wyle laboratories

May 18, 2006

Maj. G.H. Shepherd
D Air CFG - FMT Goose Bay
National Defense Headquarters
Ottawa, Ontario K1A OK2
CANADA

RE: J/N 10593

Dear Maj. Shepherd,

Attached is our prediction of the sonic boom environment from proposed supersonic operations in CYA 732. It's in the form of "Appendix X." This is the same material I e-mailed in Word and PowerPoint formats; you can reformat (and re-letter) as required to merge with the EA.

It has been a pleasure working with you. If you have any questions about this analysis, or if I can be of further service, please let me know.

Sincerely,

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Appendix 1. Sonic Boom Environment in CYA 732

Two kinds of supersonic air exercises are proposed for CYA 732: Operation Night Conventional Strike, to be conducted on eight nights in September 2006, and ongoing training missions of up to 1250 supersonic-capable sorties per year. The following sections describe BooMap, the model used for analysis, and present the predicted sonic boom environment for these exercises.

1.1 BooMap Model for Predicting Sonic Booms

The sonic boom noise environment for military supersonic training activity of the type proposed for CYA 732 is described by the BooMap model.[1] This is a phenomenological model based on analysis of data reported in References 2 through 6. In those studies, it was found that supersonic activity takes place within an elliptical region (the maneuver ellipse) whose dimensions and orientation depend on the airspace configuration and also on the nature of air to air combat. Reference 7 defines the rules for defining the maneuver ellipse when the constraint is available airspace. In a large airspace the maneuver ellipse may not be constrained by the airspace dimensions,[8] but rather by the nature of the exercise. There can be more than one maneuver ellipse in a given airspace.

Once the ellipse is defined and the sortie rate is specified, BooMap will compute two quantities that describe the boom environment. The first is the C-weighted day night level, CDNL.[9] That is a cumulative metric that accounts for the number and amplitude of booms over some period of time. It is usually computed as a monthly or annual average, but may be computed for a period as short as one day. The second is the number of sonic booms that are expected to be heard at a given point on the ground within the airspace. This is typically presented as the average number of booms per day during the same period for which CDNL was computed.

Both CDNL and number of booms per day vary throughout an airspace, BooMap output is presented as contours of each quantity.

Because of the varied nature of air combat training, the amplitude of individual sonic booms varies. The average sonic boom amplitude in this type of environment is 1 psf. Table 1 gives the percent of booms that are expected to exceed various overpressures.

1.2. Night Conventional Strike

Figure 1 is a sketch of CYA 732, showing key elements in Operation Night Conventional Strike. This is a battle simulation in which "Blue Air" forces from the east attack targets in the western part of CYA 732. Most of the Blue Air Forces have low-altitude subsonic strike missions. Eight Blue Air aircraft will have a sweep mission, to protect the strike aircraft against "Red Air" Combat Air Patrol (CAP) defenders. There will be eight Red Air CAP

aircraft. Supersonic activity will be among the eight Blue Air Sweep and eight Red Air CAP aircraft.

The three circles in the center of CYA 732 are areas where air combat between Red Air CAP and Blue Air Sweep is expected to take place. Red Air will accelerate toward the center as they attempt to intercept Blue Air Strike, while Blue Air Sweep accelerate to protect their strike aircraft. Speeds may become supersonic as they approach an engagement area, and can become supersonic at random times during the engagement and also during break at the end of the engagement.

It is expected that there will be three maneuver ellipses, one centered on each of the three engagement areas. Figure 2 shows these three ellipses. The center ellipse is slightly longer because of its position, but supersonic activity is expected to be divided equally between the three.

Figures 3 and 4 show CDNL and number of booms per day, respectively, for Operation Night Conventional Strike. It is assumed that supersonic activity occurs before 2200, so the 10 dB nighttime factor for CDNL does not apply.

CDNL in the center of the airspace is slightly above 45 dB. This is a modest value, and in ordinary lightly populated areas would be expected to annoy about one percent of the population.[8] There will be about 0.25 booms per day in the center of the airspace, so that on any one day there is a one in four chance of hearing a boom. Both CDNL and number of booms per day diminish away from the center of the airspace. Note that at the center of the north and south edges of the airspace there will be an average of 0.05 booms per day, or one boom every 20 days. At the east and west ends of the airspace there is a vanishingly small probability of sonic booms.

1.2 Ongoing Training

It is expected that routine training will consist of up to 5000 sorties, of which 1250 (25%) will be supersonic-capable missions. Because of the size of the airspace, it is not expected that CYA 732 will be used in a monolithic fashion for these missions. Rather, it will be subdivided into several sections. Three scenarios have been considered:

1. Division into six sectors, each comparable in size to the airspaces monitored for BooMap development. Operations are equally divided among these.

2. Six sectors, but only the four that are in the center and east end (closest to the airbase) are used

3. Two sectors, covering only the central and eastern part of the airspace.

The second and third scenarios involve the same basic borders as the first, just organized in various ways.

In addition to these three scenarios, BooMap has been run for a single ellipse based on the full size of the airspace. This is an extrapolation of BooMap to dimensions beyond the original monitoring studies, but is of interest for reference purposes.

1.2.1 Six Supersonic Maneuver Ellipses

Figure 5 shows the airspace divided into six maneuver ellipses. Each ellipse is of size comparable to those monitored during BooMap development, and is the amount of airspace typically used for routine air combat training. The 1250 annual sorties are distributed equally among the ellipses. The ellipses may be used simultaneously on busy days, or in rotation when full capacity is not used. The ellipses are lettered for reference.

Figures 6 and 7 show the annual average CDNL and numbers of booms per day. Note that the maximum CDNL around the center of each ellipse is between 35 and 40 dB, while CDNL is around 25 dB near the edges of the airspace. The number of booms per day is around 0.02 (one boom every 50 days) around the center of each ellipse, and is 0.005 (one every 200 days) near the edges of the airspace.

