AERONAUTICAL INFORMATION SERVICES-AERONAUTICAL INFORMATION MANAGEMENT STUDY GROUP (AIS-AIMSG)

THIRD MEETING

Montréal, 9 to 12 November 2010

Agenda Item 10: Electronic terrain and obstacle data (eTOD)

DRAFT EDUCATIONAL PAPER ON OBSTACLE CLEARANCE AND ENGINE-OUT ANALYSIS

(Presented by IATA)

SUMMARY

The attached information paper has been prepared by IATA. Please note that it contains draft information.

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INTERNATIONAL AIR TRANSPORT ASSOCIATION

Educational Paper on Obstacle Clearance and Engine-Out Analysis

A summary for NOTAM releasing authorities

Airplane Performance Task Force (APTF)
Prepared by Heinz Conrad, Walter Emmerling

Abstract

Legal requirement before commencing a takeoff is to determine the maximum allowable takeoff weight for the runway, taking into account the obstacle situation in the takeoff flight path. Doing this, the failure of an engine has to be assumed, significantly decreasing the climb performance of the aircraft. Thus, knowledge about exact location and height of obstacles is of paramount importance.

To comply with the legal requirements, operators have to evaluate all available airport information. Unclear NOTAM or airport information about obstacles have been identified as a source of unduly restriction in takeoff weight.

This white paper document is aimed at all departments involved in releasing airport information and NOTAMs. Providing information on how operators evaluate data shall increase the awareness of how information shall be presented.

Content

Engine Out Procedures

Before commencing a takeoff, operators are legally required to determine a maximum takeoff weight for the respective runway, taking into account meteorological conditions, runway information and last but not least the obstacle situation along the flight path to be pursued. Those takeoff performance calculations have to be done assuming one engine to fail during takeoff roll and the subsequent flight path flown with one engine out.

The standard instrument departures (SID) published by the authorities assume all engine performance and thus, might require climb gradients which can't be matched in an engine out case without unduly weight restrictions.

Operators therefore develop engine out procedures (EOPs, other common names: EOSID engine out standard instrument departure, EFP engine failure procedures), that might significantly deviate from the SIDs and, by avoiding limiting obstacles or terrain, are optimized for takeoff weight.

When designing those flight paths, some regulatory requirements have to be observed, as presented in the next chapter. Those requirements mainly deal with climb gradients and the area around the flight path that has to be checked for obstacles. Apart from this, operators are basically free in their engine out procedure design. Thus, operators will design EOPs as they deem appropriate for their particular operation. Different operators will come up with different EOPs and even the same operator might have different EOPs for different aircraft types.

With the above said it is obvious that airport authorities can't possibly know about all operators' EOPs. However, they could help the operators by providing precise information regarding elevation and position of obstacles. Receiving the most precise possible information is of paramount importance for operators to both comply with regulations and yet maximize the takeoff weight.

Regulatory Requirements

This document focuses on FAR and EU-OPS regulations. However, other regulations not explicitly mentioned usually comply with one of those regulations regarding obstacle clearance and engine-out analysis.
Airlines are bound to operate according to the regulations set forth by their home authorities. E.g. for an EU-operator EU-OPS apply, even when operating to an US airport that comes under FAA regulations, and vv.

Runway Requirements

A multitude of regulations exist for aircraft performance on a runway, which could be distinguished in requirements for a rejected takeoff and for a continued takeoff. This document focuses on the requirements that apply for a continued takeoff.
The takeoff distance required is the longer of the following distances:

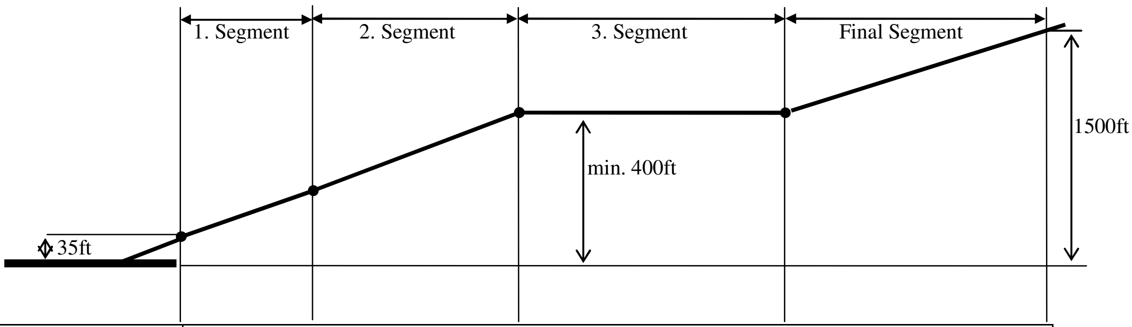
a) the distance necessary to accelerate the airplane to V1 speed (latest speed at which action has to be taken when rejecting the takeoff to stop on the runway), and continue to a height of 35ft above the runway surface under the assumption of a failure of the critical engine. (The critical engine is the one which has the most serious impact on performance and controllability of the aircraft.)
b) 115% of the distance necessary to bring the airplane to a height of 35ft if no engine fails.

