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Tel.: +1 (514) 954-8219 ext. 6712

Ref.: AN 7/1.3.96-09/57

30 June 2009

**Subject:** Proposals for the amendment of Annex 10, Volume IV, concerning the airborne collision avoidance system (ACAS)

**Action required:** Comments to reach Montreal by 13 October 2009

Sir/Madam,

1. I have the honour to inform you that the Air Navigation Commission, at the fifth meeting of its 181st Session held on 9 June 2009, considered a proposal developed by the Aeronautical Surveillance Panel (ASP) to amend the Standards and Recommended Practices (SARPs) in Annex 10 — *Aeronautical Telecommunications, Volume IV — Surveillance and Collision Avoidance Systems*, concerning the airborne collision avoidance system (ACAS), as shown in Attachment A, and authorized its transmission to Contracting States and appropriate international organizations for comments.

2. The main elements of the proposed amendment are:

- a) new requirements for display of proximate traffic, traffic advisory (TA) and resolution advisory (RA);
- b) updates to hybrid surveillance provisions in light of relevant recent developments; and
- c) introduction of a new functional requirement for monitoring own aircraft's vertical rate during an RA which would be affected by implementing a new version of the collision avoidance system (CAS) logic (commonly referred to as traffic alert and collision avoidance system (TCAS) Version 7.1). The new version of the CAS logic

would also include a change in the annunciation of the RA “Adjust Vertical Speed, Adjust” to “Level Off”.

3. The part of the proposed amendment that introduces the new functionality stated in subparagraph c) above includes an effective implementation date of 1 January 2012 for new ACAS installations. The Air Navigation Commission recognized the safety benefits of the new CAS logic and also the fact that such benefits would only be achieved when the majority of aircraft are suitably equipped. However, issues pertaining to development, certification and fielding of the TCAS Version 7.1 as well as complexity and cost of its installation on various types of aircraft need to be carefully investigated and analyzed before an effective implementation date can be agreed upon.

4. Noting the above, the Commission has asked me to request you to conduct, as part of preparing your reply to this letter, an investigation of the extent of the effort needed to suitably equip all aircraft in your registry with TCAS Version 7.1, as per ACAS equipage requirements contained in Annex 6 — *Operation of Aircraft*.

5. Please be advised that the Commission wishes to accelerate the operational certification of TCAS 7.1 systems through the use of equipage in new installations which would also encourage the retrofit for in-service aircraft.

6. Based on your investigation and analysis, your reply should ideally contain the following with respect to the implementation of or upgrading to TCAS Version 7.1:

- a) comments on suitability of the effective forward fit date of 1 January 2012 or otherwise; and
- b) the extent of the effort needed for suitably equipping or upgrading existing aircraft, and in that connection, the earliest date an effective retrofit could be practically completed.

7. In examining the proposed amendments, you should not feel obliged to comment on editorial aspects as such matters will be addressed by the Air Navigation Commission during its final review of the draft amendment.

8. May I request that any comments you may wish to make on the amendment proposals be dispatched to reach me not later than 13 October 2009. The Air Navigation Commission has asked me to specifically indicate that comments received after the due date may not be considered by the Commission and the Council. In this connection, should you anticipate a delay in the receipt of your reply, please let me know in advance of the due date.

9. For your information, the proposed amendment to Annex 10, Volume IV, is envisaged for applicability on 18 November 2010. Any comments you may have thereon would be appreciated.

10. The subsequent work of the Air Navigation Commission and the Council would be greatly facilitated by specific statements on the acceptability or otherwise of the proposals. Please note

that, for the review of your comments by the Air Navigation Commission and the Council, replies are normally classified as “agreement with or without comments”, “disagreement with or without comments” or “no indication of position”. If in your reply the expressions “no objections” or “no comments” are used, they will be taken to mean “agreement without comment” and “no indication of position”, respectively. In order to facilitate proper classification of your response, a form nhas been included in Attachment B which may be completed and returned together with your comments, if any, on the proposals in Attachment A.

