	Sidste 90 dage	Total
Type CRJ	3:27	38:20	187:33	1123:26
Alle typer		38:20	187:33	8036:41
Landinger	1	14	79	1352

1.5.2 Luftfartøj B

1.5.2.1 Fartøjschef

Fartøjschefen var indehaver af et gyldigt dansk Airline Transport Pilot License (ATPL) med udløbsdato d. 29.3.2012. Den helbredsmæssige godkendelse var gyldig indtil d. 1.7.2011. JAR-FCL 1 rettigheden til CRJ 100 var gyldig indtil d. 31.12.2011.
Fartøjschefens planlagte og aktuelle flyve- og tjenestetid lå inden for begrænsningerne fastsat af Trafikstyrelsen. (EU-OPS Subpart Q)

1.5.2.2 Styrmand.

Styrmanden var indehaver af et gyldigt dansk Commercial Pilot License (CPL) med udløbsdato d. 26.10.2011. Den helbredsmæssige godkendelse var gyldig indtil d. 5.5.2011. JAR-FCL 1 rettigheden til CRJ 100 (Co-pilot) var gyldig indtil d. 31.8.2011.

Styrmandens planlagte og aktuelle flyve- og tjenestetid lå inden for begrænsningerne fastsat af Trafikstyrelsen. (EU-OPS Subpart Q)

1.6 Oplysninger om luftfartøjet

1.6.1 Luftfartøj A.

1.6.1.1 Runway Awareness System.

Luftfartøjet var på hændelsestidspunktet ikke modificeret med et Runway Awareness System. Dette system kunne give piloterne auditive informationer om luftfartøjets position relativt til lufthavnens start- og landingsbaner. Systemet er designet til at forebygge utilsigtet baneindtrængen.

1.7 Meteorologiske oplysninger

1.7.1 METAR

262200	SPECI	ekch	262200z 07019kt 0800 r22l/p1500n r04l/p1500n r12/p1500nsn blsn few005 bkn008 m01/m02 q1004 04490122 54490212 12450451 tempo 0500=
262202	SPECI	ekch	262202z 07019kt 0500 r22l/1400vp1500d r04l/1400vp1500dr12/p1500n sn blsn few005 bkn008 m01/m02 q1004 04490122 54490212 12450451 tempo 2000 bkn012=

262220	METAR	ekch	262220z 08019kt 0500 r22l/p1500u r04l/p1500n r12/p1500n sn blsn few005 bkn009 m02/m02 q1004 04490122 5449011912450451 tempo 2000 bkn012=
262250	METAR	ekch	262250z 08018kt 1500 -sn drsn few005 sct008 bkn011 m02/m02 q1005 04490122 54490121 12450451 tempo 3000 bkn015=

1.7.2 TAF

261700	TAF-FT	ekch	262220z 08019kt 0500 r22l/p1500u r04l/p1500n r12/p1500n sn blsn few005 bkn009 m02/m02 q1004 04490122 54490119 12450451 tempo 2000 bkn012=
262000	TAF-FT	ekch	262220z 08019kt 0500 r22l/p1500u r04l/p1500n r12/p1500n sn blsn few005 bkn009 m02/m02 q1004 04490122 54490119 12450451 tempo 2000 bkn012=

1.7.3 Baneforhold

04L: 50-100% of runway covered by dry snow, depth 1 mm. Friction coefficient 22 (poor).

04R: 50-100% of runway covered by dry snow, depth 1 mm. Friction coefficient 19-21 (poor).

12: 26-50% of runway contaminated by dry snow, depth 4 mm. Friction coefficient 51 (good).

1.8 Navigationshjælpemidler

Luftfartøjerne var udstyret med de for pågældende flyvninger nødvendige navigationshjælpemidler. Der var ikke rapporteret fejl på navigationshjælpemidlerne om bord på luftfartøjerne eller på jorden.

1.9 Kommunikation

Der blev foretaget afskrift af radiokommunikationen på frekvens 118,100 MHz, 118,575 MHz samt telefoner i kontroltårnet.

1.10 Oplysninger om flyvepladsen

Københavns Lufthavn, Kastrup (EKCH).

1.10.1 Generelt.

Position (ARP):	55 37 04.50N 012 39 21.50Ø
Elevation:	17 fod
Bane 04L:	04L (MAG 038,7º) - 3000 X 45 M - ILS CAT II GP 3º
Banebelægning:	Asfalt
Indflyvningsbelysning:	04L 900M CAT II
Banebelysning:	Midterbelysning (15 M), kantbelysning (hvid 60 M), stopway (rød 570 M), endelys (rød)

1.10.2 Rulleveje.

TAXIWAYS (Except TWY N1 and TWY N2)	
Width	23, G4 27,5.
Pavemant	Concrete or asphalt
Strength	PCN 80 / F / C / X 7 U.
Day marking	Centre line, side stripes (where deemed necessary), holding positions
Lighting	Edge - blue; centre line – green; centre line on exit taxiways within ILS critical/sensitive areas and centre line within 60 M from RWY centre line – standard color. Stop bars. RLG. Deicing TWY A and TWY B: exit facility light.
Taxiing guidance system	Sign boards.
Rapid exit taxiways	A6, A7, B4 and E3

1.10.3 Oversigtsbillede over EKCH.
Se bilag 1.

1.10.4 Brug af banesystem.
AIP Danmark beskrev følgende for Københavns Lufthavn, Kastrup i afsnit 21. ”Noise Abatement Provisions”:

2.1.1 When the runway in use is RWY 04L/R, RWY 04R shall be used for take-off and RWY 04L for landing unless one of the runways cannot be used due to snow clearance, disabled aircraft, work on the runway or runway conditions. However, ATC can make use of parallel operations when regard of capacity makes it necessary. Depending on the time of the operation, certain types of aeroplanes are due to their noise characteristics only allowed to take-off on RWY 04R and land on RWY 04L.

1.10.5 Belysning
1.10.5.1 Generelt
Rullevejssystemet var på hændelsestidspunktet udstyret med grøn centerlinjebelysning, blå kantbelysning. Ved til- og frakørselsrullebaner til banesystemet var der placeret ”Runway Guard Lights” (RGL) samt røde stopbarrer.

1.10.5.2 Centerlinjebelysning
Centerlinjebelysningen var justerbart i lysintensiteten fra tårnflyvelederens position således, at centerlinjebelysningen kunne optimeres under forskellige lys- og vejrforhold og efter ønske fra piloter, der benyttede rullevejssystemet. Lysintensiteten på centerlinjebelysningen kunne indstilles til 1 %, 3 %, 10 %, 30 % og 100 %.

Centerlinjebelysningen på rullevej A var kl. 16:45 sat til 30 % og blev kl. 19:07 sænket til 10 % og forblev på dette niveau under hændelsesforløbet. Flyvesikringstjenesten har overfor Havarikommissionen oplyst, at en lysintensitet mellem 1 – 10 % var normalt for operationer i mørke.

Stoplinje ved A7 med slukket stopbarre i dagslys og snedækket. Grøn rullevejsmarkering tændt.

*Billedet er et eksempel på en snedækket rullevej med tændt centerlinjebelysning. Billedet er ikke taget i forbindelse med hændelsen og afspejler derfor ikke de aktuelle forhold.

1.10.5.3 Runway Guard Lights" (RGL)
RGL var beregnet som første forsvarsbarriere ved tilkørsel til et banesystem. RGL gav ikke tilladelse eller udelukkede tilkørsel ind på et banesystem men var ment som en visuel markering af banesystemet.

1.10.5.4 Røde baneskilte

På hændelsestidspunktet var der placeret røde baneskilte ved A7 og bane 04L/22R.

1.10.5.5 Stopbarre

På hændelsestidspunktet var stopbarrer placeret på dele af rullevejssystemet (se bilag 3) med det formål, at beskytte en bane eller et område mod utilsigtet indkørsel på eller krydsning af samme. Gældende ATS- og lokalinstruks beskrev brugen af stopbarrer:

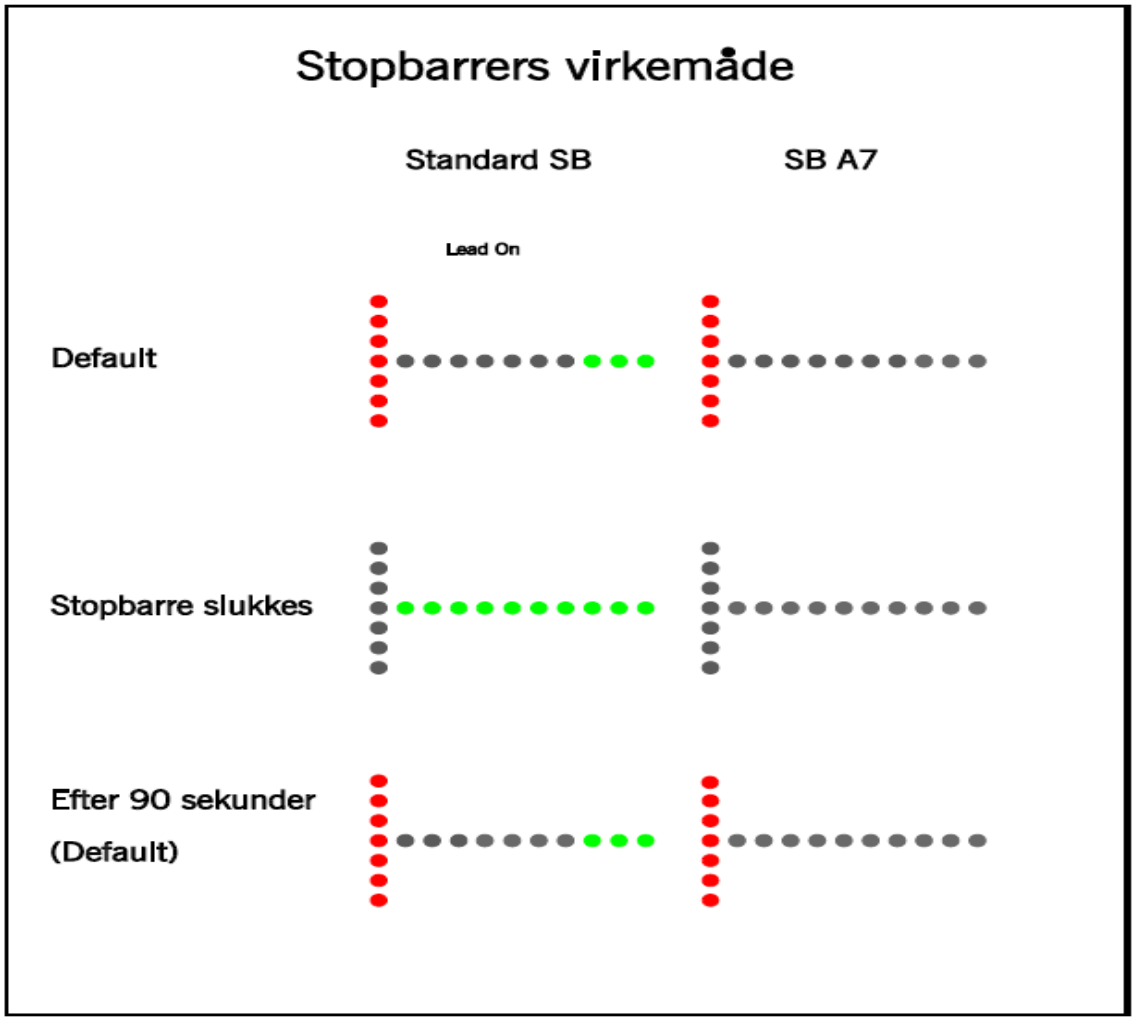
- Stopbarre V1 og V2 skulle anvendes når RWY 04R/22L blev brugt til start og landing.
- Stopbarrer ved RWY 12/30 skulle benyttes under alle vejrforhold når banen blev brugt til start og landing.
- Ved Low Visibility operationer.

1.10.5.6 Stopbarrens virkemåde på rullevej A7.

Standard stopbarre var forsynet med en automatisk timerstyret tændingsfunktion på 45 sekunder således, at flyvelederen i kontroltårnet skulle anvende færrest mulige ressourcer på at slukke stopbarrerne. De første 90 meter ”lead on” centerlinjelys efter stopbarren blev på en standard stopbarre tændt og slukket samtidigt. Centerlinjebelysningen på rullevej A7 var retningsbestemte og var kun synlig ved afkørsel fra bane 04L ad A7.

Stopbarre ved A7 blev kl. 10:44 tændt og slukket igen kl. 12:02 og tændt igen kl. 22:41, alle gange med en intensitet på 100 %.

1.10.5.7 Visuel præsentation af stopbarrens virkemåde på rullevej A7.



1.10.6 Runway Incursion Monitoring (RIM)

Københavns Lufthavn, Kastrups Advanced Surface Movement Ground Control System (A-SMGCS). system havde mulighed for flere operationelle alarmeringsfunktioner, som gav tårnflyvelederen en alarm, hvis et objekt (luftfartøj/køretøj) opførte sig ureglementeret (i forhold til gældende bestemmelser) på bane, tilkørselsvej til bane eller i anflyvningsområdet. En RIM advarsel ville blive præsenteret for tårnflyvelederen på A-SMGCS.

RIM funktionen kunne i tilfælde af fejl eller anden uønsket tilstand og efter anbefaling fra supervisor til- og frakobles fra en teknisk arbejdsplads.

1.11 Flight recorders

Data fra QAR for luftfartøj A blev udlæst og var i god kvalitet.

Data fra FDR for luftfartøj B blev udlæst og var i god kvalitet.

1.12 Vrag og havaristed
Ikke relevant

1.13 Medicinske og patologiske oplysninger
Ikke relevant

1.14 Brand
Der opstod ingen brand

1.15 Overlevelsesaspekter
Ikke relevant

1.16 Test og forskning
Der er ikke blevet udført særlige undersøgelser.

1.17 Oplysninger om organisation og ledelse
Ingen.

1.18 Supplerende oplysninger
1.18.1 Rullevejsbelysning
Rullevejsbelysning, herunder brug af stopbarrebelysning, havde indflydelse ved hændelser d. 27.1.2010 (HCLJ510-000722) og d. 15.11.2010 (HCLJ510-000808).

1.18.2 Statistik over utilsigtet indtrængen på aktiv bane (Runway Incursion)
I perioden dec-2007 til nov-2010 blev der rapporteret 256 utilsigtede baneindtrængninger på danske lufthavne. Dette betyder en lineær rate på 7 baneindtrængninger pr. måned.
Kilde: Trafikstyrelsen

1.18.3 Banesikkerhed – brug af H24 stopbarrer
European Organisation For The Safety of Air Navigation (EUROCONTROL) observerede i perioden januar – maj 2008 mere end 3600 timers aktuelle operationer med brug af H24 stopbarre som beskyttelse af banesystemerne på Manchester Lufthavn, England (se bilag 7).

Formålet med undersøgelsen var i sin enkelthed at undersøge muligheden for H24 brug af stopbarrer som beskyttelse af banesystemerne. En H24 brug af stopbarrer kunne muliggøre en ensartet brug af stopbarrer internationalt, hvilket kunne give et sikkerhedsnet med forbedret integritet i modsætning til de operationelle forskelle, der blev anvendt på lufthavne.

Undersøgelsen blev udført under forskellige scenarier, herunder afvikling af trafik under høj/lav trafikbelastning, nat/dag og under varierende vejrforhold.
Konklusionen af undersøgelsen var følgende:

The objective of this study; to examine the feasibility of using stop bars that protect the runway 24 hours per day in all weather conditions e.g. sunshine / bright light / rain / snow / ice, day and night has been fulfilled with the following key findings:

1. ***Operating of stop bars to protect the runway 24 hours per day was considered a significant safety benefit by pilots, drivers and air traffic controllers;*** *(*Fremhævning af Havarikommissionen)

2. Airports using Stop Bars today typically equip the CAT III holding point as a compliment to the pavement marking and signage according to ICAO. To move from operating a Stop Bar during low visibility conditions and at night, to 24 hour operations may require a number of changes to procedures, airport lighting, holding positions, training and organizational stop bar use policies.