The 35ft height above runway is named “screen height”. It may be reduced to 15ft in case of a wet or contaminated runway.
If no clearway is declared for a runway, the above distances must be equal or less to the published TORA (reduced by an allowance for the aircraft alignment). If a clearway is declared, it might be used on a dry or wet runway, but only as much as half of the takeoff flare (liftoff to screen height).
In compliance with these requirements, an operator has to take into account various parameters like wind, runway slope, QNH, OAT, etc.

Vertical Flight Path Requirements

The vertical flight path is divided into four segments. For each segment special performance capabilities are required according to FAR Part 25 or EU OPS.

The 1st segment starts at the screen height (35ft on dry runway) and ends at the point where gear retraction is completed. The 2nd segment starts at the point where gear retraction is completed and ends at the height where flap/slat retraction is initiated (usually named “flap retraction height” or “acceleration height”). Regulations require a minimum flap retraction height of 400ft above the runway, however, company procedures or the respective obstacle situation might raise that height. The 3rd segment starts at flap retraction height and ends when final climb configuration (flaps/slats retracted, final climb speed) is attained. It is assumed to be flown in level flight. The final segment starts when final climb configuration is attained and ends at 1500ft above runway (or more if required for obstacle clearance). Figure 1 shows the aircraft configuration changes and the legal requirements for each segment.



Engines	1 Engine Out			
Thrust	Takeoff Thrust			Max. Continuous Thrust
Gear	Retraction	Gear Retracted		
Flaps	Takeoff Flaps		Retraction	Flaps Retracted
Speed	V2	V2	Acceleration	Final Climb Speed
Climb Gradient			excess thrust equivalent	
2 Eng Aircraft	positive	2.4%	1.2%	1.2%
3 Eng Aircraft	0.3%	2.7%	1.5%	1.5%
4 Eng Aircraft	0.5%	3.0%	1.7%	1.7%

Figure 1: Vertical flight path, segment configurations and gradient requirements

The climb gradients shown are the minimum climb gradients required and depend on the number of engines. Although the 3rd segment is supposed to be flown in level flight, minimum climb gradients equivalents are required to assure the aircraft's acceleration capabilities.
The above requirements don't consider obstacles. Where obstacles have to be considered, additional regulations apply.
The obstacle clearance is defined in relation to the "net flight path". The term net flight path refers to the flight path that results when the mandatory reductions as specified by the airworthiness standard have been substracted from the "gross flight path". The gross flight path is actually flown and the minimum gradients for the gross flight path (see table above) have been demonstrated during aircraft certification.

2 engine aircraft: net gradient = gross gradient – 0.8%
3 engine aircraft: net gradient = gross gradient – 0.9%
4 engine aircraft: net gradient = gross gradient – 1.0%

The net flight path must clear all obstacles located in the departure sector (see below) by at least 35 ft. Figure 2 shows the takeoff flight path when obstacles have to be cleared.

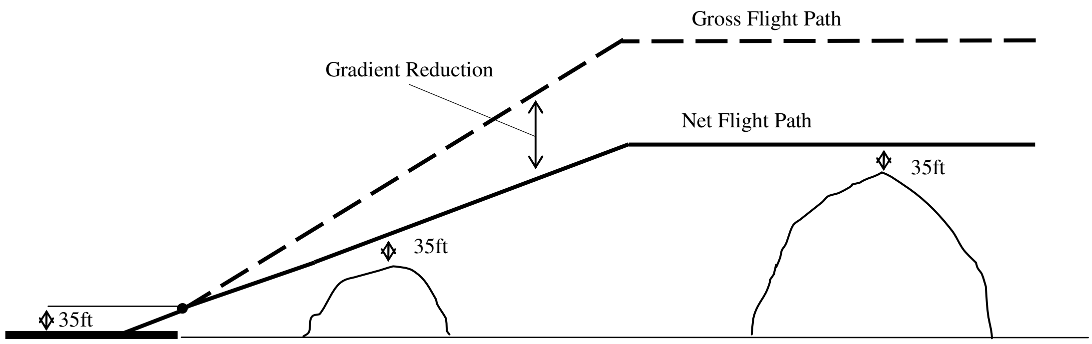


Figure 2: Takeoff flight path with obstacle clearance

Horizontal Flight Path Requirements – Obstacle Clearance Area

According to FAR 121.189, obstacles have to be considered when located within 300ft either side of the flight path (200ft either side within airport boundaries).
EU-Ops is in compliance with ICAO Annex 6. Obstacles have to be considered when located in a cone that starts at the end of the takeoff distance with 90m (approx 300ft) either side of the flight path. The cone opens up by 12.5% (0.125 x Distance travelled from end of takeoff-distance available) till a width of