1.2.2. Four Supersonic Maneuver Ellipses

Figures 8, 9 and 10 show BooMap analysis for 1250 annual sorties using four of the six ellipses (A, B, C, and D). These are the four ellipses that are closest to the airbase.

CDNL around the center of each ellipse is slightly higher than for the six ellipse case, but is still in the range of 35 to 40 dB. CDNL near the edges of the airspace (easternmost two-thirds) is around 25 to 30 dB. There will be about 0.03 booms per day (one boom per month) near the center of each ellipse, and about 0.005 booms per day (one boom every 200 days) near the edges of the easternmost two-thirds of the airspace.

1.2.3. Two Supersonic Maneuver Ellipses

Some missions may require longer setup distances than available in one of the six maneuver ellipses. This may be addressed by combining pairs of subdivisions. Figure 11 shows such a configuration: A/C, and B/D are each combined into longer ellipses, using about two thirds of the airspace. Sorties are assumed to be equally divided between the two.

Figures 12 and 13 show the BooMap predictions for this configuration. CDNL near the center of each ellipse is slightly over 40 dB, and there will be about 0.06 booms per day (one boom every 15 days). Near the edges of this portion of the airspace CDNL will be 30 to 35 dB, and there will be about 0.01 booms per day (one every 100 days).

Note that the number of booms expected at the center and edge of each ellipse will be about three times that expected for each ellipse in the six ellipse scenario. That is because the same number of sorties are considered, but they are concentrated into two ellipses, rather than spread over six areas.

1.2.4. Single Supersonic Maneuver Ellipse

BooMap analysis has been performed for a single maneuver ellipse, filling the airspace per the available airspace algorithm defined in Reference 7. Figure 14 shows the ellipse. CDNL in the center of the airspace (Figure 15) will be slightly over 45 dB, and there will be about 0.12 booms per day (about one every 8 days). Near the edges of the airspace CDNL will be about 35 dB, and there will be about 0.03 booms per day (about one every 30 days).

The single ellipse scenario is somewhat unrealistic. It represents extrapolation of BooMap data beyond the dimensions of the original monitored areas, and implies much more supersonic activity than would be possible for conventional fighter aircraft. It is much more likely that training will occur in smaller areas.

The CDNL values and numbers of booms per day for all of the 1250 sortie configurations, including the single ellipse, are relatively small, and in conventional sparsely populated areas no significant impact would be expected. The implications of this boom environment in Goose Bay are discussed in the body of this document. The comparison between the 6, 4, 2 and 1 ellipse scenarios demonstrates the value of dividing supersonic operations into several areas. Division into multiple areas fits well with the adaptive management discussed on the body of this EA.

References

1. Plotkin, K.J. and F. Grandi, 2002. "Computer Models for Sonic Boom Analysis: PCBoom4, CABoom, BooMap, CORBoom," Wyle Research Report WR 02-11, June 2002.

2. Plotkin, K.J., Desai, V.R., Moulton, C.L., Lucas, M.J., and Brown, R., "Measurements of Sonic Booms due to ACM Training at White Sands Missile Range," Wyle Research Report WR 89-18, 1989.

3. Frampton, K.D., Plotkin, K.J., and Lucas, M.J., "Measurements of Sonic Booms Due To ACM Training in R-2301E, Barry Goldwater Air Force Range," Wyle Research Report WR 92-4, 1991.

4. Frampton, K.D., Lucas, M.J., and Plotkin, K.J., "Measurements of Sonic Booms Due to ACM Training in the Elgin MOA Subsection of the Nellis Range Complex," Wyle Research Report WR 93-5, 1993.

5. Page, J.A., Schantz, B.D., Brown, R., Plotkin, K.J., and Moulton, C.L., "Measurements of Sonic Booms Due to ACM Training in R2301 W of the Barry Goldwater Air Force Range," Wyle Research Report WR 94-11, 1994.

6. Plotkin, K.J., Moulton, C.L., Desai, V.R., and Lucas, M.J., "Sonic Boom Environment Under a Supersonic Military Operating Area", Journal of Aircraft, 29 (6), pp. 1060-1072, November-December 1992.

7. Frampton, K.D., Lucas, M.J., and Cook, B., "Modeling the Sonic Boom Noise Environment in Military Operating Areas. AIAA Paper 93-4432, 1993.

8. Frampton, K.D, Plotkin, K.J., and Lucas, M.J., "Analysis of Supersonic Flight Operations in Hill AFB ACMI Arena," Wyle Report WR 92-2, 1992.

9. "Assessment of Community Response to High-Energy Impulsive Sounds," National Research Council, Committee on Hearing, Bioacoustics and Biomechanics, 1981.

Table 1. Distribution of Sonic Boom Overpressures

Overpressure, psf	Percent of Booms Exceeding overpressure
0.2	90.0
0.4	63.0
0.6	50.0
0.8	35.0
1.0	28.0
2.0	11.0
3.0	4.8
4.0	2.0
5.0	1.4
6.0	1.1
7.0	0.8
8.0	0.5
9.0	0.25
10.0	0.18

Figure 1. Sketch of CYA-732 and Operation Night Conventional Strike elements (From DND presentation, August 2005, Slide 19)