Accept, Sir/Madam, the assurances of my highest consideration.

Taïeb Chérif  
Secretary General

**Enclosures:**

- A — Proposed amendment to Annex 10, Volume IV
- B — Response form

ATTACHMENT A to State letter AN 7/1.3.96-09/57

**PROPOSED AMENDMENT TO ANNEX 10, VOLUME IV**

**NOTES ON THE PRESENTATION OF THE PROPOSED AMENDMENT**

The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

1. ~~Text to be deleted is shown with a line through it.~~ text to be deleted
2. **New text to be inserted is highlighted with grey shading.** new text to be inserted
3. ~~Text to be deleted is shown with a line through it~~ followed by **the replacement text which is highlighted with grey shading.** new text to replace existing text

**PROPOSED AMENDMENT TO**  
**INTERNATIONAL STANDARDS AND**  
**RECOMMENDED PRACTICES**  
**AERONAUTICAL TELECOMMUNICATIONS**  
**ANNEX 10**  
**TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION**  
**VOLUME IV**  
**SURVEILLANCE AND COLLISION AVOIDANCE SYSTEMS**

...

**CHAPTER 4. AIRBORNE COLLISION AVOIDANCE SYSTEM**

*Note 1.— Guidance material relating to the airborne collision avoidance system is contained in the Airborne Collision Avoidance System (ACAS) Manual (Doc 9863) Attachment.*

*Note 2.— Non-SI alternative units are used as permitted by Annex 5, Chapter 3, 3.2.2. In limited cases, to ensure consistency at the level of the logic calculations, units such as ft/s, NM/s and kt/s are used.*

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**4.3 GENERAL PROVISIONS RELATING TO ACAS II AND ACAS III**

*Note 1.— The acronym ACAS is used in this section to indicate either ACAS II or ACAS III.*

*Note 2.— Carriage requirements for ACAS equipment are addressed in Annex 6 ~~Part I,~~ Chapter 6.*

*Note 3.— The term “equipped threat” is used in this section to indicate a threat fitted with ACAS II or ACAS III.*

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## 4.3.2.2 INTERFERENCE CONTROL

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4.3.2.2.2.2 *ACAS interference limiting inequalities.* ACAS shall adjust its interrogation rate and interrogation power such that the following three inequalities remain true, except as provided in 4.3.2.2.2.1.

$$\left\{ \sum_{i=1}^{i_t} \left[ \frac{p(i)}{250} \right]^\alpha \right\} < \text{minimum} \left[ \frac{280}{1+n_a}, \frac{11}{\alpha^2} \right] \quad (1)$$

$$\left\{ \sum_{i=1}^{i_t} m(i) \right\} < 0.01 \quad (2)$$

$$\left\{ \frac{1}{B} \sum_{k=1}^{k_1} \frac{P_a(k)}{250} \right\} < \text{minimum} \left[ \frac{80}{1+n_a}, 3 \right] \quad (3)$$

The variables in these inequalities shall be defined as follows:

$i_t$  = number of interrogations (Mode A/C and Mode S) transmitted in a 1 s interrogation cycle. This shall include all Mode S interrogations including those in addition to the UF = 0 and UF = 16 interrogations used by the ACAS function;

*Note.— UF = 19 interrogations are included in  $i_t$  as specified in 3.1.2.8.9.3.*

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## 4.3.3 Traffic advisories (TAs)

4.3.3.1 *TA function.* ACAS shall provide TAs to alert the flight crew to potential threats. Such TAs shall be accompanied by an indication of the approximate relative position of potential threats to facilitate visual acquisition.

4.3.3.1.1 *Display of potential threats.* If potential threats are shown on a traffic display, they shall be displayed in amber or yellow.