3. ***Throughput was maintained at the same levels as prior to the trial;*** *(*Fremhævning af Havarikommissionen)

4. Operation of the stop bars in all categories of weather and light conditions was considered to require an acceptable workload from air traffic controllers given an appropriate procedure and co-location of user-friendly stop bar switches with the controller working position;

5. Stop bars were visible in all weather conditions for Pilots and Drivers, irrespective of the shape of the stop bar or the variety of the lamps in use, however a straight line of lamps was preferred compared to a 'V' formation;

6. ***Stop bars improve situational awareness;*** *(*Fremhævning af Havarikommissionen)

7. Key enablers to the successful use of stop bars 24 hours per day are:

• A clear stop bar policy from each significant organization: aircraft operators, air navigation service providers and aerodrome operators. These policies may be enforced by the local regulator;

"Never cross (instruct others to cross) a red stop bar"

• A clear stop bar operating procedure defined by the air navigation service provider;

• Contingency procedures for when the stop bar is unserviceable, to avoid the crossing of a red stop bar;

• A clear strategy for the planning and implementation of maintenance or other works on the maneuvering area;

• Ergonomic design of the human machine interface of the air traffic control lighting panel and stop bar switches;

• Independence of the stop bars from other air ground lighting;

• A single, consistent method for using stop bars is required by pilots to ensure a robust safety net:

"Red Lights Mean Stop"

This study and consequent work was undertaken by the Local Runway Safety Team of Manchester Airport. Due to the successful outcome of the trial, the use of stop bars 24 hours per day to protect the runway will be continued as part of normal operations at Manchester Airport.

Visuel effekt af stopbarre på Manchester Lufthavn

1.19 Specielle undersøgelsesmetoder
Ingen

2. Analyse
2.1 Luftfartøj A.

2.1.1 Generelt.

Piloterne var behørigt certificeret. Piloternes flyve- og tjenestetid lå på hændelsestidspunktet indenfor flyve- og tjenestetidsbegrænsningerne fastsat af Trafikstyrelsen (EU-OPS, Subpart Q).

2.1.2 Foregående flyvninger og planlægning.

Styrmanden beskrev foregående sektor fra Düsseldorf som værende meget ressourcekrævende grundet udredning af en funktionsfejl på luftfartøjet.

Piloterne mødte hinanden direkte ved flyet og ikke som vanligt i operatørens briefing faciliteter. Grunden til dette var, at piloterne landede fra to forskellige flyvninger, hvilket gjorde, at fartøjschefen kun havde 37 minutters turnaround tid. Piloterne har forklaret, at de til trods for den korte turnaround tid og skiftet af piloter, ikke følte unødigt stress eller kompromitterede planlægningen og forberedelsen af flyvningen. Endvidere var det ikke unormalt, at man i pressede turnaround situationer og skift af piloter mødte direkte ved flyet før afgang.

Forholdet mellem styrmandens foregående tur, skift af piloter og den generelle planlægning udenfor vante rammer har efter Havarikommissionens vurdering ikke haft en indvirkning på hændelsesforløbet.

2.1.3 Planlægning af start.

I perioden fra kl. 20:55:26 frem til kl. 22:29:29, hvor luftfartøjet befandt sig henholdsvis ved standplads D4 og frem til hvor det holdt stille før bane 12/30, blev ATIS anmodet og modtaget fire gange. Vejroplysningerne fra ATIS vendte alle gange fokus mod start fra bane 04R. TODC blev beregnet tre gange, hvoraf alle var for start fra bane 04R. Piloternes mentale trafikbillede var således i samme tidsrum fokuseret på start fra bane 04R, som var normal bane for afvikling af startende trafik. Piloternes mentale trafikbillede stemte på dette tidspunkt overens med det normale trafikmønster under operation af banesystemet 04L/R.

Ved modtagelse af ATIS kl. 22:29:29 skiftede det aktuelle trafikbillede fra bane 04R til bane 04L, da vejroplysningerne nu favoriserede start fra bane 04L. Piloterne anmodede derfor om start fra bane 04L. KL. 22:33:30 blev TODC beregning til bane 04L A9 anmodet under kørsel på bane 30. TODC anmodningen fejlede, da TODC ikke kunne finde banebetegnelsen og derfor ikke kunne beregne TODC fra denne position. Kl. 22:35:21 blev TODC anmodet fra bane 04L A10 og derefter modtaget kl. 22:35:44, hvor luftfartøjet befandt sig under kørsel på rullevej D lige før rullevej A.

Den beregnede TODC blev derefter ført ind i luftfartøjets Flight Management System (FMS). Håndteringen af TODC og FMS blev fortaget af styrmanden, mens fartøjschefen kørte luftfartøjet. Kørslen på rullevej A og frem til A7 blev derfor udført med en rollefordeling, hvor styrmanden var delvist ”head down” i cockpittet.

Det aktuelle trafikbillede var langt hen af vejen fokuseret på normal start fra bane 04R. Under de marginale vejrforhold vurderes det, at fokus blev intensiveret, hvilket gjorde det yderligere svært at bryde trafikbilledet og skifte fokus. Piloterne anmodede selv om baneskift og var derfor med i beslutningsprocessen om at ændre trafikbilledet. Efter skiftet af trafikbilledet og under udkørsel til ny startbane vurderes det, at piloternes mentale trafikbillede sammenholdt med det aktuelle ikke passede optimalt sammen.

Baneskiftet bevirkede, at opgavefordelingen ændrede sig under kørslen og gjorde, at én pilot brugte ressourcer på håndtering af TODC data. På dette tidspunkt skønnes det, at den normale rollefordeling og ”in the loop” koncept blev svækket.

2.1.4 EKCH som hjemmebase

Piloterne havde siden slutningen af 1990´erne begge opereret med EKCH som hjemmebase og var derfor meget bekendt med lufthavnens procedurer og operationer. Før hændelsen havde kun én af piloterne tidligere foretaget start fra bane 04L.

Havarikommissionen har vurderet, at ”hjemmebanesyndromet” har haft indvirkning på hændelsesforløbet, da piloterne meget naturligt har følt sig hjemme og trygge, blot i uvant terræn.

2.1.5 Kørsel på jorden

2.1.5.1 Forurening af rulleveje (contamination)

Ud fra de meteorologiske vejoplysninger før og under hændelsesforløbet og oplysninger fra piloter var rullevejssystemet dækket af tør sne. Den faktiske dybde af forureningen kunne ikke dokumenteres eller verificeres af Havarikommissionen. Piloter har oplyst, at rullevejssystemet var meget svært at se og definere. Piloterne i luftfartøj A har forklaret at de brugte mange ressourcer på at sikre, at udkørslen foregik på rigtige rulleveje og indenfor rullevejsbegrænsningerne. Ifølge piloterne på et andet luftfartøj, der kørte til start ad rullevej A, umiddelbart efter hændelsen indtraf, har forklaret, at de også brugte mange ressourcer på at sikre korrekt udkørsel og bemærkede endvidere, at de ved rullevejkryds A/A7 var ved at køre utilsigtet ad A7.

Da bane 04L umiddelbart før hændelsen blev brugt til landende trafik, hvor A7 blev brugt som frakørsel fra bane 04L, var der opkørt sne fra landende trafik. Luftfartøj B var det tredje luftartøj, der skulle starte fra bane 04L, hvorfor spor af disse førte ad rullevej A. Den opkørte sne, der førte fra bane 04L ad rullevej A7 har med stor sandsynlighed haft en ”lokkende effekt” for piloterne, hvilket har indvirket i, at piloterne sandsynligvis mistede dele af overblikket.

2.1.5.2 Rullebanebelysning

Rullevejssystemet havde på hændelsestidspunktet funktionsdygtigt centerlinjebelysning, kantbelysning. ”Runway Guard Lights” (RGL), røde oplyste baneskilte samt stopbarrer.

RGL omkring banesystemerne 04L/22R og 04R/22L var tændte og funktionsdygtige. RGL gav ikke piloterne et visuelt billede om, hvorvidt luftfartøjet havde tilladelse til at passere stoplinjen, men var kun ment som en visuel forsvarsbarriere til afgrænsning af banens sikkerhedsområde. Havarikommissionen har vurderet, at den store mængde ressourcer som piloterne brugte på at definere rullevejene under kørslen har overskygget RGL´s visuelle funktion som en forsvarsbarriere.

Centerlinjebelysningen på rullevej A var kl. 16:45 sat til 30 % og blev kl. 19:07 sænket til 10 % og forblev på dette niveau under hændelsesforløbet. Centerlinjebelysningen var således på hændelsestidspunktet sat til 10 %. Flyvesikringstjenesten har overfor Havarikommissionen oplyst, at en lysintensitet mellem 1 – 10 % var normalt for operationer i mørke.

Lysintensiteten kunne justeres fra tårnflyvelederens position efter eget initiativ eller efter opfordring fra luftfartøjer. Der blev på intet tidspunkt før hændelsen anmodet om en forøgelse af intensiteten fra luftfartøjer.

Skitse af intersection A/A7 med stopbarre tændt/slukket (se bilag 5).

2.1.6 Design af bane - og rullevejssystem

2.1.6.1 Generelt

Generelt betragtet var EKCH´s bane- og rullevejssystem designet og optimeret til operation af bane 04R/22R som afvikling af startende trafik og bane 04L/22L til afvikling af landende trafik.

Isoleret set betragtes udkørsel til bane 04L ad rullevej A som et segment, hvor designet i sig selv indeholdt en latent risiko for utilsigtet indtrængen på bane i brug via intersections A1 – A7. Endvidere ansås intersection A/A7 som et sted, hvor der var forøget risiko grundet rullevejs A's svage venstredrej efterfulgt af et svagt højredrej ved A/A7 (se bilag 4).

2.1.7 Runway Incursion Monitoring (RIM)

Havarikommissionen har fået oplyst, at på grund af snevejr og snedriver, var RIM funktionen frakoblet på hændelsestidspunktet. Det vurderes, at den frakoblede RIM ikke havde indflydelse på hændelsesforløbet, da en evt. RIM alarm samt tårnflyvelederens reaktionstid ikke ville have haft indflydelse på luftfartøj A's handlemønster.

2.1.8 Stopbarre

Stopbarre ved A7 blev kl. 10:44 tændt og slukket igen kl. 12:02 og tændt igen kl. 22:41, alle gange med en intensitet på 100 %. Stopbarren var således slukket under hændelsen og var derfor ikke til rådighed for piloterne som en forsvarsbarriere under hændelsesforløbet. Havarikommissionen har vurderet, at havde stopbarre på A7 været tændt under hændelsesforløbet, havde piloternes opmærksomhed med stor sandsynlighed været fokuseret mere omkring dette punkt, hvilket kunne have stoppet piloternes utilsigtede passage af stopbarren.

2.2 Luftfartøj B

2.2.1 Generelt

Piloterne var behørigt certificeret. Piloternes flyve- og tjenestetid lå på hændelsestidspunktet indenfor flyve- og tjenestetidsbegrænsningerne fastsat af Trafikstyrelsen (EU-OPS, Subpart Q).

Luftfartøj B bemærkede ikke at luftfartøj A befandt sig inde i bane 04L sikkerhedsområde.

3. Konklusion

3.1 Afdækkende forhold

1. Piloterne på luftfartøj A og B var behørigt certificeret og deres flyve- og tjenestetid lå indenfor begrænsningerne.
2. Styrmanden på luftfartøj A havde haft en ressourcekrævende foregående tur.
3. Piloterne i luftfartøj A mødte hinanden direkte ved flyet.
4. Planlægningen foregik i flyet.
5. Piloterne lavede TODC fire gange, hvoraf tre var for bane 04R.
6. Ved ATIS kl. 22:29:29 ændrede det aktuelle trafikbillede sig fra bane 04R til bane 04L.
7. Bane 04L blev normalt anvendt til afvikling af landende trafik.
8. Piloterne havde EKCH som hjemmebase.
9. Rullevejssystemet var forurenet af sne.
10. Rullevejsbelysningen var tændt og på 10 % lysintensitet, hvilket var normalt for operationer i mørke.
11. Rullevejssystemet var svært at identificere.

12. PF observerede ikke rullevejs A´s svage højredrejning.
13. Isoleret set blev udkørsel til bane 04L ad rullevej A betragtet som et segment, hvor designet i sig selv indeholdt en latent risiko for utilsigtet indtrængen på bane i brug via intersections A1 – A7
14. De spor i sneen, der førte fra bane 04L ad rullevej A7 har med sandsynligvis haft en "lokkende effekt" for piloterne.
15. Der var placeret røde oplyste baneskilte ved A7.
16. RGL var tændte under hændelsesforløbet.
17. Stopbarren ved A7 var slukket under hændelsesforløbet.
18. Et andet luftfartøj under udkørsel var tæt på ligeledes, at følge rullevej A7.
19. RIM funktionen var, på grund af snevejr og snedriver, frakoblet under hændelsesforløbet.
20. Tårnflyvelederen transmitterede på tårnfrekvensen 118,575 MHz – "STOP luftfartøj A".
21. Luftfartøj B bemærkede ikke, at luftfartøj A befandt sig inde i 04L sikkerhedsområde.

3.2 Sammenfatning

Bane 04L i Københavns Lufthavn, Kastrup (EKCH) blev brugt til afvikling af både startende og landende trafik.

Det er Havarikommissionens opfattelse, at de involverede piloters beslutningsproces under hændelsesforløbet var påvirket af forskellige operationelle faktorer, hvilket kumulativt bevirkede, at flere af de tilgængelige forsvarsbarrierer blev svækket.

Medvirkende forhold:

1. Ressourcekrævende foregående tur for en af piloterne.
2. Skift i vejrforhold.
3. TODC beregninger skabte et mentalt trafikbillede fokuseret på start fra bane 04R.
4. Skift af banesystem.
5. "Hjemmebanesyndrom"
6. Programmering af Flight Management System (FMS) under udkørsel.
7. Snedækkede rulleveje.
8. Svært identificerbar rullevejsbelysning.
9. Design af rullevejssystem.
10. Stopbarre ved A7 var slukket (manglende forsvarsbarriere).

De tilgængelige forsvarsbarrierer som Runway Guard Lights (RGL) og rullevejsbelysning – om end sværere at definere – forhindrede ikke udviklingen af hændelsesforløbet.

Havde en tændt stopbarre ved A7 været tilgængelig som forsvarsbarriere, var piloterne med stor sandsynlighed blevet opmærksomme på, at de var på vej ind i et område uden klarering.

Hændelsen skete under marginale baneforhold og på et tidspunkt umiddelbart efter baneskift fra bane 04R til bane 04L. Bane 04R blev anvendt primært til afvikling af startende trafik og 04L til afvikling af landende trafik.

4. Rekommandationer

4.1 Rekommandation

Havarikommissionens fremsendte d. 2.12.2010 en rekommandation som følge af de indledende undersøgelser af hændelsen:

"The Danish AIB recommends that the Danish Transport Authority evaluates and optimizes the use of stop bar lights and the proximity denotations of runway-holding positions at Danish airports (like H24 use of stop bar lights and enhanced taxiway centerline markings)
DENM-2010-005"

4.2 Forebyggende tiltag

På baggrund af Havarikommissionens rekommandation af d. 2.12.2010 udsendte Trafikstyrelsen (TS) et påbud, der medførte en ændring af lokal ATS-instruks, Kastrup TWR, gældende fra d. 1.1.2011:

"10.1.3 Stopbarrer skal anvendes H24 til alle aktive baner under alle vejrforhold"

Trafikstyrelsen udsendte d. 7.3.2011 et notat (se bilag 6), der redegjorde for Trafikstyrelsens aktioner foranlediget af HCLJ´s rekommandation. I notatet beskrev Trafikstyrelsen en alternativ og midlertidig løsning for anvendelse af stopbarre:

"Den alternative midlertidige løsning går i overordnede termer ud på, at såfremt stopbarre kun anvendes på aktive baner, kan kun ét banesystem anvendes af gangen, enten parallelbanesystemet 04/22 eller tværbane 12/30."

Trafikstyrelsen har meddelt, at implementeringen af en permanent anvendelse af stopbarre til alle baner kan forventes færdiggjort i efteråret 2011.