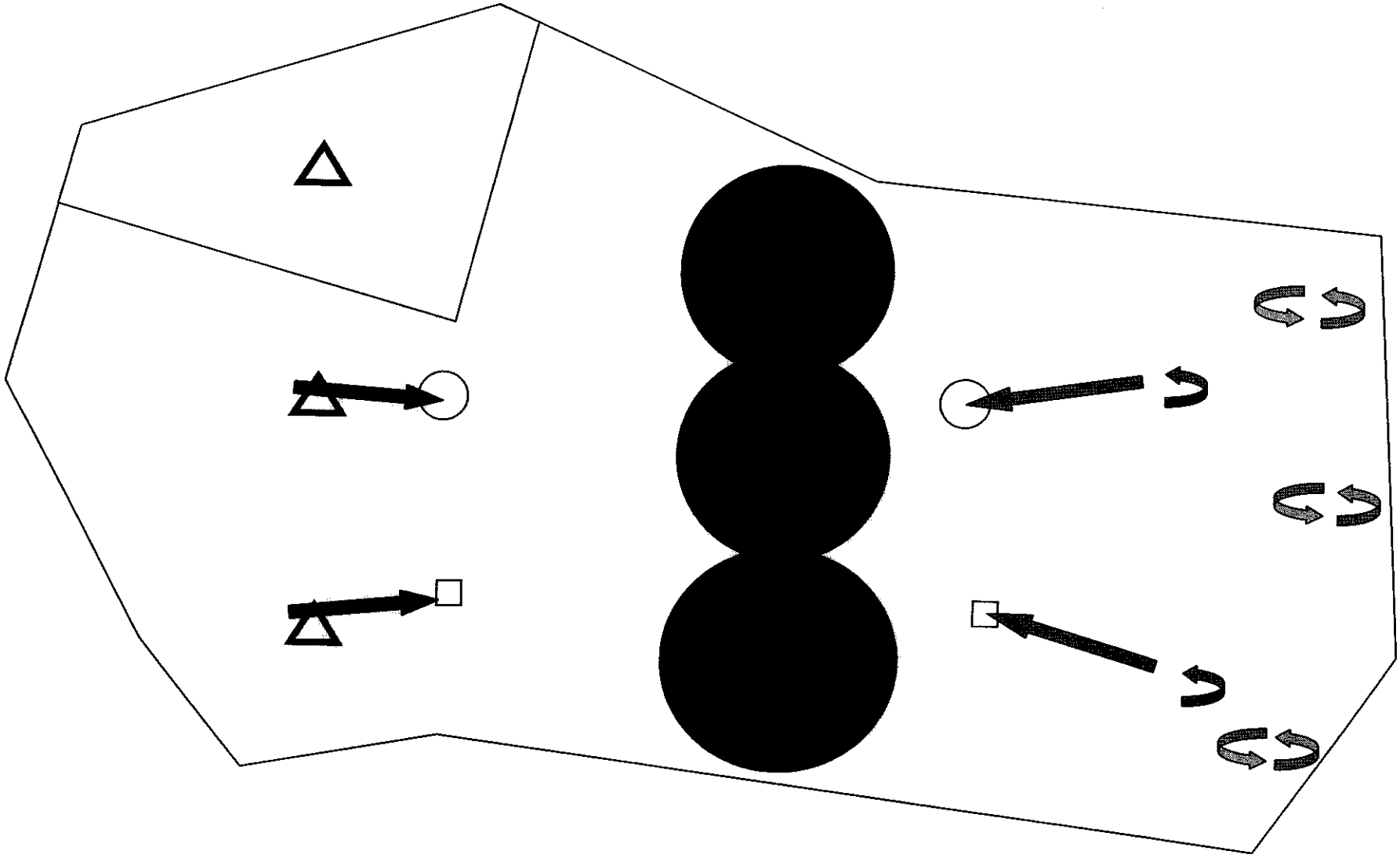
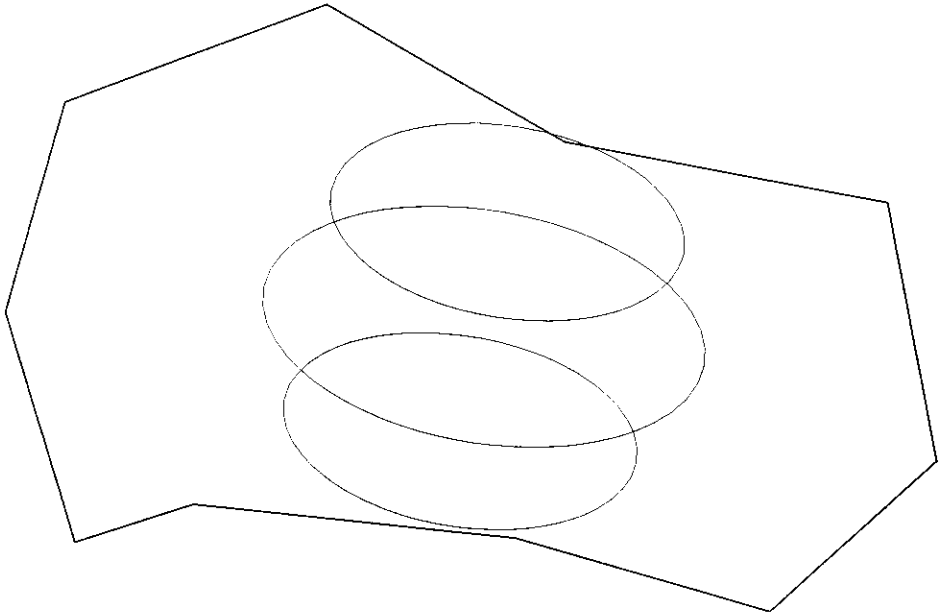