*Note 1.— These colours are generally considered suitable for indicating a cautionary condition.*

*Note 2.— Additional information assisting in the visual acquisition such as vertical trend and relative altitude may be displayed as well.*

*Note 3.— Traffic situational awareness is improved when tracks can be supplemented by display of heading information (e.g. as extracted from received ADS-B messages).*

## 4.3.3.2 PROXIMATE TRAFFIC DISPLAY

**4.3.3.2.1 Recommendation.**— *While any RA and/or TA are displayed, proximate traffic within 11 km (6 NM) range and, if altitude reporting,  $\pm 370$  m (1 200 ft) altitude should be displayed. This proximate traffic should be distinguished (e.g. by colour or symbol type) from threats and potential threats, which should be more prominently displayed.*

**4.3.3.2.2 Recommendation.**— *While any RA and/or TA are displayed, visual acquisition of the threats and/or potential threat should not be adversely affected by the display of proximate traffic or other data (e.g. contents of received ADS-B messages) unrelated to collision avoidance.*

**4.3.3.3** *TAs as RA precursors.* The criteria for TAs shall be such that they are satisfied before those for an RA.

**4.3.3.3.1** *TA warning time.* For intruders reporting altitude, the nominal TA warning time shall not be greater than  $(T+20)$  s where T is the nominal warning time for the generation of the resolution advisory.

*Note.*— *Ideally, RAs would always be preceded by a TA but this is not always possible, e.g. the RA criteria might be already satisfied when a track is first established, or a sudden and sharp manoeuvre by the intruder could cause the TA lead time to be less than a cycle.*

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## 4.3.5 Resolution advisories (RAs)

**4.3.5.1** *RA generation.* For all threats, ACAS shall generate an RA except where it is not possible to select an RA that can be predicted to provide adequate separation either because of uncertainty in the diagnosis of the intruder's flight path or because there is a high risk that a manoeuvre by the threat will negate the RA.

**4.3.5.1.1** *Display of threats.* If threats are shown on a traffic display, they shall be displayed in red.

*Note.*— *This colour is generally considered suitable for indicating a warning condition.*

**4.3.5.1.2** *RA cancellation.* Once an RA has been generated against a threat or threats it shall be maintained or modified until tests that are less stringent than those for threat detection indicate on two consecutive cycles that the RA may be cancelled, at which time it shall be cancelled.

**4.3.5.2** *RA selection.* ACAS shall generate the RA that is predicted to provide adequate separation from all threats and that has the least effect on the current flight path of the ACAS aircraft consistent with the other provisions in this chapter.

**4.3.5.3** *RA effectiveness.* The RA shall not recommend or continue to recommend a manoeuvre or manoeuvre restriction that, considering the range of probable threat trajectories, is more likely to reduce separation than increase it, subject to the provisions in 4.3.5.5.1.1 and 4.3.5.6.

*Note.*— *See also 4.3.5.8.*

4.3.5.3.1 New ACAS installations after 1 January 2012 shall monitor own aircraft's vertical rate to verify compliance with the RA sense. If non-compliance is detected, ACAS shall stop assuming compliance, and instead shall assume the observed vertical rate.

*Note 1.— This overcomes the retention of an RA sense that would work only if followed. The revised vertical rate assumption is more likely to allow the logic to select the opposite sense when it is consistent with the non-complying aircraft's vertical rate.*

*Note 2.— Equipment complying with RTCA/DO-185 or DO-185A standards (also known as TCAS Version 6.04A or TCAS Version 7.0) do not comply with this requirement.*

*Note 3.— Compliance with this requirement can only be achieved through the implementation of traffic alert and collision avoidance system (TCAS) Version 7.1 as specified in RTCA/DO-185B or EUROCAE/ED-143.*

4.3.5.3.2 **Recommendation.**— All ACAS should be compliant with the requirement in 4.3.5.3.1.