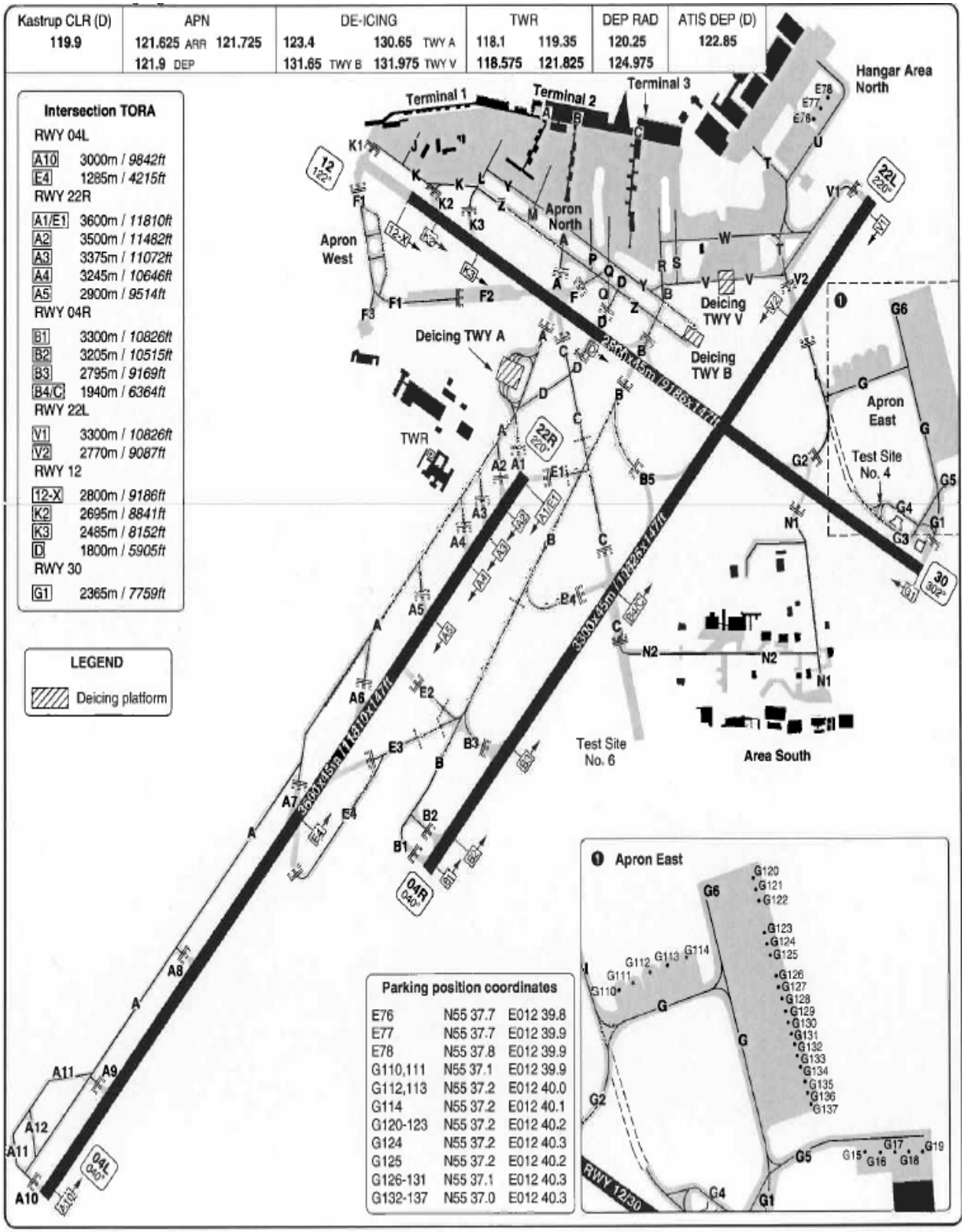
Operatøren af luftfartøj A har oplyst, at der d. 1.12.2010 blev implementeret nye procedurer i OM-A for kørsel på rullebaner til og fra banesystemerne. Endvidere fortsættes evalueringen og en eventuel implementering af et on-board Runway Awareness System, der kan forbedre piloternes opmærksomhed ved hjælp af auditive meldinger på og omkring en lufthavns banesystemer.

5. Bilag

1. Oversigtsbillede over bane – og rullevejssystem på EKCH.
2. Radarpræsentation af luftfartøj A og B under startsekvensen.
3. Bilag til lokal instruks for Kastrup TWR.
4. Intersection A/A7.
5. Skitse af intersection A/A7 med stopbarre tændt/slukket.
6. Trafikstyrelsens notat af 7.3.2011.
7. Runway Safety – Use of Stop Bars 24 (study by Eurocontrol).

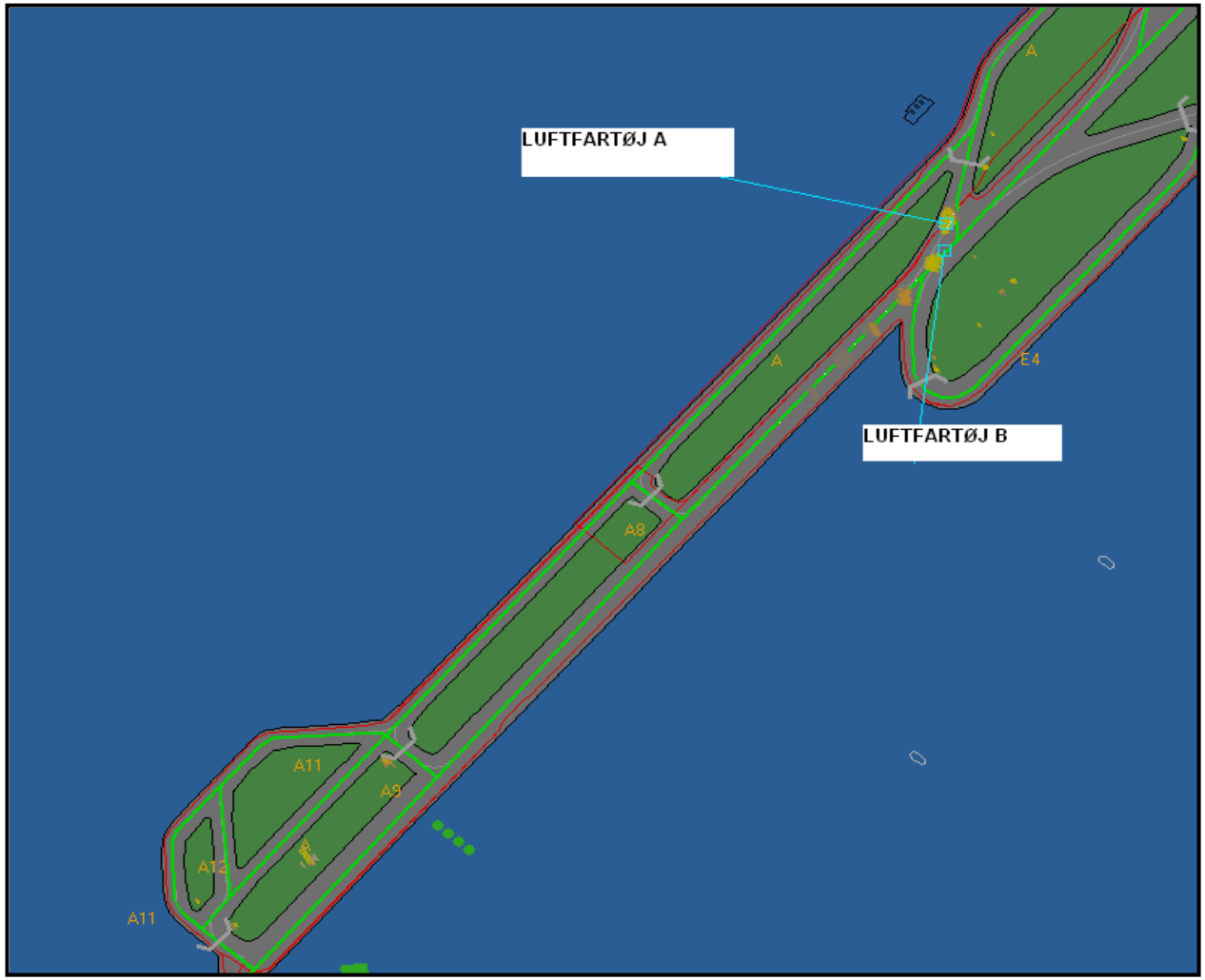
Bilag 1

Oversigtsbillede over bane – og rullevejssystem på EKCH



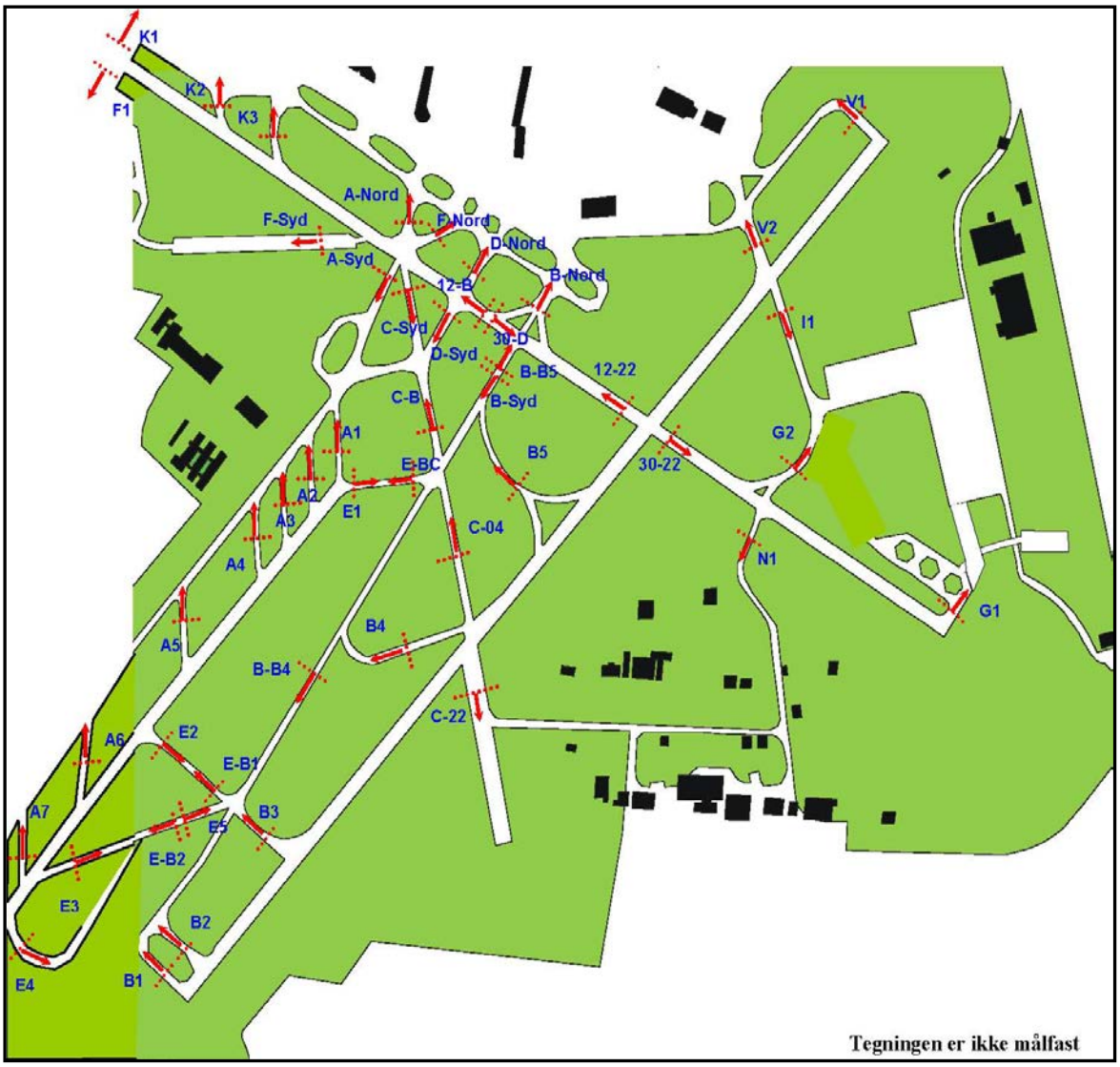
Bilag 2

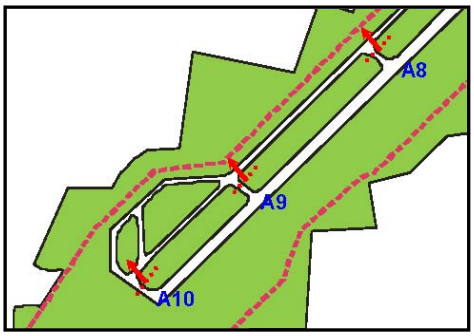
Radarpræsentation af luftfartøj A og B under startsekvensen.



Bilag 3

Bilag til Lokal ATS instruks for Kastrup TWR



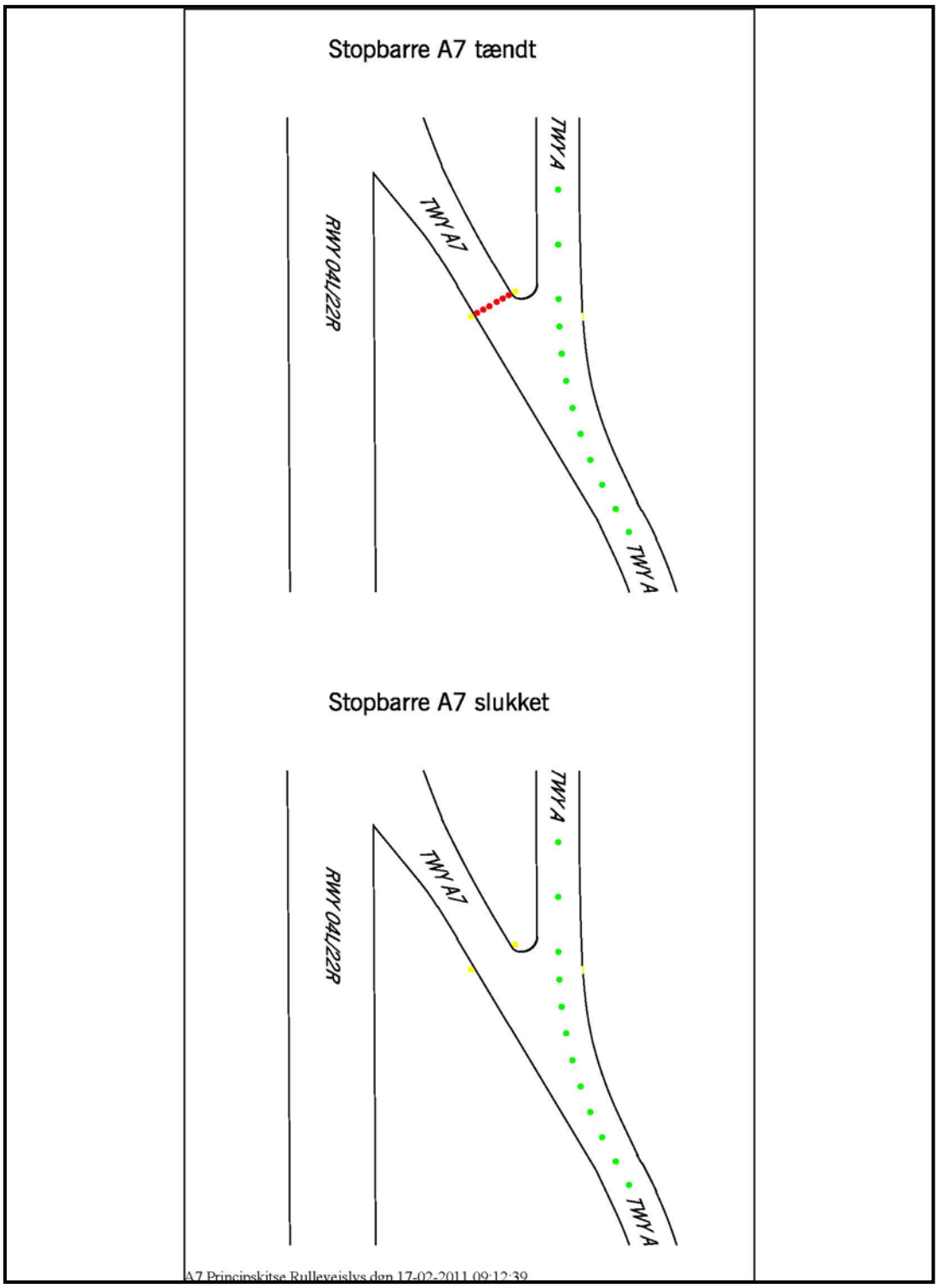


Bilag 4

Intersection A/A7.