Figure 2. Operation Night Conventional Strike Supersonic Maneuver Ellipses



goose401.cgm

Figure 3. Operation Night Conventional Strike CDNL, Daily Operations

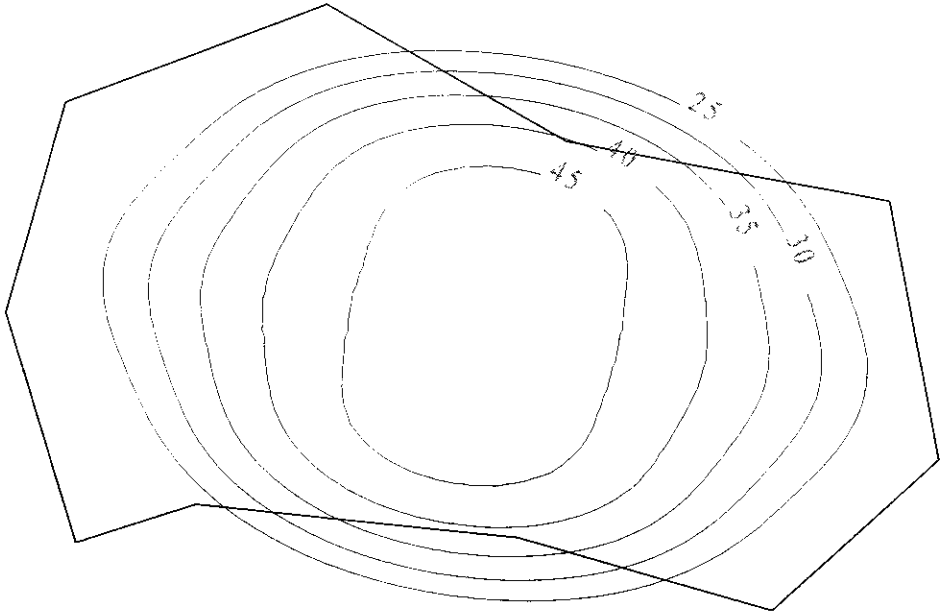


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Figure 4. Operation Night Conventional Strike Booms Per Day, Daily Operations

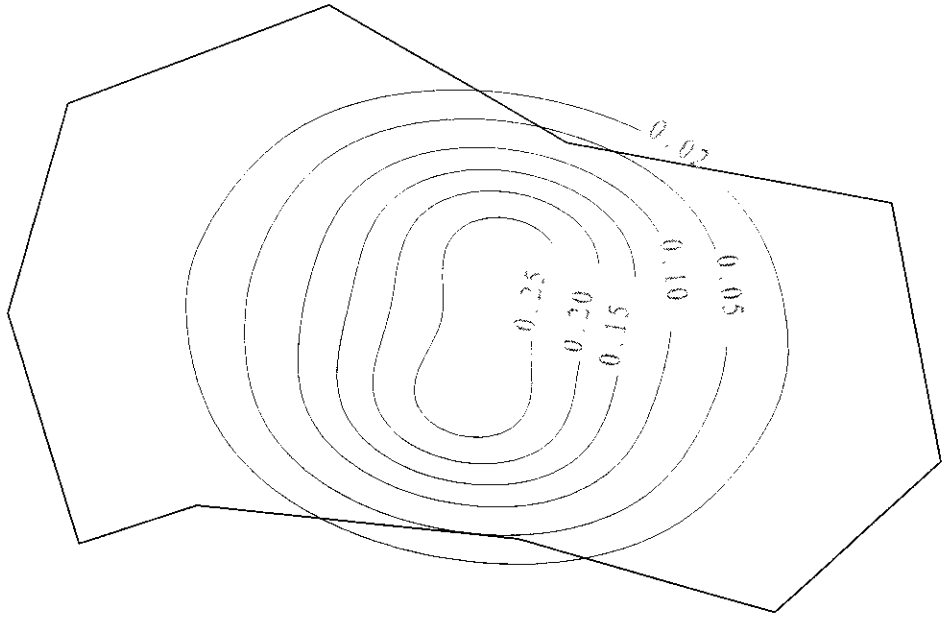

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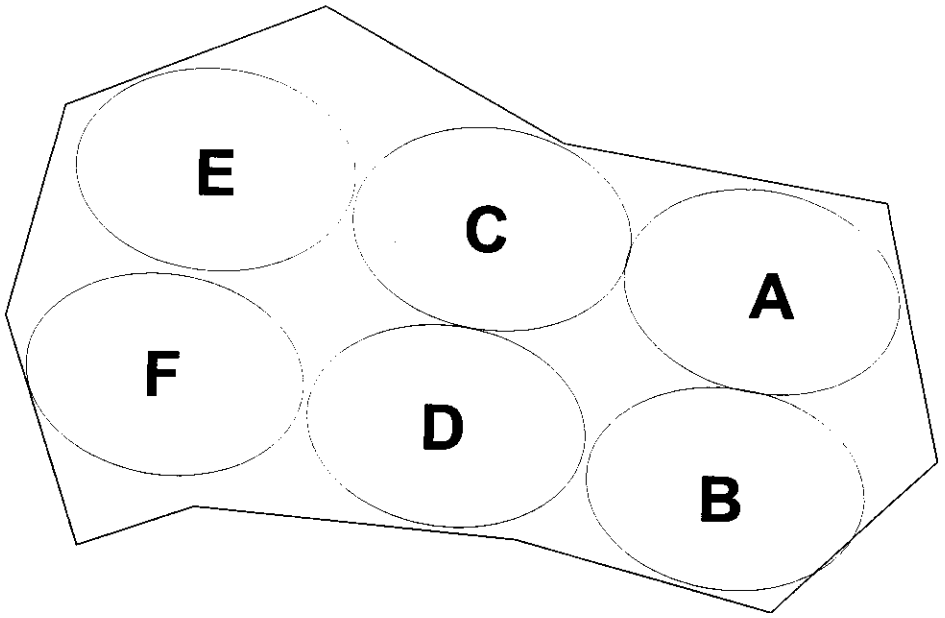
Figure 5. Six Supersonic Maneuver Ellipses,1250 Sorties per Year