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### 4.3.7 ACAS protocols

#### 4.3.7.1 SURVEILLANCE PROTOCOLS

4.3.7.1.1 *Surveillance of Mode A/C transponders.* ~~ACAS shall use the Mode C-only all-call interrogation (Chapter 3, 3.1.2.1.5.1.2) for surveillance of aircraft equipped with Mode A/C transponders.~~

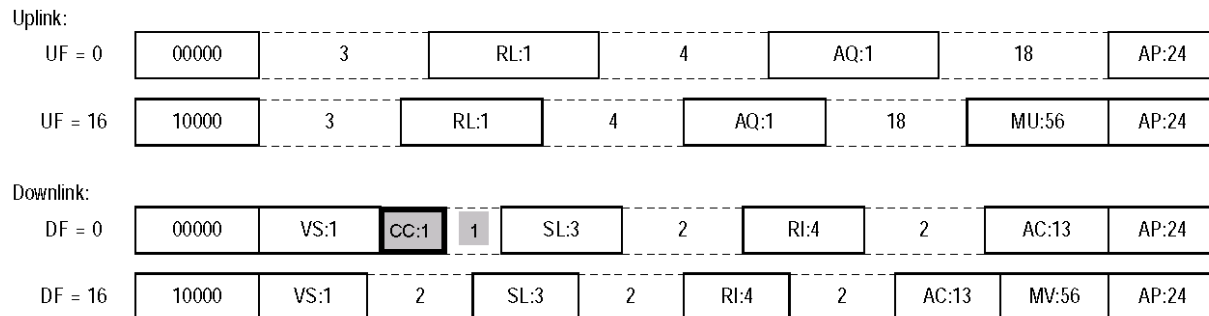
4.3.7.1.1.1 ACAS shall use the Mode C-only all-call interrogation (Chapter 3, 3.1.2.1.5.1.2) for surveillance of aircraft equipped with Mode A/C transponders.

4.3.7.1.1.2 Using a sequence of interrogations with increasing power surveillance interrogations shall be preceded by an S<sub>1</sub>-pulse (Chapter 3, 3.1.1.7.4.3) to reduce interference and improve Mode A/C target detection.

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#### 4.3.8.4 FIELD DESCRIPTION

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**Figure 4-1. Surveillance and communication formats used by ACAS**

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4.3.8.4.2.2.2 *Subfields in MB for the data link capability report.* When BDS1 = 1 and BDS2 = 0, the following bit patterns shall be provided to the transponder for its data link capability report:

|     |  |
|-----|--|
| Bit | Coding   |
| 48  | 0 ACAS failed or on standby<br>1 ACAS operating  |
| 69  | 0 <del>ACAS II</del> Hybrid surveillance not operational<br>1 <del>ACAS III</del> Hybrid surveillance fitted and operational |
| 70  | 0 ACAS generating TAs only<br>1 ACAS generating TAs and RAs  |
| 71  | 0 <del>ACAS not fitted</del><br>1 <del>ACAS fitted</del>   |
| 72  | 0 <del>Hybrid surveillance not fitted</del><br>1 <del>Hybrid surveillance fitted</del>                                       |

|        |        |   |
|--------|--------|---|
| Bit 72 | Bit 71 | ACAS version  |
| 0      | 0      | RTCA/DO-185 (pre ACAS)  |
| 0      | 1      | RTCA/DO-185A  |
| 1      | 0      | RTCA/DO-185B & EUROCAE ED 143   |
| 1      | 1      | Future version (see registers E5 <sub>16</sub> and E6 <sub>16</sub> ) |

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4.3.8.4.2.3.4.5 *AID (Mode A identity code).* This 13-bit (63-75) subfield shall denote the Mode A identity code of the reporting aircraft.

Coding:

|                 |                     |                     |                     |                     |                     |                     |    |                     |                     |                     |                     |                     |                     |
|-----------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Bit No.         | 63                  | 64                  | 65                  | 66                  | 67                  | 68                  | 69 | 70                  | 71                  | 72                  | 73                  | 74                  | 75                  |
| Mode A code bit | <del>C1</del><br>A4 | <del>A1</del><br>A2 | <del>C2</del><br>A1 | <del>A2</del><br>B4 | <del>C4</del><br>B2 | <del>A4</del><br>B1 | 0  | <del>B1</del><br>C4 | <del>D1</del><br>C2 | <del>B2</del><br>C1 | <del>D2</del><br>D4 | <del>B4</del><br>D2 | <del>D4</del><br>D1 |

...