Bilag 5

Skitse af intersection A/A7 med stopbarre tændt/slukket.



Bilag 6

Trafikstyrelsens notat af d. 7.3.2011. Havarikommissionen har bortredigeret navne.

Trafikstyrelsen
Danish Transport Authority

Havarikommissionen for
Civil Luftfart og Jernbane
Langebjergvænget 21
4000
Roskilde

Luftfartshuset
Box 744
Ellebjergvej 50
2450 København SV
Telefon + 45 3618 6000
Direkte + 45 3618 6215
Fax + 45 3618 6001
dcaa@slv.dk
www.trafikstyrelsen.dk

Dato:	Vor ref.:	Sagsbehandler:
7. marts 2011	10-9082-0016	
Deres brev af:	Deres ref.:	
2. december 2010	HCLJ510-000811	

Status – aktioner foranlediget af HCLJ's Rek. DENM-2010-005

1. Indledning

Med henvisning til lufttrafikhændelsen den 26. november 2010 på Københavns Lufthavn, Kastrup, HCLJ510-000811, fremsendte HCLJ den 2. december 2010 følgende rekommandation til Trafikstyrelsen:

"The Danish AIB recommends that the Danish Transport Authority evaluates and optimizes the use of stop bar lights and the proximity denotations of runway-holding positions at Danish airports (like H24 use of stop bar lights and enhanced taxiway centerline markings) DENM-2010-005"

Dette notat redegør kort for Trafikstyrelsens aktioner foranlediget af rekommandationen.Trafikstyrelsens aktioner kan inddeles i a) aktioner vedrørende supplerende dagmarkering ved ventepositioner, og b) aktioner vedrørende anvendelsen af stopbarrer. I forbindelse med den generelle rekommandation om anvendelse af stopbarrer henover hele døgnet, kan oplyses at Trafikstyrelsenhar prioriteret Københavns Lufthavn, Kastrup frem for øvrige flyvepladser udstyret med stopbarrer.

2. Aktioner vedr. supplerende dagmarkering ved ventepositioner

I forbindelse med Trafikstyrelsens afholdelse af IMC-flyvepladschefmøde den 26. januar 2011 blev det oplyst over for alle danske flyvepladser med instrumentbaner, at supplerende dagmarkering ved ventepositioner, som udgangspunkt, skal implementeres. Den supplerende dagmarkering består af udvidet rullevejs centerlinie og/eller obligatorisk instruktionsmarkering, jf. anbefalingerne i ICAO Annex 14, Vol. I, pkt. 5.2.8.4 og pkt. 5.2.16.2.

Trafikstyrelsen har planlagt opfølgning overfor IMC-flyvepladserne inden juni 2011 med henblik på endelig implementering ved den enkelte IMC-flyveplads.

3. Aktioner vedr. Anvendelsen af stopbarrer

Med baggrund i hændelserne den 15. og 26. november 2010 samt HCLJ's rekommandation af 2. december 2010, meddelte Trafikstyrelsen den 3. december 2010 et påbud til om anvendelse af stopbarrer til alle baner henover hele døgnet, gældende fra 1. januar 2011.

Transportministeriet

Mandag – torsdag: 09.00-15.30
Fredag: 09.00-15.00
CVR: 55569517
EAN: 5798000893412

har meddelt Trafikstyrelsen, at påbuddet af 3. december 2010, dvs. anvendelse af stopbarrer til alle baner henover hele døgnet, under visse forhold kan medføre, at kapaciteten bliver reduceret under de kapacitetsmål, som er aftalt mellem og , men at der ikke vil være sikkerhedsmæssige konsekvenser.

Som resultat af efterfølgende drøftelser med sagens parter ( ) blev der af Trafikstyrelsen den 23. december 2010 givet mulighed for anvendelse af en alternativløsning af midlertidig karakter.

Den alternative midlertidige løsning går i overordnede termer ud på, at såfremt stopbarrer kun anvendes på aktive baner, kan kun ét banesystem anvendes af gangen, enten parallelbanesystemet 04/22 eller tværbane 12/30.

Forslaget blev af Trafikstyrelsen nærmere beskrevet i brev af 7. januar 2011.

Trafikstyrelsen, og er enige om, at den bedste fremadrettede løsning, som tilgodeser flyvesikkerhed såvel som kapacitet fuldt ud, er en løsning med permanent anvendelse af stopbarrer til alle baner. Denne løsning arbejdes der nu på at kunne implementere hurtigst muligt, men der kræves visse systemmæssige ændringer, som det vil tage en vis tid at indføre. har med baggrund i udmeldt handlingsplan, på møde med Trafikstyrelsen den 11. februar 2011, oplyst at implementeringen af en permanent anvendelse af stopbarrer til alle baner kan forventes færdiggjort i efteråret 2011.

Indtil ovennævnte permanente ændring kan indføres, anses den alternative midlertidige løsning, med kun et aktivt banesystem af gangen og med tændte stopbarrer til aktive baner, som en sikkerhedsmæssig fuldt forsvarlig løsning.

Med venlig hilsen

Bilag 7

Runway Safety – Use of Stop Bars 24 (study by Eurocontrol).

EUROPEAN ORGANISATION
FOR THE SAFETY OF AIR NAVIGATION

Runway Safety - Use of Stop Bars 24H

Edition Number	:	1.0
Edition Date	:	September 2008
Status	:	Released Issue
Intended for	:	General Public

EUROPEAN AIR TRAFFIC MANAGEMENT PROGRAMME

DOCUMENT CHARACTERISTICS

TITLE		
Runway Safety - Use of Stop Bars 24H		
EATMP Infocentre Reference:		
Document Identifier	**Edition Number:**	1.0
	Edition Date:	September 2008

Abstract

Stop bars operated 24 hours per day in all weather conditions are considered a significant safety benefit by Pilot, Drivers working on the manoeuvering area and Air Traffic Controllers. Controller workload is considered acceptable given an appropriate procedure and co-location of the stop bar switches with the Controller working position.

Keywords

Stop bars	Controller workload	Conspicuity	Pilot
Vehicle driver	Working position	Safety benefits	Procedure
Local controller			

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STATUS, AUDIENCE AND ACCESSIBILITY

Status		Intended for		Accessible via	
Working Draft	☐	General Public	☑	Intranet	☐
Draft	☐	EATMP Stakeholders	☐	Extranet	☐
Proposed Issue	☑	Restricted Audience	☐	Internet (www.eurocontrol.int)	☐
Released Issue	☐	*Printed & electronic copies of the document can be obtained from the EATMP Infocentre (see page iii)*			

ELECTRONIC SOURCE

Path:	C:\apr_rwy_saf_2006\P5 Procurement\Red Stop Bars 24hr	On	HBRUPX00R

Host System	Software	Size
Windows_NT	Microsoft Word 10.0	2547 Kb

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DOCUMENT APPROVAL

The following table identifies all management authorities who have successively approved the present issue of this document.

AUTHORITY	NAME AND SIGNATURE	DATE
Please make sure that the EATMP Infocentre Reference is present on page ii.		
Runway Safety Project Manager	 Yvonne Page	16/09/2008
APR Programme Manager	 Eric Miart	17/09/2008
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DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION NUMBER	EDITION DATE	INFOCENTRE REFERENCE	REASON FOR CHANGE	PAGES AFFECTED
1.0	2008		Documentation Creation	ALL

CONTENTS

EXECUTIVE SUMMARY

The objective of this study; to examine the feasibility of using stop bars that protect the runway 24 hours per day in all weather conditions e.g. sunshine / bright light / rain / snow / ice, day and night has been fulfilled with the following key findings:

1. Operating of stop bars to protect the runway 24 hours per day was considered a significant safety benefit by pilots, drivers and air traffic controllers;

2. Airports using Stop Bars today typically equip the CAT III holding point as a compliment to the pavement marking and signage according to ICAO. To move from operating a Stop Bar during low visibility conditions and at night, to 24 hour operations may require a number of changes to procedures, airport lighting, holding positions, training and organisational stop bar use policies.

3. Throughput was maintained at the same levels as prior to the trial;

4. Operation of the stop bars in all categories of weather and light conditions was considered to require an acceptable workload from air traffic controllers given an appropriate procedure and co-location of user-friendly stop bar switches with the controller working position;

5. Stop bars were visible in all weather conditions for Pilots and Drivers, irrespective of the shape of the stop bar or the variety of the lamps in use, however a straight line of lamps was preferred compared to a 'V' formation;

6. Stop bars improve situational awareness;

7. Key enablers to the successful use of stop bars 24 hours per day are:

    - A clear stop bar policy from each significant organisation: aircraft operators, air navigation service providers and aerodrome operators. These policies may be enforced by the local regulator;

      "Never cross (instruct others to cross) a red stop bar"

    - A clear stop bar operating procedure defined by the air navigation service provider;

    - Contingency procedures for when the stop bar is unserviceable, to avoid the crossing of a red stop bar;

    - A clear strategy for the planning and implementation of maintenance or other works on the manoeuvring area;

    - Ergonomic design of the human machine interface of the air traffic control lighting panel and stop bar switches;

    - Independence of the stop bars from other air ground lighting;

- A single, consistent method for using stop bars is required by pilots to ensure a robust safety net:

"Red Lights Mean Stop"

This study and consequent work was undertaken by the Local Runway Safety Team of Manchester Airport. Due to the successful outcome of the trial, the use of stop bars 24 hours per day to protect the runway will be continued as part of normal operations at Manchester Airport.

Photograph by Blue Sky Services

INTRODUCTION

1.1 Preventing Runway Incursions

Signs markings and lighting act as safety nets to prevent drivers or pilots from entering a runway incorrectly. Today stop bars that protect the runway are used differently across the ECAC area resulting in pilots and drivers systematically crossing red lights and degrading their value as a safety net.

This report describes the potential safety benefits of using stop bars that protect the runway 24 hours per day in all weather and light conditions. The intention of 24 hour use is to consistently reinforce instructions given by air traffic control, to protect traffic using the runway correctly.

This study and consequent work was undertaken by the Local Runway Safety Team of Manchester Airport.

1.2 Context

The European Action Plan for the Prevention of Runway Incursions (EAPPRI) was first released with the full support of the EUROCONTROL Provisional Council in 2003.

The EAPPRI contains 56 recommendations that are targeted at specific stakeholder groups, i.e. Regulators, Aircraft Operators, Air Navigation Service Providers, Aerodrome Operators, Safety Managers, and Aeronautical Information Managers.

The EAPPRI contains several recommendations applicable to the use of stop bars:

Aircraft Operators 4.4.2 Pilots shall not cross illuminated red stop bars when lining up or crossing a runway, unless contingency procedures are in force, for example to cover cases where the stop bars or controls are unserviceable.

Air Navigation Service Providers 4.5.5 Aircraft shall not be instructed to cross illuminated red stop bars when entering or crossing a runway unless contingency measures are in force, e.g. to cover cases where the stop bars or controls are unserviceable. Stop bars that protect the runway must be controllable by the runway controller.

The role of the **Aerodrome Operator** is addressed by recommendation **4.2.1** Verify the implementation of ICAO Annex 14 provisions and implement maintenance programmes relating to Runway operations e.g. markings, lighting, signage. Ensure that signs and markings are clearly visible, adequate and unambiguous in all relevant conditions.

Local Runway Safety Teams 4.1.3 Confirm that all infrastructure, practices and procedures relating to runway operations are in compliance with ICAO provisions.

The approach taken to preventing runway incursions continues to address issues and concerns about runway safety together with the stakeholders.

1.3 Objectives

As an aid to preventing runway incursions, the objective of this study is to examine the feasibility of using stop bars that protect the runway 24 hours per day in all weather conditions e.g. sunshine / bright light / rain / snow / ice, day and night.

The study considers the following aspects:

1.3.1 ICAO

Use of stop bars 24 hours per day is compared to the current ICAO standards and recommended practices for the use of red stop bars in category II/III weather operations.

ICAO provisions act as the benchmark for the purpose of measuring the effect of any changes.

The ICAO definition of a runway incursion is used as the basis for this study.

> "Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take off of aircraft"
> *Applicable 25 November 2004*

UK NATS has adopted this definition and further interpreted it for practical use as shown in appendix A.

1.3.2 UK CAA differences to ICAO

The trial airport is governed by UK regulation and requires stop bars to be provided at each runway holding point (UK CAA CAP168), irrespective of category.

In accordance with CAP 168 the CAT II/III holding point is placed at 137m. The local air traffic control procedure is contained in the UK Manual of Air Traffic Services Part 2 General Operating Instructions Chapter 11 paragraph 11.2 (Localiser Sensitive Area).

At Manchester Airport there were two sets of stop bars, one at the visual and CAT I holding point (90m or 105m depending on location) and one at the CAT II/III holding point (137m). Runway Guard Lights (wig wags) were co-located with each of the stop bars. This is a typical lighting configuration for UK airports.

1.4 Purpose

This study has explored the feasibility of 24 hour use of stop bars to protect the runway. 24 hour use of stop bars could enable the consistent operation of stop bars internationally, providing a safety net with improved integrity compared to the variety of operational practices available at aerodromes today.

1.5 Scope

There are a variety of ways to use stop bars to protect a runway in current operational practice.

This study includes (Appendix B) a procedure for use by Air Traffic Control that when correctly applied, permits current levels of throughput to be maintained.

This study has been based upon live operational trials of the use of stop bars that protect the runway 24 hours per day, in all light conditions, at a busy international airport.

The trial included operations during high season traffic peaks and low season workload peaks with a variety of weather conditions.

The following aspects have been considered by the participating pilots, drivers and air traffic controllers, human factors and safety experts:

- Preliminary Hazard Assessment used as input to the stop bar procedure, temporary operating instructions, contingency procedures and other preparations for the trial discussed in this report;
- Proposed air traffic control procedures;
- A view of air traffic control human machine interface requirements;
- Effect on air traffic controller workload;
- Training and transition;
- Aerodrome infrastructure, e.g. Air / Ground lighting, markings;
- Equipment e.g. light intensity, stop bar selection, position of switches, lamp configuration;
- Maintenance and contingency on the manoeuvring area;
- Safety effectiveness and operational efficiency;

2. STUDY DESCRIPTION

More than 3600 (January – May 2008) hours of live traffic has been observed during 24 hour operations using the stop bars protecting the runway.

2.1 Description of Actual Manoeuvring Area Operations

In recent years the trial airport has had an average of 188 hours per year of safeguarded operation. This is made up of:

22 hours of low-visibility operations due to low cloud (200ft or below)

76 hours of low-visibility operations due to low visibility (600m runway visual range or less)

90 hours of precautionary safeguarding where weather is just above these limits.

50 % of UK operations on average are in darkness (UK Met Office)

Snow is unusual at Manchester, disruption due to snowfall is experienced on average two days per year. Ice operations are negligible as pre-emptive de-icing is carried out. Snow and ice were not experienced during the trial.

Peak traffic - 70 movements per hour, dependent parallel runways, operated in segregated mode.

Runway configuration changes typically occur 4 times per day.