g201.cgm

Figure 6. Annual Average CDNL,1250 Sorties per Year, Six Ellipses

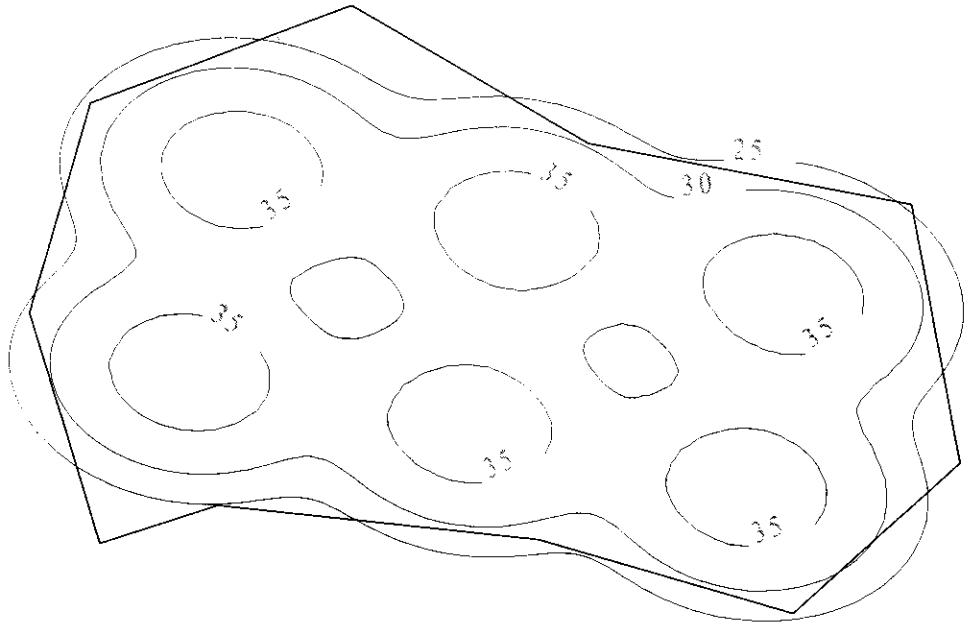


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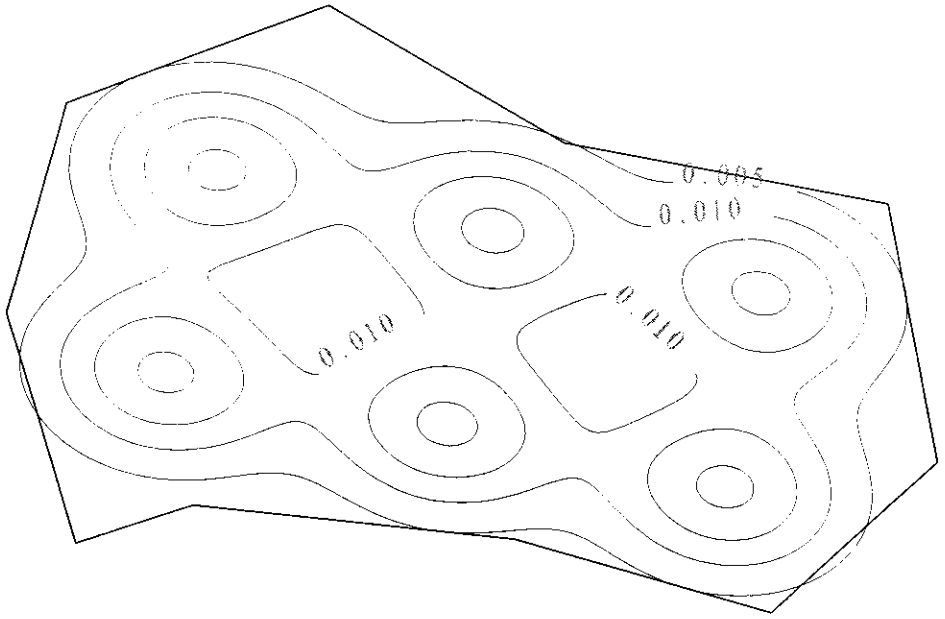
Figure 7. Annual Average Booms per Day, 1250 Sorties per Year, Six Ellipses



g203.cgm

Figure 8. Four Supersonic Maneuver Ellipses, 1250 Sorties per Year

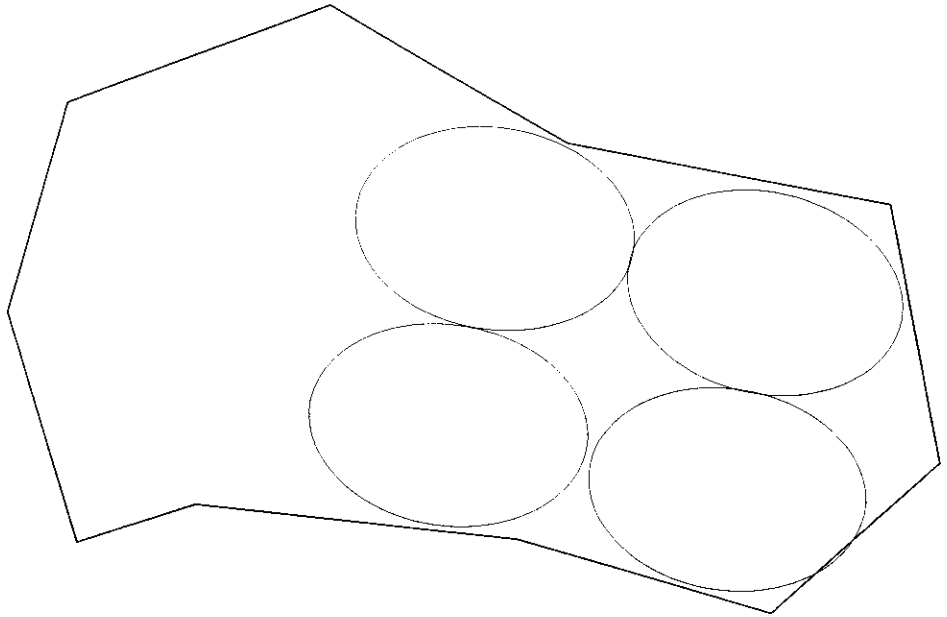


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Figure 9. Annual Average CDNL, 1250 Sorties per Year, Four Ellipses