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*Insert new text as follows:*

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4.3.8.4.2.6 *CC: Cross-link capability.* This 1-bit (7) downlink field shall indicate the ability of the transponder to support the cross-link capability, i.e. decode the contents of the DS field in an interrogation with UF equals 0 and respond with the contents of the specified GICB register in the corresponding reply with DF equals 16.

**Coding**

0 signifies that the transponder cannot support the cross-link capability.

1 signifies that the transponder supports the cross-link capability.

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End of new text.

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## 4.5 ACAS USE OF EXTENDED SQUITTER REPORTS

### 4.5.1 ACAS hybrid surveillance using extended squitter position data

*Note.— Hybrid surveillance is the technique used by ACAS to take advantage of passive position information available via extended squitter  $DF = 17$ . Using hybrid surveillance, ACAS validates the position provided by extended squitter through direct active range measurement. An initial validation is performed at track initiation. Revalidation is performed once every 60 seconds for targets that do not meet the conditions in altitude or range. Revalidation is performed once per 10 seconds if the intruder becomes a near threat in altitude or range. Finally, regular active surveillance is performed once per second on intruders that become a near threat in both altitude and range. In this manner, passive surveillance (once validated) is used for non-threatening intruders thus lowering the ACAS interrogation rate. Active surveillance is used whenever an intruder becomes a near threat in order to preserve ACAS independence as an independent safety monitor.*

#### 4.5.1.1 DEFINITIONS

**Active surveillance.** The process of tracking an intruder by using the information gained from the replies to own aircraft's ACAS interrogations.

~~**Active track.** A track formed by measurements gained by active interrogation.~~

**Hybrid surveillance.** The process of using active surveillance to validate and monitor other aircraft being tracked principally using passive surveillance in order to preserve ACAS independence.

**Initial acquisition.** The process of starting the formation of a new track upon receipt of a squitter from a Mode S aircraft for which there is no track by making an active interrogation.

~~**Initial validation**~~**Validation.** The process of verifying the relative position of a ~~an intruder new track~~ using passive information by comparing it to the relative position obtained by active interrogation.

**Passive surveillance.** The process of tracking another aircraft without interrogating it, by using the other aircraft's extended squitters. ACAS uses the information ~~contained in passive tracks~~ obtained to monitor the need for active surveillance, but not for any other purpose.

**Passive track.** ~~After initial acquisition, a track maintained without active interrogation, using information contained in extended squitters.~~

4.5.1.2 An ACAS equipped to receive extended squitter airborne position reports messages for passive surveillance of non-threatening intruders shall utilize this passive position information in the following manner.

#### 4.5.1.3 PASSIVE SURVEILLANCE

4.5.1.3.1 ~~Initial Validation validation. At initial acquisition of an aircraft reporting~~ To validate the position of an intruder reported by extended squitter information, ACAS shall determine the relative range and relative bearing as computed from the position and geographical heading of own aircraft and the intruder's position as reported in the extended squitter. This derived range and relative bearing and the altitude reported in the squitter shall be compared to the range, relative bearing and altitude determined by active ACAS interrogation of the aircraft. Differences between the derived and measured range and relative bearing and the squitter ~~and squitter~~ and reply altitude shall be computed and used in tests to determine whether the extended squitter data is valid. If these tests are satisfied the passive position shall be considered to be validated and the track shall be maintained on passive data unless it is a near threat as described in 4.5.1.4 below. If any of the these above validation tests fail, the track active surveillance shall be declared an active used to track the intruder and no further use shall be made of the subsequent passive surveillance data received for this track.