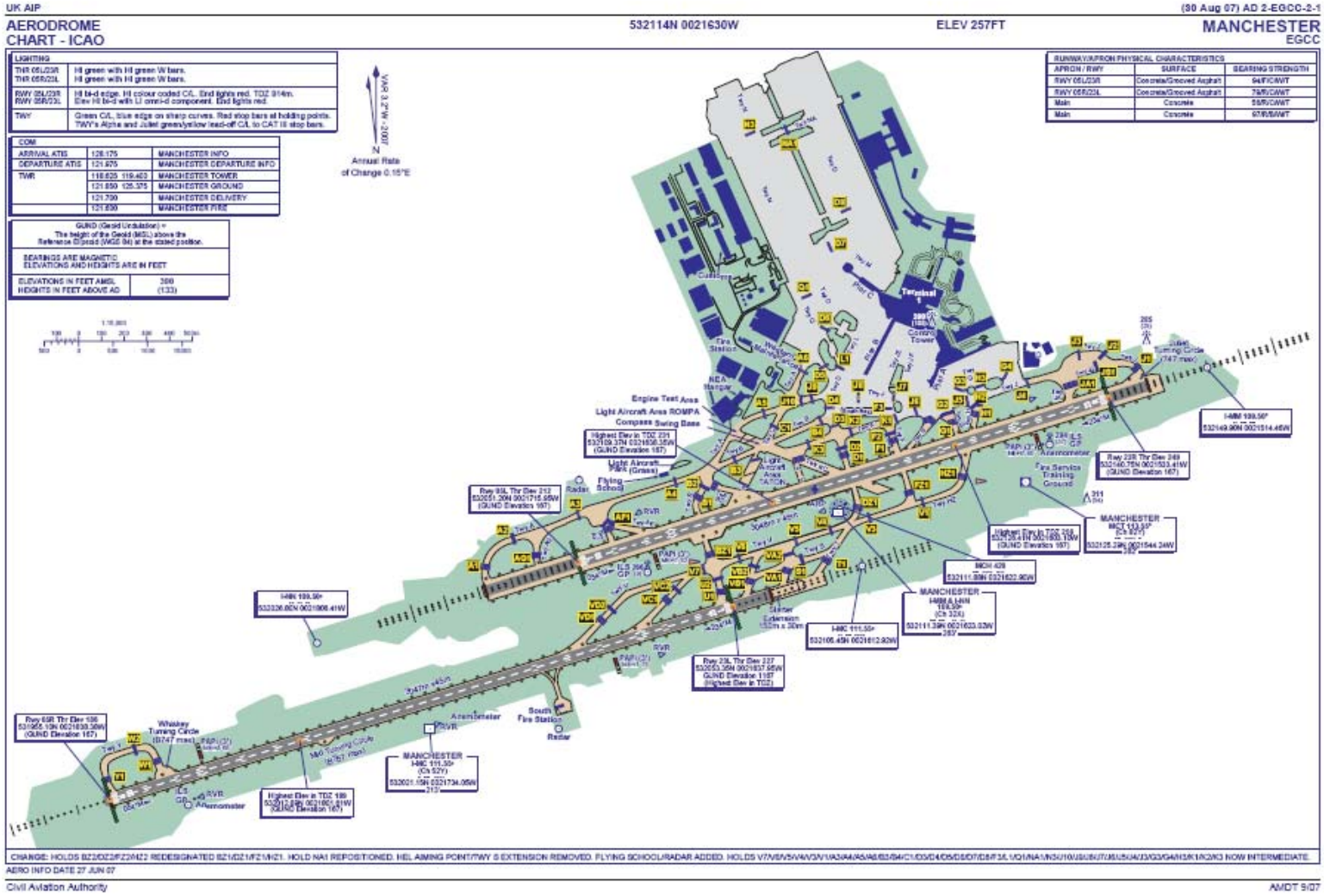

Figure 1. Manchester Airport Aerodrome chart

2.1.1 Signs

Signage at Manchester airport is ICAO compliant.

2.1.2 Holding Point location and markings

The CAT II/III holding point is placed at 137m as opposed to the ICAO standard 90m. There is a CAT I visual holding point in use at 90m or 105m depending on location; at the runway ends, the distance is permitted to be reduced to 75m in the UK under CAP168.

This is a typical lighting configuration for UK airports and is a filed difference from ICAO.

In conjunction with NATS, the Airport Operator started a programme of moving the runway holding points and stop bars to a common distance of 137m across the airfield. The south side crossing points for runway 23R/05L (BZ1, DZ1, FZ1 and HZ1) are set up in this way.

Once complete, there will be a single holding point at each runway entrance location which will be used in all conditions and will be accompanied by a Pattern A painted marking, a red stop bar and Runway Guard Lights (wig wags).

It is believed that a single holding point reduces complexity and confusion when pilots and drivers are manoeuvring their aircraft or vehicles close to the runway. It also provides an added safety net for the controller as there is more time to identify and correct errors.

2.1.3 Lighting

Red stop bars are fitted at all taxiway access points to the runway, an exception is made for the South Fire Station where emergency vehicles can access at a location where no stop bar is provided. This situation is being addressed by the airport operator. Vehicles are not allowed to enter the runway from service roads; they must use the runway entrance points.

Taxiway routing guidance is provided by the use of green taxiway centreline lighting at night and in CAT II/III conditions based upon the “sea of green” principle – individual route guidance is not provided unless specifically requested except where the Runway Visual Range falls below 200m

2.1.4 Microwave sensors

The crossing points on runway 23R/05L are fitted with microwave incursion sensors that provide a visual and audible alert to the air controller (and in some cases the pilot) if an aircraft crosses an illuminated stop bar. Where the stop bars have been relocated to 137m this system illuminates the original

visual stop bar closer to the runway at the same time as the alert is generated to the controller.

2.1.5 RIMCAS Logic

The surface movement radar is also fitted with a Runway Incursion Monitoring and Collision Avoidance System (RIMCAS) which operates independently from these sensors and provides visual alerts to controllers where a risk of collision is detected.

2.2 Actions to prepare the trial

2.2.1 Aerodrome Operator

2.2.1.1 Stop bar policy

The airport operator at Manchester Airport has a zero tolerance policy on crossing illuminated red stop bars:

“Never cross a red stop bar. If instructed to cross a red stop bar, challenge the controller to switch off the stop bar, or provide an alternative routing.”

A runway incursion at Manchester Airport includes when an aircraft, vehicle or pedestrian is cleared to enter the runway and does so, as instructed and intended, but before the red stop bar has been deselected.

2.2.1.2 When a stop bar is out of service

UK CAA rules (MATS Part 1 Section 2, Chapter 1, Paragraph 9.3.4) allow the use of “follow me” vehicles where runway stop bars fail. The airport operator at Manchester will not permit the use of this procedure unless no alternative exists; generally where a stop bar cannot be extinguished the link will be taken out of service in favour of an alternative.

2.2.1.3 Lighting

Lighting software was updated to allow use of red stop bars at runway entrance links during daylight hours when the full ground lighting system was not required. This was done to allow lighting to be used to reinforce the air traffic control instruction; and to prevent misleading traffic onto or across a runway.

All air ground lighting is manually switched on and off by the air traffic controller e.g. stop bars are manually de-activated (switched off).

The position of the lighting switches was adjusted for ease of use by the Local controller.

2.2.1.4 Driver Training

At Manchester Airport drivers receive a specific training and a permit to drive on the manoeuvring area. The permit and training is reviewed every twelve months. Drivers permitted to operate in areas close to the runway receive specialist training; the Airfield Operations drivers in particular require a uniquely high level of skill and are required to undertake monthly competency sign-off. These drivers are typically involved in runway inspections and bird control duties.

2.2.2 Air Traffic Control

2.2.2.1 Stop bar policy

The air navigation service provider, NATS has the following policy on the use of stop bars at Manchester Airport:

> "Never instruct an aircraft or vehicle to cross a red (lit) stop bar."

2.2.2.2 Stop Bar Operating Procedure

Air Traffic Controller Trial Procedures (Appendix B) and Temporary Operating Instructions (Appendix C) provided formal stop bar procedures that were issued for the trial period. Key points are listed below. See the relevant appendix for full information.

When issuing a conditional clearance - extinguish the stop bar only when the subject of the condition has passed and it is safe for the aircraft or vehicle to enter the runway at that entry point at that time.

Use of green taxiway centreline lights was decoupled from the stop bars. During daylight hours, only the stop bars protecting the runway were illuminated.

At night taxiway centreline lights were illuminated on the taxiway. The lights are coupled to the stop bar so that when a stop bar is deselected the green centreline lights are activated.

The stop bars are re-lit manually by the controller to assure that all crossings and entries are complete prior to re-illumination. There is no automated action, except for links where only vehicles will normally enter the runway in the selected configuration. In such cases a "quick drop" function enables the controller to de-select a stop bar which then illuminates automatically after ten seconds.

The unprotected entrance used by the fire service was controlled under strict procedures that included local briefing and training for the fire service staff.

The taxiway green centreline lights extinguish in timed stages at crossing points to allow crossing traffic to complete the cross after the stop bar is re-selected.

Runway Guard Lights (wig wags) are co-located with stop bars and are always on when the runway is in use.

2.2.2.3 Conditional Clearances

Conditional clearances for lining up on a runway are permitted at Manchester but their use is discouraged and strict conditions apply. The use of stop bars provides a re-enforcement of the conditional clearance as the stop bar will not be dropped until the condition has passed.

2.2.2.4 Human Machine Interface design

At Manchester Airport tactile buttons are used by the Local Controller to activate stop bars. This means the lights can be reliably switched without the controller having to be distracted from looking out of the visual control room to look down at a touch screen.

2.2.3 Aircraft operator

2.2.3.1 Policy

Most aircraft operators employ a “never cross a red stop bar” policy. If instructed to cross a red light, pilots should challenge the controller to switch off the red lights, provide a “follow me” vehicle or use an alternative entrance. However, as there is some difference in the approach to stop bar use internationally it is difficult for flight crews to apply this principle in a consistent manner.

As mentioned above, UK CAA rules (MATS Part 1 Section 2, Chapter 1, Paragraph 9.3.4) allow the use of “follow me” vehicles where runway stop bars fail. Where this procedure is in place, experience shows that most flight crews comply.

A Local Runway Safety Team briefing included the participating airlines.

2.2.4 Pre trial awareness

A Notice to Airmen (NOTAM) was created by the airport Local Runway Safety Team to make all airport users aware of the changed use of stop bars.

Local Runway Safety Team members participated in a hazard analysis of the trial, specifically the air traffic control procedure. Air traffic controllers were advised via their shift briefings and the Air Traffic Controller Trial Procedures (Appendix B) and Temporary Operating Instruction (Appendix C). Drivers were briefed by the Airport Operator and aircraft operators were asked to notify their pilots. The Local Runway Safety Team took responsibility for all aerodrome users having the possibility to know about the trial, this includes the police, fire service etc.

3. TRIAL FINDINGS

Measurement of the effectiveness of safety measures represented in this report – such as the use of stop bars 24 hours per day – takes account of quantitative data in terms of runway incursion alerts generated from surface movement radar data, runway incursion reports and qualitative data from user feedback.

During the previous twenty years Manchester Airport has worked on establishing and improving its safety culture. Many runway incursion hot spots have been eliminated at certain intersections during that time (T1 entry point 23L – JA entry point 23R – D1 crossing point 23R). The all time peak of runway incursions was 17 in 2006 with two serious incidents (severity class A) having taken place in 2002 and 2004. It is worth noting that almost all incursions at Manchester are made by aircraft rather than vehicles.

The runway incursion rate increased during the trial, year to date (January to May 2008) there were 20 recorded incursions. It is believed that this has been due to aircraft crossing stop bars that should have been deselected when aircraft were cleared to enter the runway.

This issue is believed to be a transition problem with a minority of controllers; the fact that such events have been recorded would suggest that controllers are keen to address the issue and ensure full compliance.

26 air traffic controllers, 29 pilots, 23 drivers and 16 fire service staff completed questionnaires (Appendix D). All feedback was analysed and is included in the following findings.

3.1 Work in progress

Issues regarding periods when air traffic control loses control of Airfield lighting due to maintenance were identified. Improved airfield lighting handover procedures have been developed to minimise disruption of throughput due to runway / taxiway maintenance.

It was felt in the pre-trial planning that it would not be acceptable to switch off the stop bars and revert to voice-only when there is a lighting failure or a maintenance requirement. This has led to a more formalised approach to the management of works in progress (WIP) between the Air Navigation Service Provider (ANSP) and the Airport Operator. Now the ANSP hands sections of the airfield over to the Airport Operator for maintenance; this includes the runways and has been successful. The process is largely derived from successful practices used by the UK railway industry.

A specific occurrence resulted in 5 incursions in the same circumstances. During a taxiway closure aircraft were required to enter runway 23R from link AF to backtrack and vacate at B (see airport diagram, figure 1). The runway entry point at this location is AF1 which is directly adjacent to the rapid exit taxiway (RET) at AE. RET AE is protected from the taxiway side by a permanently illuminated red stop bar as runway entry at RETs is not permitted

at Manchester. However, when cleared to enter the runway at AF1 (with the stop bar deselected) several aircraft crossed the red stop bar at AE and entered the runway via the RET. This area is marked with an ICAO “Pattern A” painted runway holding point marking and “no entry” signs in addition to the red stop bar.

Investigations revealed that this area is difficult to navigate in smaller aircraft. However, 4 out of 5 incursions involved aircraft of Boeing 737 size or above (including one Boeing 747). Neither the Airport Operator nor the ANSP were able to interview the crews concerned, but it appears that the desire to take the shortest route and hence minimize runway occupancy time overrode the desire not to cross an illuminated red stop bar. Consequently there has been no tangible change (reduction or increase) in the number of runway incursions for the trial period.

3.2 Lights

Manchester Airport is gradually migrating from using traditional tungsten bulbs to the use of LED fittings upon the recommendation of the field maintenance engineers. Operational staff did not comment on a significant difference in luminosity or conspicuousness of the lights due to the type of lamp in use. A straight line of lights was preferred to a V shape.

It was important to assure the Independence of the stop bars that protect the runway from other air ground lighting to avoid switching on all or unnecessary air ground lights when operating the stop bars.

3.3 Consistent use of Stop Bars

There was a feeling that the 24 hour use of runway stop bars was “a good idea” and moving to a permanent procedure has been popular with controllers as it provides an opportunity for consistency in stop bar operating procedure.

3.4 Impact on throughput

Traffic throughput was recorded at the same levels before and during the trial.

3.5 Human Machine Interface design - stop bar control switch panel

The design and location of the stop bar control switch panel is fundamental to the successful operation of stop bars 24 hours per day.

The stop bar control switch panel must be co-located with the Local Controller working position. For the trial, Manchester Airport placed the switch closer to the controller to minimise the arm reach required. Occupational health analysis has since concluded that the revised panel design is satisfactory only in the short-to-medium term (i.e. for a period of months) and that any new panel must be better suited to the ergonomic requirements of 24 hour stop bar operation.

A new panel will be introduced later this year. Through controller feedback, it is proposed that the new lighting controls will be of a modern touch-screen design, but that the runway stop bar controls remain as traditional tactile buttons. Operating stop bars that protect the runway through touch screens is not appropriate when the controller needs to be heads up, looking out of the visual control room to the manoeuvring area. Tactile buttons allow sensory acuity of actions stop bar selection and de-selection taken.

Further design considerations may be given by industry to the quality of the control buttons.

3.6 Pilot awareness and consequent safety net effectiveness

At the local Flight Operations Safety Committee (FLOPSC) it was suggested that pilot briefings prior to the trial were not sufficient, possibly accounting for the increased number of runway incursions. Aircraft operators attending the FLOPSC were briefed in detail – this includes most local operators. The Airport Operator issued a NOTAM on the subject of the use of stop bars.

It has become clear through this trial and other recent events at Manchester that pilots do not always correctly assimilate NOTAM information, even when it has reached the flight deck. Although outside the direct scope of this report, this issue warrants further investigation as many local procedures (especially during works-in-progress) rely upon the correct interpretation of NOTAM information for their integrity.

It would appear that awareness measures to compliment the use of NOTAMs as a primary source of communication with pilots is required from the aircraft operators.

A consistent use of stop bars internationally is expected to influence pilot behaviour favourably improving the reliability of the safety net.

3.7 Airport Vehicle Drivers - consistent placing of stop bars

All drivers (including Fire Service personnel) responded well to the briefings.

A comprehensive briefing and awareness programme was carried out, both through the Local Runway Safety Team and through the Airport Operator's driver training unit. The airport has operated a zero-tolerance approach to vehicles crossing red stop bars for some time, so the training and briefing requirements were not onerous. The procedure already in use during the hours of night and in poor weather was simply extended to 24 hour operation.

Driver feedback indicated that the brightness/visibility of stop bars was generally satisfactory. Some specific recommendations for improvements were made.

It is worth noting that the only vehicle incursion during the trial period occurred during CAT III operations at a location where stop bar protection is only available at the CAT I holding point. This is the only such location at

Manchester; vehicle drivers rely on special training and blue edge markers in order to position themselves correctly in this area (this is not ICAO compliant). The controller saw the incursion by using the surface movement radar and the situation was resolved; reports were filed both by vehicle driver and controller enabling a full investigation. The importance of having the stop bars in “the right place” was emphasized by this incident and the Airport Operator has sought to urgently remedy the situation at this link.

3.8 Measured Safety Benefits

Almost everyone involved in the trial has stated that the 24 hour use of runway stop bars is a positive step.

The trial has proved that runway stop bars can be used without adverse effects on controller workload, traffic throughput or energy use by lamps.