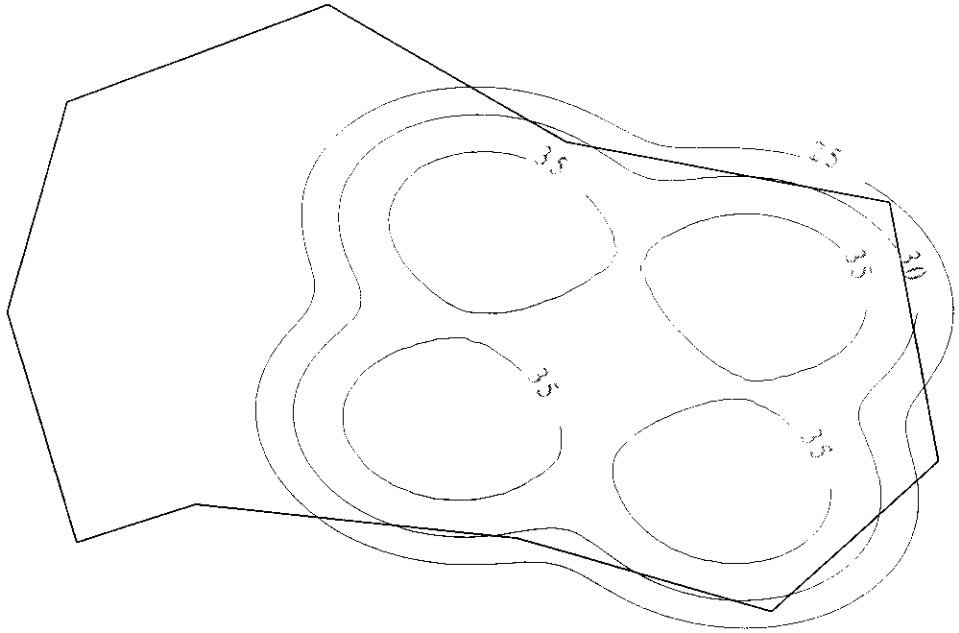

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Figure 10. Annual Average Booms per Day, 1250 Sorties per Year, Four Ellipses

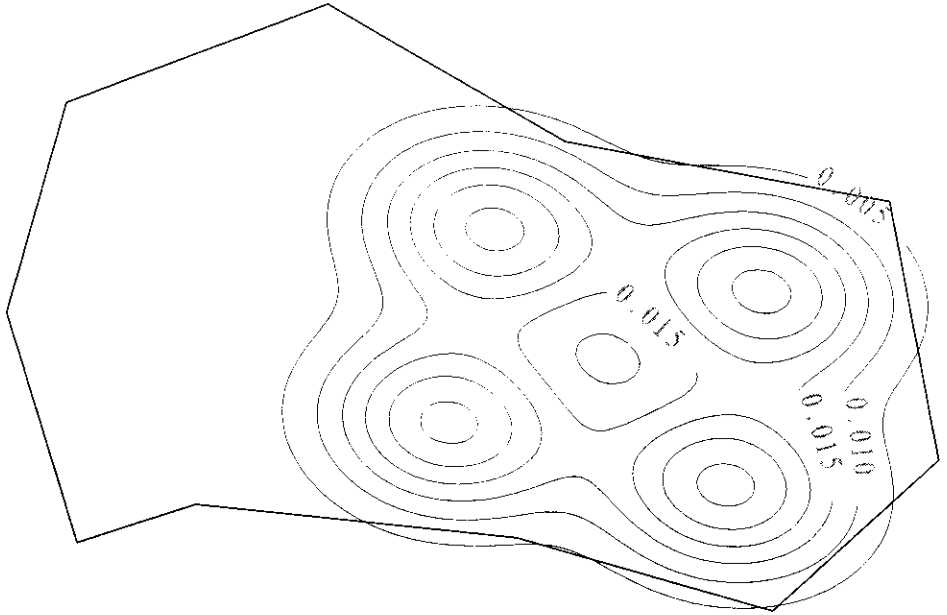

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Figure 11. Two Supersonic Maneuver Ellipses, 1250 Sorties per Year