*Note.— Suitable tests for validating extended squitter data information for the purposes of ACAS hybrid surveillance can be found in RTCA/DO-300.*

4.5.1.3.2 **Recommendation.**— *The following tests should be used to validate the position reported in the extended squitter message:*

~~+slant range difference| ≤ 200 m; and~~

~~+bearing difference| ≤ 45 degrees; and~~

~~+altitude difference| ≤ 100 ft.~~

4.5.1.3.3-2 **Supplementary active interrogations.** In order to ensure that an intruder's track is updated at least as frequently as required in the absence of extended squitter data (4.3.7.1.2.2), each time a track is updated using squitter information the time at which an active interrogation would next be required shall be calculated. An active interrogation shall be made at that time if a further squitter has not been received before the interrogation is due.

4.5.1.4 **Near threat.** An intruder shall be tracked under active surveillance if it is a near threat, as determined by separate tests on the range and altitude of the aircraft. These tests shall be such that an intruder is considered a near threat before it becomes a potential threat, and thus triggers a traffic advisory

as described in 4.3.3. These tests shall be performed once per second. All near threats, potential threats and threats shall be tracked using active surveillance.

*Note.— Suitable tests for determining that an intruder is a near threat can be found in RTCA/DO-300.*

4.5.1.4-5 *Revalidation and monitoring.* If the following condition is met for a track being updated an aircraft is being tracked using passive surveillance, periodic active interrogations shall be performed to validate and monitor the extended squitter data as required in 4.5.1.3.1. The default rates of revalidation shall be once per minute for a non-threat and once per 10 seconds for a near threat. data:

a)  $|a| \leq 10\,000$  ft and either;

b)  $|a| \leq 3\,000$  ft or  $|a - 3\,000 \text{ ft}| / |\dot{a}| \leq 60$  s; or

c)  $r \leq 3$  NM or  $(r - 3 \text{ NM}) / |\dot{r}| \leq 60$  s;

where:  $a$  = intruder altitude separation in ft

$\dot{a}$  = altitude rate estimate in ft/s

$r$  = intruder slant range in NM

$\dot{r}$  = range rate estimate in NM/s

an active interrogation shall be made every 10 seconds to continuously revalidate and monitor the extended squitter data for as long as the above condition is met. The tests required in 4.5.1.3.1 shall be performed for each interrogation, and active surveillance shall be used to track the intruder if. If any of these revalidation tests fail, the track shall be declared an active track.

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4.5.1.5.1 All near threats, potential threats and threats shall be tracked using active surveillance.

4.5.1.6 A track under active surveillance shall transition to passive surveillance if it is neither a near/potential nor a threat. The tests used to determine it is no more a near threat shall be similar to those used in 4.5.1.4 but with larger thresholds in order to have hysteresis which prevents the possibility of frequent transitions between active and passive surveillance.

*Note.— Suitable tests for determining that an intruder is no longer a near threat can be found in RTCA/DO-300.*

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**ATTACHMENT B** to State letter AN 7/1.3.96-09/57

**RESPONSE FORM TO BE COMPLETED AND RETURNED TO ICAO TOGETHER WITH ANY COMMENTS YOU MAY HAVE ON THE PROPOSED AMENDMENTS**

To: The Secretary General  
 International Civil Aviation Organization  
 999 University Street  
 Montreal, Quebec  
 Canada, H3C 5H7

(State) \_\_\_\_\_

Please make a checkmark (✓) against one option for each amendment. If you choose options “agreement with comments” or “disagreement with comments”, **please provide your comments on separate sheets.**

|  | <i>Agreement without comments</i> | <i>Agreement with comments*</i> | <i>Disagreement without comments</i> | <i>Disagreement with comments</i> | <i>No position</i> |
|--|-----------------------------------|---------------------------------|--------------------------------------|-----------------------------------|--------------------|
| Amendment Annex 10 — <i>Aeronautical Telecommunications</i> , Volume IV — Surveillance and Collision Avoidance Systems (Attachment B refers) |                                   |                                 |                                      |                                   |                    |

\* “Agreement with comments” indicates that your State or organization agrees with the intent and overall thrust of the amendment proposal; the comments themselves may include, as necessary, your reservations concerning certain parts of the proposal and/or offer an alternative proposal in this regard.

Signature \_\_\_\_\_

Date \_\_\_\_\_

— END —