3.9 Human Factors analysis and Recommendations

A sample of the air traffic control questionnaire is appended – the questionnaires to other user groups were based upon this so are not individually included.

The findings from Human Factors questionnaires provide a set of conclusions regarding the impact of the introduction of 24 hour use stop bars for each of the participating groups, namely controllers, pilots, airfield operations drivers and the fire service. The information is summarised into a set of overall conclusions. Recommendations are also provided and, for ease of use, these are referenced in brackets in the body of the text.

3.9.1 Controller Feedback

3.9.1.1 Lighting Panel

Overall, the lighting panel was not acceptable for use without modification in the long term but it was sufficient as an interim measure until the move to the new tower.

The tactile user feedback from the lighting panel was acceptable for both current and future operations without modification but it was noted that a greater degree of tactile feedback would be advantageous. The back indications (i.e. the indication of actual lighting status on the panel) from the lighting panel were also acceptable for current and future use with no further modifications. However, the back indications could be difficult to see in daylight operations and thus some improvement in this respect would be beneficial.

The two-button press functionality of the lighting panel was only acceptable as an interim measure as it was labour-intensive and prone to induce errors. It

was suggested that a one-press button would be more efficient for crossing aircraft. The two-button press functionality resulted in an increase in the number of incorrect selections particularly when crossing aircraft in westerly dual operations. This was attributed to the size and position of the buttons and the speed of execution needed during dual operations, especially during the day when it is harder to discern the back lighting indications. As such, the buttons on the lighting panel would benefit from being larger and/or more spaced apart to reduce the number of incorrect selections made. However, they were acceptable in their current form until the move to the new Tower.

The use of 24 hour stop bars increased the amount of physical movement required to access the lighting panel, particularly for the Air 1 controller and the Air 2 controller who were more negatively affected than the Ground Movement Controller. The Alpha stop bar was explicitly mentioned as being in a difficult position. It was also noted that the positioning of the panel could be problematic for left-handed controllers to operate.

3.9.1.2 Workload

The use of 24 hour stop bars increased overall controller workload because it was an additional task which detracted controller attention from the primary air traffic control task. Moreover, the panel was poorly positioned and difficult to use which introduced the potential for errors (i.e. pressing buttons accidentally).

On the whole, the use of 24 hour stop bars did not have any effect on R/T workload. However, it was noted that co-ordinating the de-selection of stop bars with R/T transmissions was sometimes difficult.

3.9.1.3 Planning

Overall, the use of 24 hour stop bars had little effect on controller ability to plan ahead or to execute this plan. However, disparate results made it difficult to ascertain whether the use of 24 hour stop bars had any notable effect on controller ability to prioritise air traffic control tasks.

3.9.1.4 Situational Awareness (SA)

It was generally agreed that the use of 24 hour stop bars had no effect on controller ability to maintain situational awareness. However, it was noted that operating the stop bars in daylight conditions served to draw controller attention towards the operating panel and thus away from the runway. Furthermore, the use of stop bars 24 hours a day did not have any effect on controller ability to scan for information via the runway, lighting panel or strip display.

3.9.1.5 Memory

On the whole, the necessity to remember to re-select the stop bar had no effect on a controller's ability to plan ahead or execute air traffic control tasks. However, the use of 24 hour stop bars did result in an increase in the number

of times controllers forgot to re-select the stop bar after turning it off, particularly in the Air 1 and Air 2 positions. It was suggested that the panel does not lend itself to rapid operation and it was again noted that the amount of time and attention required to operate the panel detracts controller attention from their primary task.

3.9.1.6 Safety

The use of 24 hour stop bars resulted in an increase safety at Manchester Airport. Moreover, controllers were reassured by the extra layer of security the introduction of this measure provided with regard to runways incursions. However, some concern was expressed regarding the fact that controller attention is necessarily directed towards the lighting panel rather than looking at the traffic outside. Nevertheless, it was generally agreed that with an improved panel and adequate practice, such distraction should be minimised.

3.9.1.7 General

General comments suggested that concern over the lighting panel is a major limiting factor to the benefit of using 24 hour stop bars, particularly the two-button press functionality and the size and position of the buttons.

Concerns about pilots and vehicle drivers crossing red stop bars were countered by examples of pilots asking for a clearance when a stop bar did not match their expectations from the air traffic control instructions received. However, it is apparent that the rules around stop bars are not uniform across all airports, which may result in pilot confusion. It was suggested that the implementation of 24 hour stop bars should be standard practice at all airfields to minimise the risk of such confusion. Furthermore, concerns were raised over the potential for confusion at the end of this trial when stop bars are no longer used during daylight hours.

3.9.2 Pilot Feedback

3.9.2.1 Workload

Overall, the use of 24 hour stop bars had no effect on pilots' overall workload in daylight, darkness or low visibility conditions. This was also the case with regard to pilots' R/T workload although it was noted that, on repeated occasions, it was necessary to call air traffic control to ask for a stop bar to be dimmed.

In general, the use of 24 hour stop bars had no impact upon pilot ability to monitor for relevant information. However, in some cases the stop bars improved pilot ability to monitor for such information.

3.9.2.2 Planning and execution of tasks

The use of 24 hour Stop Bars did not have any effect on pilot ability to prioritise tasks or their ability to respond to air traffic control requests in a timely manner.

3.9.2.3 Situational Awareness

The introduction of 24 hour stop bars increased pilot ability to maintain situational awareness in daylight, darkness and low visibility conditions. The use of 24 hour stop bars served as a useful reinforcement of air traffic control instructions, which reassured pilots that they were navigating accurately around the airfield. In addition, they acted as a cue to boosting mental awareness.

On the whole 24 hour stop bars did not have any effect on pilot ability to scan the runway for information. However, in some cases pilot ability to scan for information on the runway increased in daylight, darkness and low visibility conditions.

3.9.2.4 Visibility of Stop Bars

It was generally agreed that the stop bars were sufficiently visible at all times and in all conditions (i.e. daylight, darkness, low visibility and ambient light). However, it was noted that there was variation in the intensity of the lighting, with some being more effective others. LED lights were more visible than tungsten bulbs. However, some pilots were unable to differentiate between tungsten and LED lighting or were unaware that two different types of bulbs were in use.

Perpendicular stop bars were more visible than V-shaped stop bars. It was also noted that, since perpendicular stop bars were more common internationally, this design was less open to interpretation and thus most beneficial.

3.9.2.5 Procedures

On the whole, having received an air traffic control clearance, pilots would always wait for a stop bar to be de-selected prior to entering the runway in daylight, darkness or low visibility conditions. However, the pilot might elect to cross a red stop bar in the event of an emergency which meant that not doing so would endanger their aircraft; similarly, if the stop bar could not be deselected due to malfunction – although local procedures at Manchester do not permit this.

Having received an air traffic control clearance and seen that the stop bar was de-selected, all pilots would ensure they read back the clearance before entering the runway. Moreover, if a garbled transmission was received from air traffic control, a clearance would always be clarified prior to entering the runway even if the stop bar was de-selected.

Pilots stated they would not enter a runway if the stop bar was de-selected but an air traffic control clearance had not been given.

3.9.2.6 Safety

It was generally agreed that the use of 24 hour stop bars had improved safety at Manchester Airport.

3.9.2.7 Training

On the whole, there would not be any need for additional training if the use of 24 hour stop bars was introduced on a permanent basis. However, a short brief or a NOTAM would be useful to clarify what was expected of pilots.

3.9.2.8 General

Pilots are familiar with the use of red stop bars but the variability of practice surrounding stop bars internationally is a cause for concern.

3.9.3 Airfield Operations Feedback

3.9.3.1 Workload

On the whole, the use of 24 hour stop bars did not have any effect on the R/T workload or overall workload of airfield operations staff in daylight, darkness of low visibility conditions. However, overall workload was increased by the necessity to enter the runway from the south side fire station to inspect runway 23L/05R when it was closed as stop bars could not be de-selected at the normal entry point.

3.9.3.2 Planning and execution of tasks

The introduction of 24 hour stop bars did not have any effect on the ability of airfield operations staff to carry out their planned runway duties in daylight, darkness or low visibility conditions. Furthermore, the use of 24 hour stop bars did not impact upon the ability of airfield operations staff to respond to an air traffic control request or cross the runway in a timely manner.

3.9.3.3 Situational Awareness

Overall, the use of 24 hour stop bars had no impact on the ability of airfield operations staff to maintain situational awareness. However, it was also noted that the reassurance provided by having the extra safety barrier of 24 hour stop bars in place was beneficial.

3.9.3.4 Visibility of Stop Bars

On the whole, the type of lighting fitting (LED lighting or tungsten bulbs) did not appear to have any effect on the ability of airfield operations staff to see

the stop bars. However, it was noted that the LED lighting was easier to see from an angle.

The stop bars were sufficiently visible in daylight, darkness and low visibility and ambient conditions. In terms of ease of viewing and visibility, there was no preference for either the v-shaped or perpendicular design of stop bar. However, there was concern regarding an increased potential for error with the v-shaped stop bar as it was less likely be seen when rushing. Furthermore, areas where the ground is raised or sloping hindered the visibility of the v-shaped stop bars.

3.9.3.5 Procedures

Having received air traffic control clearance, airfield operations staff would always wait for the stop bar to be de-selected before entering the runway. If it were not possible to de-select a stop bar, they would select another entry point to avoid having to cross a red stop bar.

On the whole, having received an air traffic control instruction and seen the stop bar drop, airfield operations staff would read back the clearance before entering the runway. Furthermore, if the air traffic control transmission was garbled, the clearance would be clarified before entering the runway.

If a stop bar were de-selected but no air traffic control clearance had been received, airfield operations staff would not enter the runway.

In general, a red stop bar would not be crossed for either an aircraft emergency or an airfield operations emergency. However, this might be overruled in the case of aircraft emergency where air traffic control was unable to de-select the stop bar but could provide clearance. Most staff felt risk of life was a sufficient motive to cross a red stop bar, if an air traffic control clearance was given.

3.9.3.6 Safety

Overall, safety was increased at Manchester Airport following the introduction of the use of 24 hour stop bars.

3.9.3.7 Training

Additional training was not generally considered necessary for the introduction of 24 hour stop bars on a permanent basis. However, if training were to be provided, it was suggested that it should be minimal, explaining why 24 hour stop bars had been introduced and the impact on the users.

3.9.3.8 General

The consensus of opinion was that the use of 24 hour stop bars is a positive move, which will help to prevent runway incursions. It was suggested that

airfield operations staff would benefit from a basic knowledge of what can and cannot be achieved with the stop bars in all modes of operation and that it would be a good opportunity to identify all the reasons for runways incursions and to review the airfield operations SMS at an operational level.

3.9.4 Airfield Fire Service Feedback

3.9.4.1 Workload

Overall, the introduction of the 24 hour stop bars did not have any impact on either the overall workload or the R/T workload of the Airfield Fire Service (AFS) in daylight, darkness or low visibility conditions. Moreover, the use of 24 hour stop bars did not have any effect on the AFS crews' ability to monitor for relevant information.

3.9.4.2 Planning and Execution of Tasks

In general, the use of 24 hour stop bars had no effect on the AFS crew's ability to prioritise tasks in daylight, darkness or low visibility conditions. Furthermore, it had no effect their ability to respond to a request in a timely manner in any of the three conditions. However, it was noted that crossing the runways from north to south, and vice versa, incurred some delays and any delay in response time could have life threatening consequences in the event of an emergency. This comment has been noted by ATC.

3.9.4.3 Situational Awareness

On the whole the use of 24 hour stop bars had no effect on the ability of the AFS to maintain situational awareness in daylight, darkness or low visibility conditions.

3.9.4.4 Visibility of Stop Bars

It was generally agreed that the stop bars were visible in daylight, darkness or low visibility conditions. Moreover, the design of the stop bar (i.e. perpendicular or v-shaped) did not have any effect on the ability to the AFS to see them.

Stop bars that used LED lighting were generally considered more visible than those with tungsten bulbs. However, it was suggested that the LED stop bars could be slightly raised and enlarged to increase their visibility.

3.9.4.5 Procedures

The AFS would not enter the runway when a stop bar was de-selected without having received an air traffic control clearance to do so. However, it was further noted that most fire service officers would feel uncomfortable waiting at

a stop bar when any time delay could be critical in saving lives, as their response time is critical in emergency scenarios.

Having received an air traffic control clearance and noted that the stop bar had been de-selected, the AFS would read back the clearance before entering the runway. Furthermore, if the transmission were garbled, they would clarify the clearance before entering the runway.

3.9.5 Safety

It was generally agreed that safety at Manchester Airport had increased due to the use of 24 hour stop bars. However, the introduction of a possible delay in responding to an emergency was highlighted as an issue.

3.9.6 Training

It was generally agreed that additional training would be required if stop bars were to be used 24 hours a day on a permanent basis. Suggestions for such training included briefings, one day courses, the opportunity to practise crossing at speed (i.e. within the 10 second limit) and the inclusion of additional training during driver re-validation checks or on the annual runway incursion course. Presentations, lectures, and scenario-style practice sessions were also suggested.

4. TRIAL OUTCOME AND CONCLUSIONS

Operating stop bars to protect the runway 24 hours per day was considered a success by pilots, drivers and air traffic controllers and will continue at Manchester airport.

4.1 Holding Point Location and Markings

Airports using stop bars today typically equip the CAT III holding point as a compliment to the pavement marking and signage according to ICAO. To move from operating a stop bar during low visibility conditions only, to 24 hour operations may require a number of changes to procedures, airport lighting, holding points, training and organisational stop bar use policies.

Red lights at a CAT III holding point in Visual Meteorological Conditions are confusing to pilots when the Runway Guard Lights (wig wags) are on at the CAT I holding point.

The CAT I marking is typically the last holding point the pilot expects to see before the runway. A CAT II/III marking can be misleading if it is in fact the last holding point before the runway.

4.2 Lighting

Stop bars were visible in all weather conditions experienced. LED lighting was preferred to tungsten bulbs by the aerodrome operator, particularly when viewing the stop bar from an angle. Moreover, it would be beneficial to have a common design in use i.e. a straight line of lamps.

Note: Stop bars protecting the runway do not look different to those used on intermediate taxiway holding points and may be confused with background lights. Manchester Airport plc is now conducting a trial with a stop bar at one link (FZ1) containing twice (1.5m spacing instead of 3m) the number of LED lamps recommended by ICAO. The trial stop bar configuration is instantly distinguishable from taxiway lights and other background lights. The intensity of the lights during the day could be increased from 30% brilliancy to 80% without a significant increase in energy consumption.

4.3 Throughput

Traffic throughput was maintained at the same levels as prior to the trial.

4.4 Stop Bar Contingency

A robust procedure is required for dealing with situations where the stop bars are not available and/or switchable. The main consideration during the trial was where the lighting system was required to be under the control of engineers (instead of air traffic control) for software upgrades to be installed.

A process was devised where certain elements of the system could be surrendered to the engineers without handing over the whole system.

Where a runway is taken out of service, the use of stop bars is maintained except where control (possession) of the runway is taken by the Airport Operator. This way, vehicle drivers are in no doubt that when a runway is under the control of air traffic control, a positive clearance is required to enter a runway and stop bars will be in use that they must not cross.

The study shows that well thought out contingency in the event of an unserviceable stop bar is essential to the provision of a robust safety net.

Pilots and drivers are expected to challenge a controller instructing them to cross a lit stop bar.

A good contingency plan requires air traffic control and the airport operator to stop using an intersection with a permanently lit stop bar until it is repaired or, to marshal aircraft across a stop bar that is unserviceable and for vehicles to drive around the red lights, not cross over them.

The study shows that well thought out contingency in the event of an unserviceable stop bar is essential to the provision of a robust safety net.

4.5 ICAO Provisions Update

The main risk which has been identified during the trial is the lack of an international standard for the use of runway stop bars. Flight crew feedback indicates that the use of stop bars differs at many airports, with some evidence that pilots are instructed to cross illuminated stop bars as a matter of routine at some airports. This leads to confusion as to what is expected of flight crews.

4.6 Emergency Situations

One concern was raised regarding attitude towards air traffic control during emergency situations. The introduction of 24 hour stop bar use had a positive impact on safety at Manchester Airport. However, the airfield fire service (AFS) expressed concern that it might result in a delay in their response time to an emergency. As such, although the AFS would generally wait for a stop bar to be de-selected before entering the runway, this might not be the case if there was an aircraft emergency in progress. Moreover, pilots and airfield operations drivers felt they would also cross a red stop bar unless in the event of an emergency in which life was at risk.