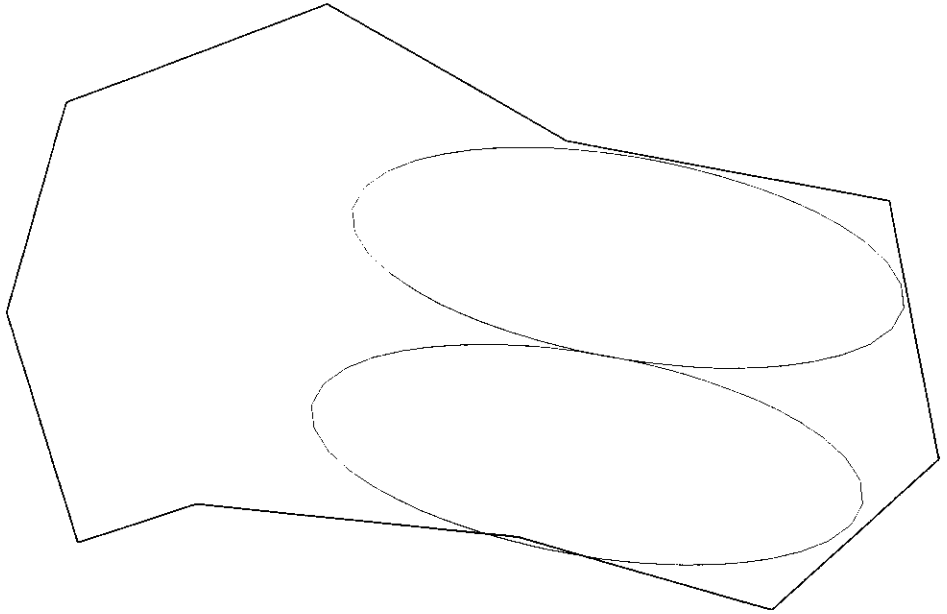

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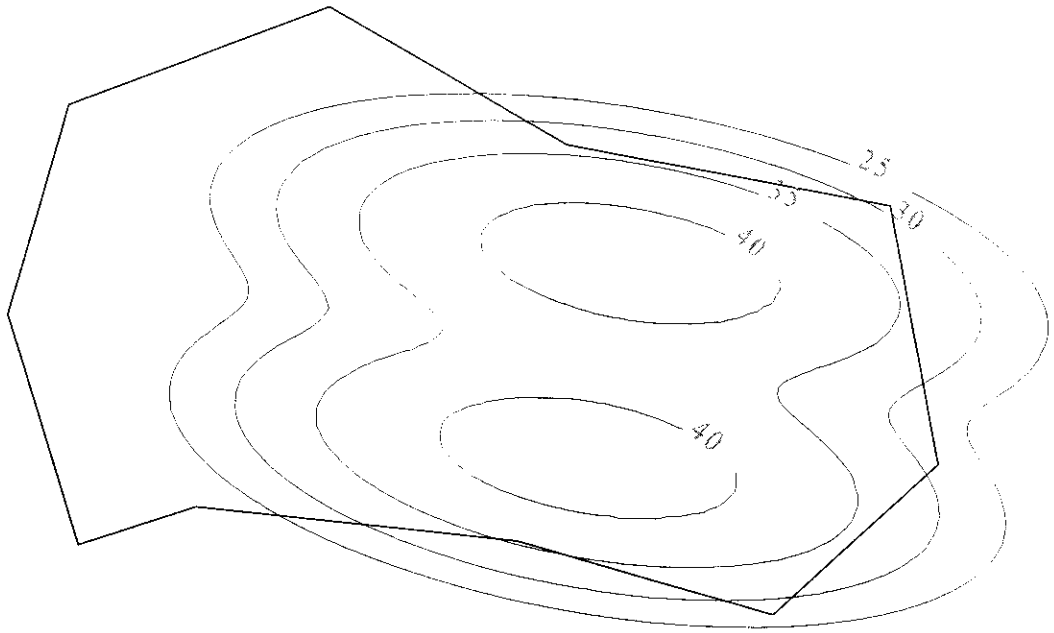
Figure 12. Annual Average CDNL, 1250 Sorties per Year, Two Ellipses



g302.cgm

Figure 13. Annual Average Booms per Day, 1250 Sorties per Year, Two Ellipses

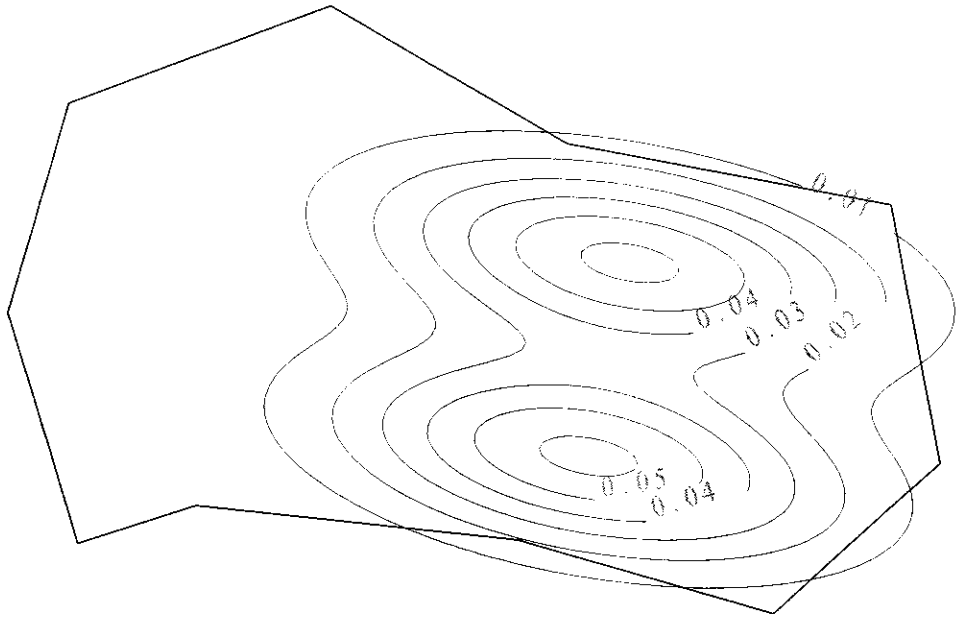


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Figure 14. One Supersonic Maneuver Ellipse, 1250 Sorties per Year