300m (approx 1000ft) for VMC by day with track changes less than 15deg
600m (approx 2000ft) for VMC by day with track changes more than 15deg or
for VMC by night or IMC with track changes less than 15 deg
900m (approx 3000ft) for VMC by night or IMC with track changes more than 15 deg

either side of the flight path is achieved.
Figure 3 shows both horizontal surfaces to be considered for obstacle analysis. FAR splay is shown above the centerline, ICAO Annex 6 below the centerline. Obstacles located within the respective boundaries have to be included in the takeoff weight determination.

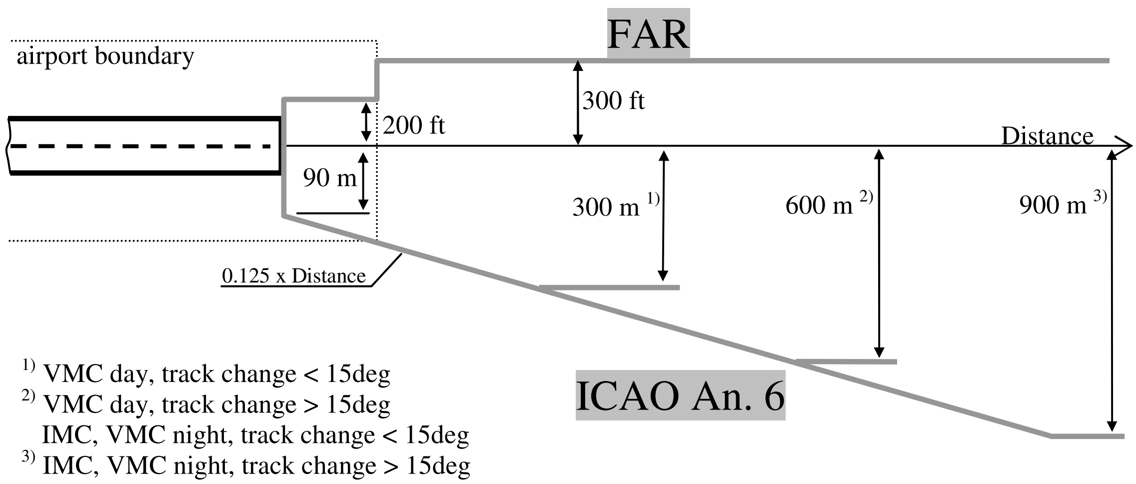


Figure 3: FAR and ICAO Cone

NOTAM examples with Impact on PerformanceTakeOff Mass (PTOM)

Airport and NOTAM publishing organizations do have a great influence on the actual operation of aircraft by providing NOTAM or airport information with unclear or less precise description of the location and/or height of obstacles, as aircraft operators always need to apply a conservative approach. Hence the aircraft operator is required to assume that the obstacle is within the horizontal flight path or may use a higher than necessary height for equipment used in working area close to the runway/flight path if not precisely specified. The following examples will provide some information on the impact of less precise NOTAM content on the performance takeoff mass on typical aircraft.

Example 1: Location of temporary crane not precisely specified

In 2009 a Notam was published for runway 07R at Los Angeles Intl (LAX/KLAS) airport which contained the following statement:

“…TEMPORARY CRANE, 292 FT MSL, 4232 FEET SW OF RWY 07R….”

An operator evaluating this NOTAM would make the following assumptions:

- The NOTAM is probably given for an approach towards RWY 07R, thus, 4232ft is most likely referenced to the threshold of RWY 07R.
- SW (southwest), used in a division S-SW-W, covers 45deg on the compass.

With this rationale, the position of the temporary crane is somewhere on the red colored arc in figure 4. Thus it is not clear whether the crane is - or is not - located in the T/O cone of RWY 25L.