4.7 Human Machine Interface Design

Although it was sufficient as an interim measure until the move to the new Tower, the lighting panel was not acceptable for use with 24 hour stop bars in its current format in the long term. This was due to the increase in usage and thus the number of incorrect controller selections resulting from the two-button press functionality and the size and position of the buttons. Moreover, the

positioning of the lighting panel resulted in some minor controller discomfort when being used on a 24 hour basis.

Co-location of the stop bar operating switch with the operational controller position is essential.

Stop bar control switches are best when tactile, allowing the controller to remain heads up, looking out of the Visual Control Room.

Re-lighting a stop bar is best controlled manually.

4.8 Controller Workload

Operation of the stop bars in all categories of weather operation was not considered an extra workload by the controllers.

Actual controller workload increased due to the introduction of 24 hour stop bars and there was a negative impact on controller memory with regard to remembering to reselect a stop bar. However, there was no effect on controller R/T workload, ability to plan ahead and to execute a plan. Furthermore, the controller's ability to maintain situational awareness and to scan for information was not affected.

4.9 Pilot Situational Awareness and Workload

The use of 24 hour stop bars had a positive impact on pilot situational awareness, serving as an effective means of reinforcing air traffic control instructions. There was no effect on either overall workload or R/T workload. There was no impact on pilot ability to monitor for relevant information or prioritise and respond to air traffic control requests in a timely manner.

4.10 Airfield Operations Workload

The introduction of 24 hour stop bars resulted in a minimal increase to airfield operations drivers' overall workload. There was no impact on R/T, the ability of staff to carry out planned runway duties or to respond to an air traffic control request to cross the runway in a timely manner. Moreover, although the use of 24 hour stop bars had no impact on the ability of airfield operations staff to maintain situational awareness, the reassurance of having the extra safety barrier was beneficial.

The use of 24 hour stop bars did not have any effect on AFS situational awareness, overall workload, R/T workload or ability to monitor for relevant information. In addition, the use of 24 hour stop bars did not have any effect on AFS ability to prioritise tasks or to respond to a request in a timely manner.

4.11 Training and Awareness

Pilots and airfield operations staff would require minimal, if any, additional training if the use of 24 hour stop bars was introduced on a permanent basis.

Pilot suggestions included a short brief or NOTAM while airfield operations would favour an explanation of the rationale behind the introduction of 24 hour stop bars and the consequent impact on the users. The AFS noted a need for training if the use of 24 hour stop bars was introduced on a full time basis and suggested the integration of information on stop bars into their runway incursion course or driver re-validation checks. Furthermore, presentations or lectures would be useful.

4.12 Key Performance Enablers And Critical Success Factors

Consistent use of a stop bar builds a reliable safety net.

A clear procedure for stop bar use must be agreed by all airport partners with operational staff working on the manoeuvring area.

To obtain full benefits from using stop bars 24 hours per day, airports around the world need to switch the stop bars off before permitting an aircraft or vehicle to enter or cross a runway.

The possible effects of other measures such as taxiway maintenance on runway safety should be considered.

4.13 Possible Future Use

Consideration could be given to the development of a Europe-wide policy on the routine use of stop bars 24 hour, including failure modes and the specific responsibilities of pilots, air traffic controllers and vehicle drivers.

It is also possible that the use of stop bars could be integrated with technology such as Advanced Surface Movement Guidance and Control (A-SMGCS) to use A-SMGCS derived data to lock stop bars in certain configurations when a collision hazard is detected by surveillance equipment. Surveillance data is used in combination with the operation of lights by the Federal Aviation Authority's (FAA) Runway Status Light system. It is possible that this technology could be adapted to make use of RIMCAS logic to obtain the outcome of locked stop bars when a collision hazard is detected.

Nothing in the trial findings suggests that the 24 hour use of stop bars would conflict with the emerging technologies such as Runway Status Lights, which are designed to operate independently of stop bars.

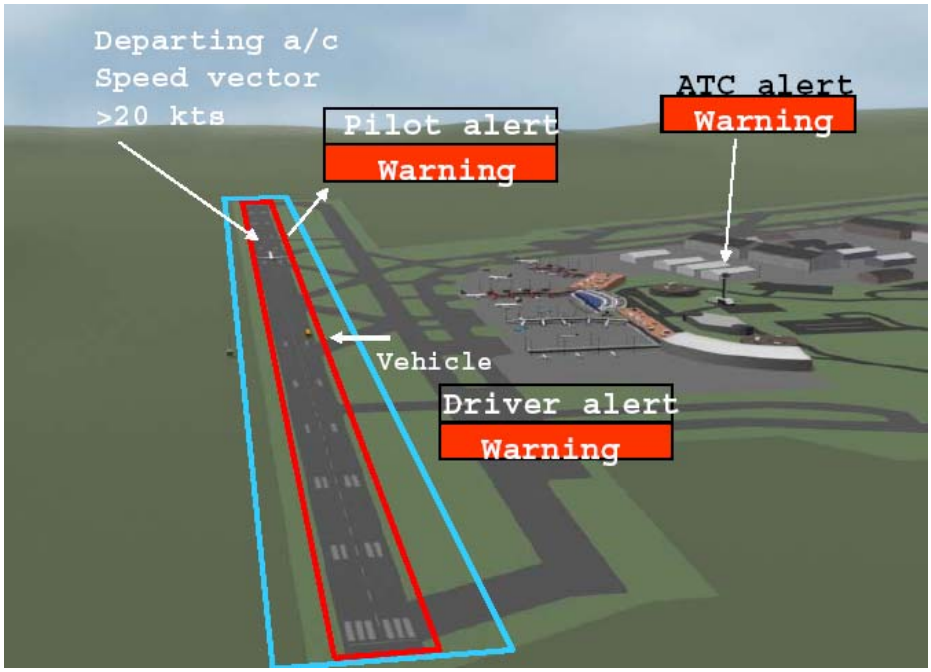

Figure 2. Simultaneous proximity warning of collision hazard that could be derived from A-SMGCS data.

Appendix A -
An application of the ICAO Runway Incursion definition issued as a NATS Air Safety Notice for this study

The following if the guidance to NATS/NSL incident investigators regarding the classification of incidents as "runway incursions".

NATS' Runway Incursion Definition Information & Guidance Introduction

This notice is intended to provide guidance to investigators regarding the criteria for assessing runway incursions and events or observations, which may be related to runway safety, whether or not they are classified as "incursions".

In order to align with ICAO and Eurocontrol, the CAA now defines a runway incursion as:

'Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft.'

Regardless of the cause of an incident we need to ensure we are aware of all events concerning runway safety, regardless of fault.

In addition to the CAA's decision, recent refinements to STAR have given us a greater ability to categorise, analyse and track runway safety related incidents and observations - whether or not they merit classification as an "incursion".

The following explanations are intended to provide further clarification:

"Protected area of a surface designated for the landing and take-off of aircraft".

This is to be interpreted as the physical surface of a runway, from the centreline to the holding point appropriate to the type of runway. Where operations are being conducted under Low Visibility Procedures, this should be the holding point appropriate to the procedures in force. The "protected surface" includes the ILS glide-path and localiser critical areas at all times, and the ILS sensitive areas during Low Visibility Procedures.

"Incorrect presence"

This should be interpreted as the unsafe or undesirable presence, or movement of, an aircraft, vehicle or pedestrian.

Helicopter Operations

Classification of incidents involving rotary wing aircraft as incursions should only be made when the aircraft was taxiing (whether ground or hover) or when actually taking off or landing from the runway. In other words, incidents involving aircraft crossing a runway in flight (i.e. transit) should not be categorised as runway incursions.

Similarly, incidents involving rotary wing aircraft should only be recorded as incursions if the incident relates to the "protected area of a surface designated for the landing and departure of aircraft". In other words, incidents where helicopter movements are being made on parts of the manoeuvring area, other than a runway, which is not designated and protected by the appropriate markings and holding points, are not classified as incursions. They should, however, be recorded as "Runway Safety – NOT Incursion" events.

Until recently, within STAR, only a single "runway incursion" category was available. This meant that the only way to identify incidents with runway safety implications was by classifying them as incursions. However, it is now possible to grade an incident or observation as "Runway Safety – Runway Incursion" or "Runway Safety – NOT Incursion". The selection of either of these categories generates a further "runway safety" page within STAR, where more detailed information regarding the type of event may be entered. The benefit of this is that we are now able to identify all events, which may have runway safety implications, including non-MOR reports.

Classification

The following table provides examples of the types of incidents to be classified as either "Runway Incursions" or "Runway Safety – NOT Incursion). These guidelines are not intended to be fully comprehensive and there will be occasions where further clarification is required. These should be referred to the Runway Safety Focal Group (RSFG), via the unit RSFG representative or to Manager Safety, Airport Services, for clarification.

These following examples are intended as guidance only:

Example	Runway Safety – Runway Incursion	Runway Safety – NOT Incursion
Aircraft, vehicle or pedestrian is cleared, correctly, to enter or cross a runway and proceeds as cleared, but does not read-back the clearance.		X
Aircraft is cleared, correctly, to land or take-off and proceeds as cleared, but does not read back the clearance.		X
Aircraft lands without clearance.	X	
Aircraft lands without clearance and evidence shows that the pilot was acting appropriately in accordance with Loss of Communication procedures due to R/T failure.		X
Aircraft takes off without clearance	X	
Aircraft, vehicle or pedestrian enters runway without clearance.	X	
Aircraft, vehicle or pedestrian is cleared to enter the runway and does so, as instructed and intended, but before the red stop bar has been “dropped”. (this also applies to traffic lights where so positioned)		X
Aircraft, vehicle or pedestrian enters the runway at the incorrect holding point	X	
Aircraft, vehicle or pedestrian vacates at the incorrect holding point		X
Controller incorrectly clears an aircraft, vehicle or pedestrian to enter or cross runway	X	
Controller incorrectly clears an aircraft to land or take-off.	X	
Aircraft lines-up out of instructed sequence.	X	

Appendix B - Air Traffic Controller Trial Procedures

Text from NATS Manchester Airport TOI 02/008

Trial of 24 hour Stop Bar Use

INTRODUCTION

Manchester Airport plc and NATS have agreed to a Eurocontrol proposal to conduct a trial to evaluate the use of Runway Red Stop Bar lights 24 hour. Manchester Airport is the principal location for the study. Experience will also be drawn from Luton Airport.
Manchester Airport has a mature safety culture and therefore the ability to accommodate and then feed back information from such a trial.
Additionally, MA has included the intention to provide 24 hour Red Stop Bars in their ongoing Runway Safety Plan, therefore it becomes vital to trial current systems before such a procedure is implemented.
The feedback from Air Traffic Controllers, pilots and airfield drivers will be absolutely essential in determining the success or otherwise of the trial and the means of air traffic control recording any appropriate data are described later.
To help facilitate this trial, modifications have been made to improve the ergonomics of the Lighting Panels - the Lighting Panels in all Controller positions have been moved and re-housed approximately 10cm forward of their previous positions, in order to reduce the reach to the input buttons.

PROCEDURE

All active Runway Holding Point Red Stop Bar lights will be selected 24 hour in both Single and Dual Runway operations and deselected for aircraft and vehicles entering the Runway.
Red Stop Bars on Runway exits [one way – taxiway side] will also be illuminated 24 hour and will require deselecting for vehicle access to the runway [e.g. for runway inspections].

NIGHT TIME AND POOR WEATHER OPERATIONS

Procedures will be exactly as at present.

TRIAL MODE - DAYTIME OPERATIONS - VISIBILITY > 1500M AND CLOUD CEILING ABOVE 300 FEET

'Day Override' must be selected 'ON' via the Lighting Panel in order to illuminate runway red stop bars and taxiway green centreline lights.
The procedure for de-selecting and then re-selecting Stop Bars is exactly as per the current procedure for Night and Poor Weather Ops**.**

Note: The Trial Procedure only applies to Runway Stop Bars [an aircraft being held tactically at e.g. J2 will not require a Red Stop Bar].

Runway Incursion sensors [at crossing points] will operate as normal [i.e. will alert if a Red Stop Bar is crossed].

RUNWAY 05R/23L CLOSURE PERIODS

When the control of Runway 05R/23L [i.e. closure periods] is assumed by the GMP AIR TRAFFIC CONTROLLER, it is not possible for the controller to access the lighting panel and control Red Stop Bars, as required, for vehicular access to the runway. Therefore,

MA Ops have agreed that during the period of the trial, when 05R/23L is closed for aircraft movements, all vehicles will be required to request access to the runway via the South Side Fire Station Access Road. There is currently no Stop Bar at this position: normal R/T procedures will apply.
If Runway 05R/23L is required for an aircraft movement during the closure period [e.g. emergency traffic] then control of the runway reverts to either Air 1 or Air 2, either of whom have control of the lighting panel for normal use of runway entry points.

AGL FAILURE

Under no circumstances is it permissible for an aircraft or vehicle to cross a Red Stop Bar in order to proceed onto a runway.
If a failure or lock-up of the AGL or Lighting Panel results in the loss of control of Stop Bar switching at a runway entry point, then that entry point **must not be used for runway access until a temporary procedure to enable aircraft to enter the runway is agreed between the ADM and the air traffic control WM**.
Due to the numerous potential combinations of failures, it is not possible to be totally prescriptive for all failure situations. Consideration will be given to factors such as the ability to handswitch AGL, the availability of alternative entry points, the mix of pending traffic and the availability of Ops vehicles to monitor the holding points.
The ADM and air traffic control WM will conduct a 'Level 3 Hazoperations' to establish any temporary procedure.
Landing aircraft may continue to use the runway provided that runway entry points continue to be protected either by Stop Bars [failed to "on"] or by "Follow Me" vehicles in position at the holding points.

AIR TRAFFIC CONTROLLER Feedback

Trial data will be collected by various means; Pilot and Driver surveys, Runway Incursion sensor history and, vitally, Air Traffic Controller feedback.
Controllers are encouraged to complete an Air Traffic Controller feedback Form following any period of working in Air 1 or Air 2. Copies of these will be kept on the WM desk in the VCR [part-completed to indicate that they are reference to the Stop Bar Trial only and to ease Air Traffic Controller workload to complete]. Any observations whatsoever are welcomed, particularly with reference to the ergonomics and switching of the Lighting Panel. It is also requested that controllers record any Stop Bar "event", where noticed, such as:

1) An aircraft or vehicle is cleared to cross/enter a runway but crosses the Red Stop Bar before the controller had time to deselect it.

2) A controller forgets to deselect the Stop Bar but the aircraft/vehicle crosses it anyway.

3) Functionality/switching of the Lighting Panel prevents the Stop Bar being deselected in good time or at all.

4) An aircraft/vehicle has a clearance to enter the runway but will not enter until the Stop Bar is deselected.

If an aircraft/vehicle crosses a Runway Red Stop Bar that is its clearance limit, then that is a Runway Incursion and normal MOR reporting action is required.
As this is a trial of Red Stop Bars **24 hour,** feedback is requested for any occurrences whenever they occur, day or night.
Towards the end of the Trial period, all Air Traffic Controllers plus all MA Ops drivers, a cross section of AFS drivers and pilots (local and non-local), will be requested to

complete a comprehensive HF questionnaire about the Trial. All data will be collected locally and a summary of conclusions will be submitted for the final report to Eurocontrol.

GENERAL NOTES

- **Pilots and aircraft operators have been advised of the Trial by means of NOTAM action, the contents of which are reproduced:**

  "ILLUMINATED RUNWAY HOLDING POINTS IN OPERATION 24 hour [LIT RED]. PILOTS MUST NOT CROSS ILLUMINATED STOP BARS."