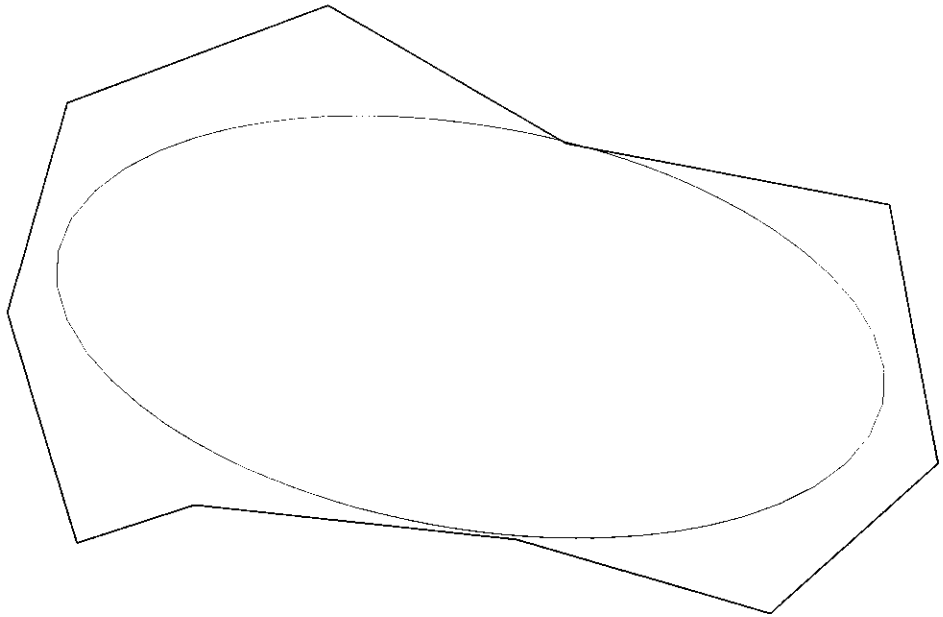

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Figure 15. Annual Average CDNL, 1250 Sorties per Year, One Ellipse

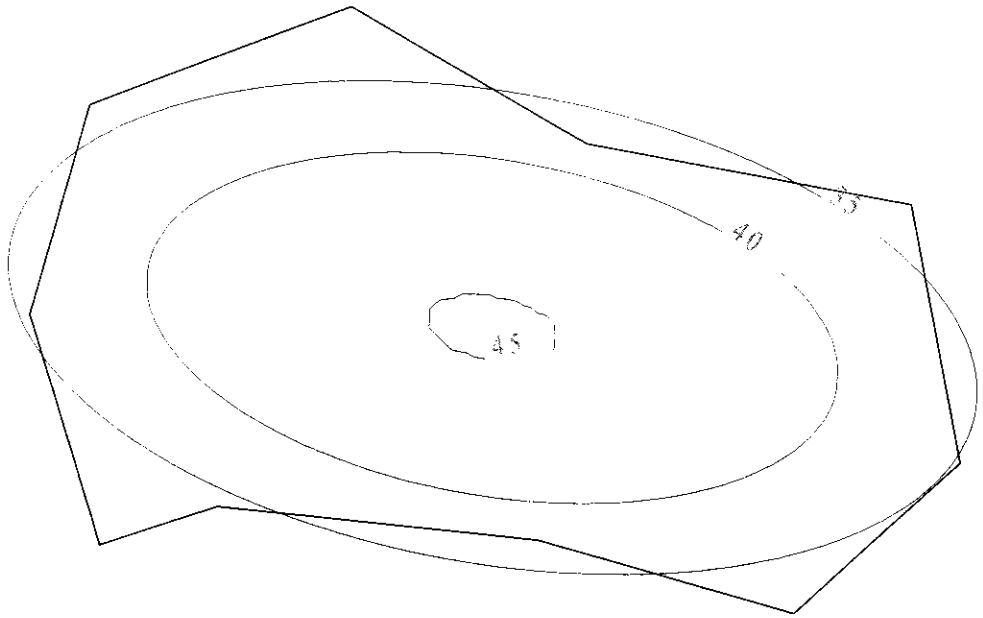

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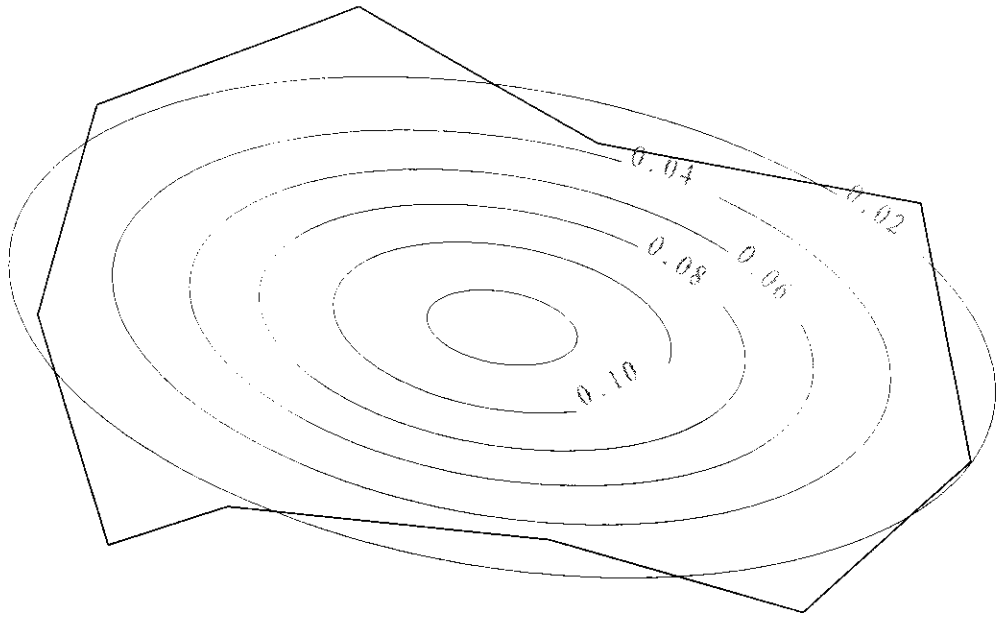
Figure 15. Annual Average Booms per Day, 1250 Sorties per Year, One Ellipse



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