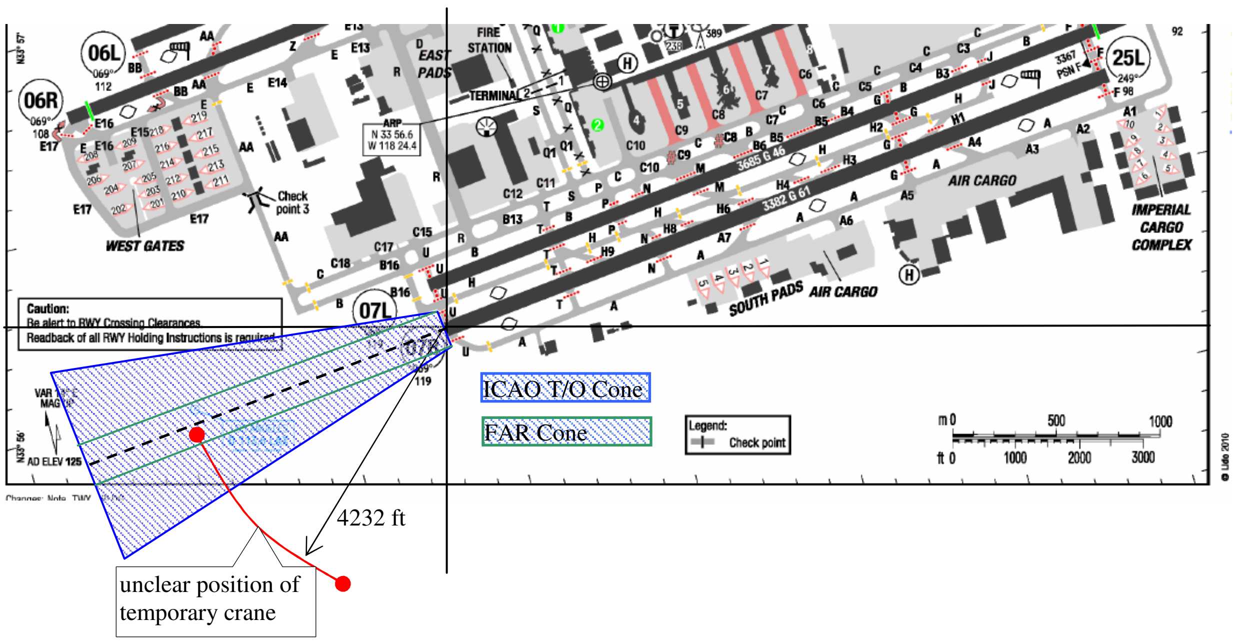


Figure 4: Uncertain position of obstacle

The operator has no choice but to conservatively include this crane into the obstacle set used to calculate T/O performance data for RWY 25L and accept the performance penalties.
In the table below, PTOM denotes the performance limited takeoff mass, MTOM denotes the maximum certified takeoff mass (1000 kg equals 2205 lbs). The rightmost column shows the penalty in PTOM due to the crane compared to the PTOM without crane or to the MTOM, whichever is lower.

(32°C/90°F, zero wind, 1013hPa, optimum performance).

Aircraft	Engine	MTOM [kg]	PTOM [kg] RWY25L without temp. crane	PTOM [kg] RWY 25L with temp. crane	Penalty [kg] Crane – NO Crane
MD80	JT8D-219	72570	74990	69190	-3380
A320-233	IAE V2527E-A5	77000	80050	75260	-1740
B737-800W	CFM56-7B26	79010	84610	78850	-160
A321-211	CFM56-5B3	93500	93930	88320	-5180
B757-200W	RB211-535E4	113500	123550	115630	No penalty
B767-300W	PW4060	186880	184480	171590	-12890
A330-223	PW4168A	230000	234990	217690	-12310
A330-343	TRENT 772B	230000	243570	224550	-5450
B777-200ER	GE90-90B	294830	284490	265590	-18900
B747-400ERF	CF6-80C2B5F	412770	403540	403110	-430

The loss in T/O mass (i.e. payload) due to the crane is significant for some aircraft (B777, A330-223, B767) and could well jeopardize a profitable operation, especially on longhaul missions.
This loss in T/O mass could well result from the conservative operator's assumptions only, in case the crane was in fact located outside the takeoff cone. However, the operator can't possibly know due to the unprecise information and has to assume the worst case for safety reasons.

To improve information precision in this case, the following should be observed when releasing the NOTAM:

1) Providing the coordinates of the obstacle will help the operator's flight operations department to determine the exact position and to check, which runways are affected. When providing coordinates, use WGS 84 system, which evolved to a kind of world-wide standard. However, since sometimes NOTAM have to be evaluated by flight crews prior to takeoff, additional information are required that are easier to process without back office tools.
2) The reference should be unambiguous. In this case RWY 07R was only assumed to denote THR RWY 07R. Possible unambigous references could be ARP (airport reference point), THR RWY 07R or DER (departure end of runway) 25L.
3) The direction from the reference should be precise. As stated above, "SW" covers a sector of 45deg on the compass. The exact magnetic heading (bearing) from the reference point is required. Alternatively, the position could be specified by the distance to THR 07R on the extended RCL (runway center line) and lateral deviation from the extended RCL.