- **Additionally, pilots and operators will be advised via the FLOPSC and also by publicity material circulated by MA/NATS.**

- **Airfield Driver training already encompasses awareness that under no circumstances may a vehicle cross a Red Stop Bar. MA plc will be conducting additional briefings to all airside driving agencies regarding the 24 hour Trial of Runway Stop Bars.**

- **An** ATIS message **of the above NOTAM text will be broadcast to advise pilots of 24 hour Stop Bar use.**

Appendix C – Supplementary Instruction

Text from NATS Manchester Airport SI53/07 (since incorporated into MATS 2)

Use of Runway Stop Bar Lights

Introduction

Manchester Airport has, for many years, been accustomed to using Red Stop Bar lights to protect runway entry points during night time and poor weather operations. The method of selection and de-selection of these Stop Bars has always been an accepted good practice which has never actually been a formal procedure.
Having been made aware of varying methods of the use of Stop Bars at other airfields (e.g. at more than one UK airfield the Red Bar can be de-selected whenever a clearance to enter a runway is given, even if it is a conditional clearance against a landing aircraft and that aircraft is still on final approach – this would not be acceptable at Manchester) it has become necessary to formalise our existing procedures.
This is consistent with continuing initiatives to improve Runway safety and is also necessary ahead of the forthcoming trial of the use of Runway Red Stop bars 24 hour, as we endeavour to demonstrate that the Manchester mode of operation should be 'best practise' for all UK and European airfields.
This instruction should be read in conjunction with MATS pt 2 ADC Chapt 6 'Aerodrome and Obstruction Lighting', which details the display and operation of Airfield Lighting during day/night and in varying weather conditions.
The methodology detailed below is our current mode of operation and refers specifically to runway Holding Point Stop Bars – Taxiway Stop Bar operation is covered in MATS pt 2.

Procedure

During operations at night time or when the Visibility is less than 1500m or cloud ceiling 300' or below, Aerodrome Groung Lighting (AGL) Taxiway and Stop Bar Lighting is required.
AGL Taxiway and Stop Bar Lighting is selected either by:

1) switching the Lighting panel to a 'Night' setting (selection 1, 2 or 3, depending on the visibility),

2) selecting 'Primary Routes' at each operational postion (Air 1, Air 2 and GMC, as required), or

3) selecting 'Day Overide' on the main panel.

Once AGL is selected, in both single and dual runway configurations, taxiway green centerline lights illuminate and all Runway entry/crossing points and exits are protected (from the taxiway side) by a Red Stop Bar.

In CAT 1 operations at runway entry points, Red Stop Bars illuminate at the designated CAT 1 Holding Points and and in LVPs at the designated CAT 3 Holding Points (in order to protect the LSA of the landing runway). Therefore, the procedures detailed below apply to aircraft/vehicles entering/crossing a runway in either Normal or LVP operations, as the same method applies.

For an aircraft or vehicle to be able to enter the runway, when so cleared, at a designated entry or crossing point, the following procedure is to be used:

1. At Departure Entry Points

A runway entry point Stop Bar is required to be manually de-selected for an aircraft or vehicle to proceed onto the runway at that position, when so cleared. A single push of the green lead-on light button de-selects the Red Stop Bar and illuminates green lead on lights. The Red Stop Bar is not to be de-selected until air traffic control clearance has been given for the aircraft/vehicle to enter the runway **and, if it is a conditional clearance** ,the conditional aircraft has passed and it is safe to enter the runway at that position (subject to the normal restrictions governing the use of conditional clearances).

Once an aircraft is then seen to be turning onto the runway centerline (i.e. lead on lights no longer required) the Red Stop Bar shall be re-selected by a single push of the green lead on button. For successive departures which are in a queue at the same departure point, the Stop Bar may be left de-selected ('lead on' lights illuminated) providing that a succeeding departing aircraft will be the next movement on that runway. If there are any other intersection departures or landing aircraft, the Stop Bar shall be re-selected.

When a vehicle enters a runway at a departure point, the Red Stop Bar shall be re-selected immediately after the vehicle has crossed it.

2. At Runway Crossing Points

A runway crossing point Stop Bar is required to be manually de-selected for an aircraft or vehicle to cross the runway at that position, when so cleared. The Stop Bar is de-selected by operating the arrowed buttons at the crossing point in the required direction of travel, i.e. first pushing the green button on the crossing entry point (with the white arrow in direction of crossing) followed by pushing the green button on the exit side of the crossing link (with the white arrow in the same direction). As the Stop Bar extinguishes, green/yellow crossing lights are provided.

The Red Stop Bar is not to be de-selected until air traffic control clearance has been given for the aircraft or vehicle to enter the runway **and , if it is a conditional clearance** ,the conditional aircraft has passed and it is safe to enter the runway at that position (subject to the normal restictions governing the use of conditional clearances).

The Red Stop Bar is re-selected by operating the same buttons again in any order. Additionally, in order to clearly identify the holding point to successive aircraft or vehicles, further functionality has been programmed into the AGL at crossing points – when a Stop Bar is re-selected, the first 30m of green/yellow centerline crossing lights (beyond the stop bar in the direction of crossing) is extinguished. This enables the Stop Bar to be re-selected whilst an aircraft or vehicle is midway across the runway, so that successive traffic may safely hold at the designated holding point. At the same time, a timer is activated which, after 45 seconds, extinguishes the remainder of the crossing centerline. *(Whilst the timer is running, the back indication on the lighting panel shows one flashing LED and one steady LED.)*

To enable multiple crossings at the same crossing point, there are three options:

- Once a crossing route is selected, the green/yellow centerline will remain illuminated until the Stop Bar re-selected.

- If the Stop Bar has been re-selected, the full green/yellow centerline can be re-established at any time by selecting the entry and exit arrowed buttons for the crossing point This operation overides the timer. The Stop Bar can be re-selected when required.

- In order to de-select the green/yellow centerline and illuminate the Stop Bar *without the timer operating and the first 30m of centerline being extinguished*, the buttons 'Reset', 'Confirm' and then the desired crossing arrowed buttons should be selected.

When crossing more then one aircraft in trail, the crossing point Stop Bar must be re-selected once the last aircraft in the crossing sequence has crossed the runway.

Note: Controllers are reminded that careful timing is required in the operation of the Stop Bars at crossing points of Runway 05L/23R as the installation of Runway Incursion Sensors will trigger an alert if a Red Stop Bar is crossed (see MATS pt 2 ADC 6-15).

If,exceptionally,an aircraft **departs** from a crossing point (e.g. UKP152 from F, D or B) that has crossing lights without lead ons, then the lighting procedure for 'crossing traffic' is followed until such time as the departing aircraft is seen to turn on to the runway centerline, at which point the Stop Bar is to be reselected and the crossing lights extinguished.

3. At Runway Exits (Vehicles only)

Runway exits are protected by a one way Red Stop Bar (showing taxiway side). To facilitate access for a vehicle onto a runway at an exit point, e.g. for runway inspection, when air traffic control clearance is given to enter the runway the Stop Bar is deselected by a single push of the green 'lead-off' light button at that exit. This extinguishes the Stop Bar for 10 seconds (no lead on lights provided). The Red Stop Bar will automatically re-illuminate by means of a timer function.

4. AGL Failure

Under no circumstances is it permissible for an aircraft or vehicle to cross a Red Stop Bar in order to proceed onto a runway.

If a failure or lock-up of the AGL or Lighting Panel results in the loss of control of Stop Bar switching at a runway entry point, then that entry point **must not be used for runway access until a temporary procedure to enable aircraft to enter the runway is agreed between the ADM and the air traffic control WM**. Due to the numerous potential combinations of failures, it is not possible to be totally prescriptive for all failure situations. Consideration will be given to factors such as: the ability to handswitch AGL, the availability of alternative entry points,the mix of pending traffic and the availability of Ops vehicles to monitor the holding points.

The ADM and air traffic control WM will conduct a 'Level 3 Hazoperations' to establish any temporary procedure.

Landing aircraft may continue to use the runway provided that runway entry points continue to be protected either by Stop Bars (failed to 'on') or by 'Follow Me' vehicles in position at the holding points.

Appendix D - Human Factors Questionnaire Sample

For the purposes of accurate data collection, please try to answer as objectively as possible. In order to do so it may be necessary for you to look beyond any initial feelings of discomfort related to the process of change rather than the revised procedures. However, any concerns that remain are clearly of value and should be noted within the questionnaire.

INSTRUCTIONS

- **Please answer every question on BOTH sides of the paper**
- **Please write clearly**
- **If it helps, please draw a diagram to support your answer**
- **Be as brief or as detailed as you like**
- **If you need to know anything please ask**
- **If you have a point to make but none of the questions are relevant, please write on the last page**
- **If necessary, please continue your answer(s) on a blank sheet of paper**

Please write your name and/or watch here:

Participant names and/or watch are requested to allow the Human Factors Specialist to follow up any point that might need further explanation. All answers will remain confidential and anonymous after analysis by the Human Factors Specialist. However, participant names are not obligatory and can be left blank if preferred.

Please return to

Lighting Panel

Please indicate whether you consider the size of the buttons on the lighting panel acceptable for use with 24 hour stop bars

	Yes	No
Acceptable for current and future use with no further modifications	☐	☐
Acceptable for a limited period of time (i.e. as an interim measure until the move to the new Tower)	☐	☐
Unacceptable	☐	☐

If you do not consider the size of the buttons on the lighting panel are acceptable for use with 24 hour stop bars, please explain why and note any suggestions you have for improvement

Please indicate whether you consider the back indications from the lighting panel acceptable for use with 24 hour stop bars

	Yes	No
Acceptable for current and future use with no further modifications	☐	☐
Acceptable for a limited period of time (i.e. as an interim measure until the move to the new Tower)	☐	☐
Unacceptable	☐	☐

If your do not consider the back indications from the lighting panel are acceptable for use with 24 hour stop bars, please explain why and note any suggestions you have for improvement

Please indicate whether you consider the tactile user feedback (i.e. click of the button on the lighting panel to indicate that it has been fully depressed) acceptable for use with 24 hour stop bars

	Yes	No
Acceptable for current and future use with no further modifications	☐	☐
Acceptable for a limited period of time (i.e. as an interim measure until the move to the new Tower)	☐	☐
Unacceptable	☐	☐

If your do not consider that the tactile user feedback is acceptable, please explain why and note any suggestions you have for improvement

Please indicate whether you consider the 2-button press functionality of the lighting panel at crossing points acceptable for use with 24 hour stop bars

	Yes	No
Acceptable for current and future use with no further modifications	☐	☐
Acceptable for a limited period of time (i.e. as an interim measure until the move to the new Tower)	☐	☐
Unacceptable	☐	☐

If your do not consider that the 2-button press functionality is acceptable, please explain why and note any suggestions you have for improvement

Please indicate what impact the 2-button press (i.e. at the crossing point on either side of the runway) functionality had on the number of incorrect selections when using 24 hour stop bars

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Single runway operations	☐	☐	☐	☐	☐
Crossing aircraft in westerly dual operations	☐	☐	☐	☐	☐
Crossing aircraft in easterly dual operations	☐	☐	☐	☐	☐
Lining up aircraft in dual operations	☐	☐	☐	☐	☐

If the number of incorrect selections increased, please explain why, whether this increase would be acceptable and what the consequence of it would be

Please clarify which of the above modes of operation you are referring to in your response

Please indicate what impact the use of 24 hour stop bars had on the physical movement (i.e. reaching, leaning, stretching) required to access the lighting panel

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Air 1	☐	☐	☐	☐	☐
Air 2	☐	☐	☐	☐	☐
GMC	☐	☐	☐	☐	☐

If the amount of physical movement required increased, please explain why, whether this increase would be acceptable and what the consequence of it would be

Please clarify whether your response refers to the Air 1, Air 2 or GMC position

Overall, do you consider the current lighting panel acceptable for the use of 24 hour stop bars

	Yes	No
Acceptable for current and future use with no further modifications	☐	☐
Acceptable for a limited period of time (i.e. as an interim measure until the move to the new Tower)	☐	☐
Unacceptable	☐	☐

If your do not consider the current lighting panel acceptable, please explain why

WORKLOAD

Please indicate what impact the use of 24 hour stop bars had on your R/T workload

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Single runway operations	☐	☐	☐	☐	☐
Crossing aircraft in westerly dual operations	☐	☐	☐	☐	☐
Crossing aircraft in easterly dual operations	☐	☐	☐	☐	☐
Lining up aircraft in dual operations	☐	☐	☐	☐	☐

If your R/T workload increased, please explain why, whether this increase was acceptable and what the consequence of it would be

Please clarify which of the above modes of operation you are referring to in your response

Please indicate what impact the use of 24 hour stop bars had on your overall workload

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Single runway operations	☐	☐	☐	☐	☐
Crossing aircraft in westerly dual operations	☐	☐	☐	☐	☐
Crossing aircraft in easterly dual operations	☐	☐	☐	☐	☐
Lining up aircraft in dual operations	☐	☐	☐	☐	☐

If your overall workload increased, please explain why, whether this increase was acceptable and what the consequence of it would be

Please clarify which of the above modes of operation you are referring to in your response

PLANNING

Please indicate what impact the use of 24 hour stop bars had on your ability to plan ahead

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Single runway operations	☐	☐	☐	☐	☐
Crossing aircraft in westerly dual operations	☐	☐	☐	☐	☐
Crossing aircraft in easterly dual operations	☐	☐	☐	☐	☐
Lining up aircraft in dual operations	☐	☐	☐	☐	☐

If your ability to plan ahead decreased, please explain why, whether this decrease would be acceptable and what the consequence of it would be

Please clarify which of the above modes of operation you are referring to in your response

Please indicate what impact the 24 hour stop bars had on your ability to prioritise air traffic control tasks

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Single runway operations	☐	☐	☐	☐	☐
Crossing aircraft in westerly dual operations	☐	☐	☐	☐	☐
Crossing aircraft in easterly dual operations	☐	☐	☐	☐	☐
Lining up aircraft in dual operations	☐	☐	☐	☐	☐

If your ability to plan ahead decreased, please explain why, whether this decrease would be acceptable and what the consequence of it would be

Please clarify which of the above modes of operation you are referring to in your response

Please indicate what impact the 24 hour stop bars had on your ability to execute your plan

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Single runway operations	☐	☐	☐	☐	☐
Crossing aircraft in westerly dual operations	☐	☐	☐	☐	☐
Crossing aircraft in easterly dual operations	☐	☐	☐	☐	☐
Lining up aircraft in dual operations	☐	☐	☐	☐	☐

If your ability to execute your plan decreased, please explain why, whether this decrease would be acceptable and what the consequence of it would be

Please clarify which of the above modes of operation you are referring to in your response

SITUATIONAL AWARENESS

Please indicate what impact the use of 24 hour stop bars had on your ability to maintain situational awareness (i.e. the picture)

	Positive Impact	No effect	Negative Impact
Daylight	☐	☐	☐
Darkness	☐	☐	☐
Low visibility	☐	☐	☐

If there were any benefits, please explain what they were. If there were any disadvantages, please explain what they were and how you think this could be improved.

Please clarify whether your response refers to daylight, darkness or low visibility conditions

Please indicate what impact the use of 24 hour stop bars had on your ability to scan for information

	Positive Impact	No effect	Negative Impact
Runway	☐	☐	☐
Lighting panel	☐	☐	☐
Strip Display	☐	☐	☐

If there was a negative impact, please explain why and whether this had an effect on your overall situation awareness

Please clarify whether your response refers to your scan of the runway, lighting panel or strip display

MEMORY

Please indicate what impact the necessity to remember to reselect the stop bar had on your ability to plan ahead

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Air 1	☐	☐	☐	☐	☐
Air 2	☐	☐	☐	☐	☐
GMC	☐	☐	☐	☐	☐

If there was a negative impact, please explain why, and whether this was acceptable

Please clarify which position you are referring to in your response

Please indicate what impact the necessity to remember to reselect the stop bar had on your ability to execute your tasks

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Air 1	☐	☐	☐	☐	☐
Air 2	☐	☐	☐	☐	☐
GMC	☐	☐	☐	☐	☐

If there was a negative impact, please explain why, and whether this was acceptable

Please clarify which position you are referring to in your response

Please indicate what impact the use of 24 hour stop bars had on the number of times you forgot to reselect the stop bar having turned it off

	Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
Air 1	☐	☐	☐	☐	☐
Air 2	☐	☐	☐	☐	☐
GMC	☐	☐	☐	☐	☐

If number of times you forgot increased, please explain why, whether this increase was acceptable and what the consequence of it would be

Please clarify which of the above modes of operation you are referring to in your response

SAFETY

Please indicate what impact the use of 24 hour stop bars had on safety at Manchester Airport

Significantly Decreased	Decreased	No effect	Increased	Significantly Increased
☐	☐	☐	☐	☐

If you think safety was decreased, please explain why, whether this decrease was acceptable and what the consequence of it would be

GENERAL

Are there any other aspects not covered by the questionnaire on which you wish to comment?