Example 2: Reference point of temporary crane distance not clearly defined

A Notam with the following statement was published in 2009 for Miami International (MIA/KMIA):

"…..TEMPORARY CRANE 310 FT MSL, 2180 FEET EAST OF RWY 27….."

In this example, the reference point for the distance measurement is defined ambiguously. At that time, Miami's RWY 27 had a displaced landing threshold, approx. 1270 ft west of the beginning of RWY 27. Whether the distance given in the NOTAM (2180 ft) refers to this landing threshold or to the start of RWY 27 is unclear. Since the NOTAM was released regarding the approach (ILS or LOC RWY27), the distance to the crane might count from the landing threshold.

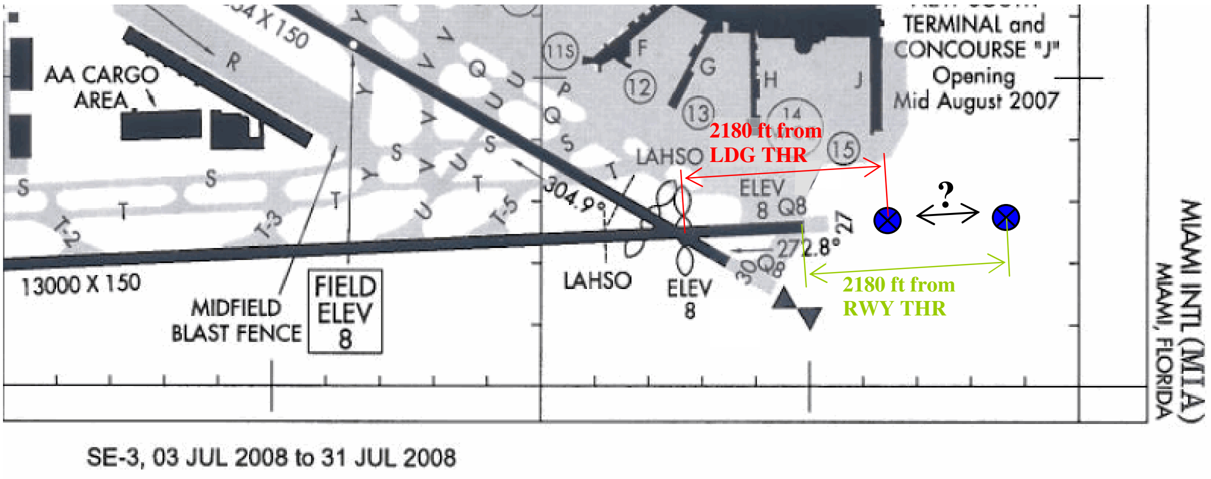


Figure 5: Unclear reference of distance to the obstacle

The safety-minded operator would have to choose the displaced landing threshold as the starting point to measure the distance to the crane. This will bring the obstacle much closer to the 35ft screen height point and reduce the performance takeoff mass for a takeoff on RWY 09 considerably.

(32°C/90°F, zero wind, 1013hPa, optimum performance).

Aircraft	Engine	MTOM [kg]	PTOM [kg] RWY09 crane 2180ft from RWY end	PTOM [kg] RWY 09 crane 2180 ft from LDG THR	Penalty [kg] LDG THR – RWY end
MD80	JT8D-219	72570	63350	61340	-2010
A320-233	IAE V2527E-A5	77000	70170	67920	-2250
B737-800W	CFM56-7B26	79010	72590	70170	-2420
A321-211	CFM56-5B3	93500	81710	79170	-2540
B757-200W	RB211-535E4	113500	107640	103550	-4090
B767-300W	PW4060	186880	155120	152180	-2940
A330-223	PW4168A	230000	199120	192340	-6780
A330-343	TRENT 772B	230000	205130	198140	-6990
B777-200ER	GE90-90B	294830	244370	236150	-8220
B747-400ERF	CF6-80C2B5F	412770	374650	360890	-13760

To improve information precision in this case, the following should be observed when publishing the NOTAM:

1) Providing the coordinates of the obstacle will help the operator's flight operations department to determine the exact position and to check affected runways.
2) When giving a distance, the reference should be unambiguous. Use wordings like:
   - LDG THR if reference was the landing threshold
   - DISP THR if reference was a displaced threshold
   - APP END RWY 27 or DEP END RWY 09 if reference was physical start of RWY 27

Example 3: Temporary obstacle with unclear elevation information

Quite often NOTAM are published informing about temporary obstacle due to work in progress (WIP) close to the runway, but use AGL (above ground level) as reference for the obstacle height. A typical phrase could be:

... WIP 300 ft FM DEP END RWY XY, MAN AND EQPMT UP TO 30FT AGL

The airport publications usually show the elevations at beginning and end of runway, most airports additionally publish a slope or the vertical runway profile. However, there is hardly any information provided about the ground elevation beyond the runway ends. Thus, a height information given as AGL can't be properly evaluated.
In those cases, operators usually take the nearest officially published elevation information and use it as the ground elevation (i.e. elevation at end of RWY XY).

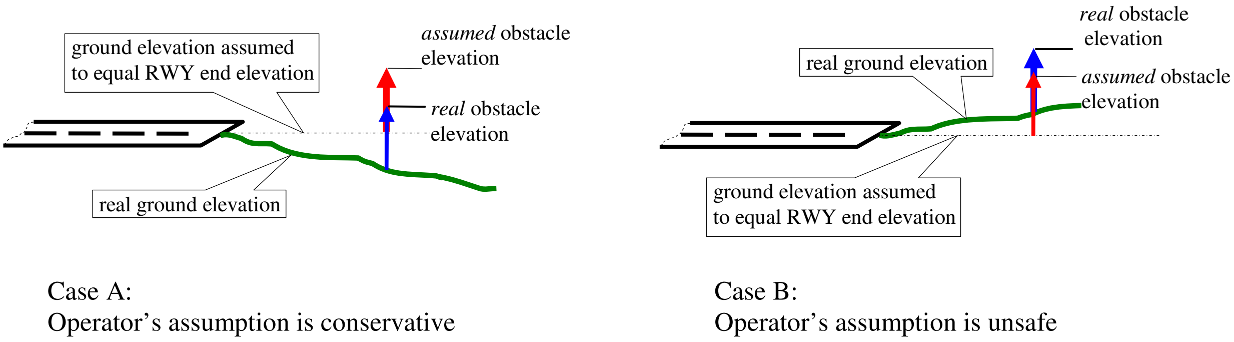


Figure 6: Unclear information about obstacle elevation due to missing ground elevation

Case A in figure 6 shows a down sloping terrain beyond the runway end. Assuming the ground elevation to be equal to the runway end elevation is conservative. With the NOTAM information "30ft AGL" the operator considers the overall obstacle elevation higher than it really is. As a result he has to accept a loss in payload.
Case B in figure 5 shows a rising terrain beyond the runway end. In this case assuming the ground elevation to be equal to the runway end elevation is unsafe! Adding the obstacle height to the assumed ground elevation yields a lower overall obstacle elevation than the obstacle really has.
Without any information on true ground elevation, the operator can't be sure whether he processed a height information given with AGL reference correctly or not.

The following sample calculations show the effect of obstacles located 300 ft from runway end, assuming different heights above runway end.

With the above NOTAM information evaluated based on our normal assumptions, the obstacle is 30ft high above runway end. The associated takeoff masses are shown in the right column. If the real obstacle protruded only 10ft (20ft) above the runway end elevation, much higher masses could legally be used.
On the other hand, if we assumed the obstacle to be 10ft above runway end elevation, but the real height would be 30ft above end elevation, the higher takeoff mass of the aircraft could jeopardize the terrain clearance requirements in case of an engine failure during takeoff.

An artificial runway (2743m/9000ft, zero slope, sea level) has been chosen for the sample calculations, which are based on 32°C, zero wind and 1013 hPa:

Aircraft	Engine	MTOM [kg]	PTOM [kg] NO obstacle	PTOM [kg] 10ft AGL temporary obstacle	PTOM [kg] 20ft AGL temporary obstacle	PTOM [kg] 30ft AGL temporary obstacle
MD80	JT8D-219	72570	72020	71560	70470	69360
A320-233	IAE V2527E-A5	77000	81320	80230	78590	76970
B737-800W	CFM56-7B26	79010	81520	80690	78900	77400
A321-211	CFM56-5B3	93500	92710	91970	90720	89400
B757-200W	RB211-535E4	113500	118720	117910	115840	114210
B767-300W	PW4060	186880	180320	178210	174220	170530
A330-223	PW4168A	230000	229150	227900	226030	221910
A330-343	TRENT 772B	230000	234380	233190	226030	221910
B777-200ER	GE90-90B	294830	274300	273010	269040	265190
B747-400ERF	CF6-80C2B5F	412770	369770	369770	368120	364730

To improve the information precision in this case, the following should be observed when publishing the NOTAM:

1) Provide the obstacle elevation in reference to mean sea level (MSL).
2) If you deem a height AGL information useful, provide it as additional information only or use an officially published reference (elevation of airport reference point, elevation of runway end, etc.).

Example 4: Inconsistent obstacle information

In many cases obstacle information is given by different sources and unfortunately sometimes show different information.
As an example the obstacle information for runway 25R at Las Vegas/McCarran Intl. airport (LAS/KLAS) has been selected.

Obstacle information published by NOAA as an UDDF file.

```
|7L  |BV  |      (Obstacles on App 07L to be considered for T/O 25R)
|OL ON GS      | 360432.08|-1150746.67|1A| 2069| |...|-11987| | 300R| | outside ICAO cone
|OL DME        | 360430.52|-1151019.17|1A| 2207| |...|   533| | 444R| | outside ICAO cone
|OL ON LOC     | 360434.91|-1151019.18|1A| 2195| |...|   533| |   0R| | in ICAO cone
|ROD ON BLDG   | 360431.27|-1151019.18|1A| 2202| |...|   534| | 369R| | outside ICAO cone
|RD(N)         | 360430.20|-1151020.83|1A| 2208| |...|   670| | 477R| | outside ICAO cone
|RD(N)         | 360435.08|-1151020.94|1A| 2201| |...|   678| |  17L| | in ICAO cone
|TREE          | 360429.51|-1151024.30|1A| 2219| |...|   954| |*546R| | outside ICAO cone
|TREE          | 360440.08|-1151024.38|1A| 2232| |...|   960| | 523L| | outside ICAO cone
|TREE          | 360440.39|-1151032.64|1A| 2237| |...|  1637| | 555L| | outside ICAO cone
|TREE          | 360429.02|-1151038.94|1A| 2245| |...|  2156| | 594R| | outside ICAO cone
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Additionally further obstacle information is provided on the FAA published page below:

C5

TAKE-OFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES

10210

LAS VEGAS, NV

MCCARRAN INTL (LAS)
AMDT 6 10210 (FAA)

Rwy 25R, multiple poles and trees 533' from DER, 1' left of centerline, up to 271' AGL/2457' MSL. Building 1822' from DER, 652' left of centerline, 59' AGL/2238' MSL. Roads 669' from DER, 17' right of centerline, up to 29'AGL/2208'MSL.

The UDDF file (similar to an AOC Type A chart, published in the AIP in other parts of the world) shows several obstacles, none of which matches the one shown as highlighted on the Take-Off Minimums and (Obstacle) Departure Procedure (TOMDP) page. At the distance of 533 ft from DER 25R, the UDDF file shows an obstacle with 2195 ft elevation, while the TOMDP page shows 2457 ft of elevation. None of the UDDF obstacles come anywhere near 2457 ft of elevation.

Furthermore, the obstacle information on the TODMP page is not precise, stating that multiple obstacles starting at “533 ft from DER” are “up to 2457 ft MSL”. With a description like this, the operator is required to use the most conservative assumption, i.e. the obstacle 2457 ft is located at 533ft from DER. However, in reality it might turn out that the obstacle located at 533 ft from DER only has 2195 ft MSL (in accordance with the UDDF file) and that the obstacle with 2457 ft is actually located much farther from DER.

The following table will show the effect of conservatively interpreting the information given on the TODMP page. Takeoff performance on runway 25R was calculated at 38°C/100°F, zero wind and 1000hPa:

Aircraft	Engine	MTOM [kg]	PTOM [kg] RWY25R UDDF obstacles	PTOM [kg] RWY 25R plus 2457ft obstacles	Penalty [kg]
MD80	JT8D-219	72570	63060	51720	-11340
A320-233	IAE V2527E-A5	77000	76820	63320	-13500
B737-800W	CFM56-7B26	79010	76150	60780	-15370
A321-211	CFM56-5B3	93500	82680	67160	-15520
B757-200W	RB211-535E4	113500	112600	90100	-22500
B767-300W	PW4060	186880	164000	130050	-33950
A330-223	PW4168A	230000	213910	169140	-44770
A330-343	TRENT 772B	230000	223280	175500	-47780
B777-200ER	GE90-90B	294830	256450	202620	-53830
B747-400ERF	CF6-80C2B5F	412770	386600	314040	-72560

This example clearly shows that an obstacle description “up to ... ft AGL, starting from ... ft DER” is not an appropriate way of defining obstacles.

While the TOMDP page in this example was valid for the AIRAC cycle 29-Jul-2010 to 26-AUG-2010, the UDDF file has April 2005 as verification date and thus, is significantly older. This further contributes to the uncertainty and inaccuracy of the information.

To improve the information precision in this case, the following should be observed when publishing the information:

1) Reduce the amount of sources. Define one department/authority to be in charge of collecting and providing all airport relevant data.
2) Keep the data up-to-date.
   Where new information is available due to new surveys, update all affected sources. Additionally provide information about the validity of all released sources. Having an UDDF file that is several years old is not a problem if we knew that it is still valid.
3) Larger number of obstacles increase the effort if each obstacle has to be surveyed individually. However, don’t provide information on multiple obstacles as on the TOMDP page. An easier and more precise way to provide the information is to define a sloped surface that is not protuded by any obstacle.

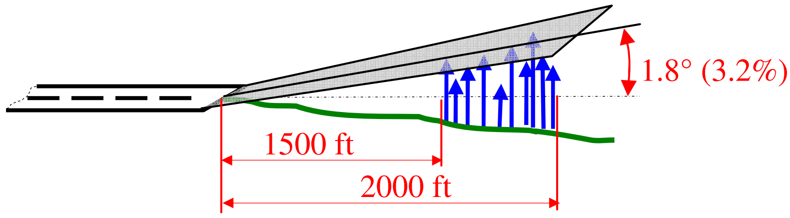

Figure 7: Alternaticve way to publish great amounts of obstacles

The NOTAM information for this example would be:
... MULTIPLE OBST 1500FT TO 2000FT FM DEP END RWY XY. OBST NOT PROTUDING SURFACE OF 1.8 DEG STARTING AT DEP END RWY XY
This is a precise information that can be evaluated by the operator.

Summary, Do's and Don't's

The best way of defining obstacles are the publication of up-to-date type A aerodrome obstacle charts supplemented by Notams with a precise definition of the location and elevation of the temporary obstacles.

Furthermore the examples above clearly show the possible impact of new or temporary obstacles on takeoff performance. Therefore it is necessary to control the flight path area around runways to be as obstacle free as possible. As many countries already enforce a policy that severely restricts buildup of new obstacles in flight path areas, respective legislation may be required to enable air traffic organisations and/or airports to object and control the build up of additional temporary or permanent obstacle within the flight path area to avoid negative effects on takeoff performance.

The following overview shows some examples of Do's and Don't's regarding NOTAM publishing from a flight operations engineer's perspective.

Source material

Don't:
- × distribute information over many sources
- × discontinue older sources without notice

Do:
- √ reduce the amount of different sources
- √ update older sources regularly
- √ even if no newer information is available, update the date information regularly or provide a list of effective sources

NOTAM duration

Don't:
- × use "UFN" (until furcer notice)
- × don't forget your own NOTAM

Do:
- √ try to be as precise as possible about the duration
- √ rather publish a replacement NOTAM than provide unduly long effectivities in the first NOTAM
- √ cancel NOTAM when no longer valid

NOTAM history

Don't:
- × break chain of history
- × publish multiple NOTAM for the same issue

Do:
- √ notify if a NOTAM replaces an existing one

Changes to Runway Length

Don't:
- × omit the information about where the runway is shortened/elongated
- × provide only "length" information

Do:
- √ state clearly which ends of the runway are shortened/elongated
- √ provide complete information on new TORA, TODA, ASDA and LDA for both runway directions

cont'd

Obstacle Height/Elevation

Don't:
- × provide height "AGL" information, especially if ground elevation is unclear
- × leave out any information on height/elevation at all

Do:
- √ use elevation "MSL"
- √ where height "AGL" has to be used, provide a published reference (e.g. ARP elevation, RWY end elevation)
- √ when NOTAM says "obstacle might be lowered on prior request", also provide the lowered obstacle elevation

Obstacle Location

Don't:
- × use rough heading information (in front of, N, NW, W, etc)
- × forget a reference when providing bearing and distance
- × use unclear references

Do:
- √ use coordinates (WGS 84) whenever possible
- √ provide coordinate system information if WGS 84 was not used
- √ when providing bearing and distance information use a precise reference (see below)
- √ alternatively use distance along centerline from reference (see below) and lateral distance (e.g. 10500 ft from start of TORA, 50 ft left of CL)

Multiple Obstacles/Obstacle Clusters

Don't:
- × provide obstacle cluster information by just stating the closest distance and the highest elevation (e.g. obstacle starting 500ft from DER, up to 200ft MSL)

Do:
- √ publish and maintain an obstruction chart
- √ provide detailed information on each single obstacle
- √ if providing detailed information on each obstacle is not sensible (e.g. trees in a forrest, etc), use alternative methods. Example 4 shows an alternative method.

Moving Obstacles

Don't:
- × only provide the current location of a moving obstacle

Do:
- √ provide detailed information about the area in which the obstacle will move
- √ take into account that e.g. cranes might have a crane arm, sometimes of significant length, that can turn 360 degrees

Reference Points

Don't:
- × omit clear references (e.g. SW of airport, SW of RWY)
- × use ambiguous references (e.g THR if a Ldg THR is meant)

Do:
- √ be precise about the reference
- √ use one of the following wordings

ARP	Airport Reference Point
AER	Approach End of RWY (i.e. Start of TORA)
DER	Departure End of RWY (i.e. End of TORA)
THR	Runway Threshold
Ldg THR	Dispalced Landing Threshold

cont'd ?