Importation of ammonium nitrate through Esperance

ICI Australia Operations Pty Ltd

Report and recommendation
of the Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 618
March 1992

THE PURPOSE OF THIS REPORT

This report contains the Environmental Protection Authority's environmental assessment and recommendations to the Minister for the Environment on the environmental acceptability of the proposal.

Immediately following the release of the report there is a 14-day period when anyone may appeal to the Minister against the Environmental Protection Authority's recommendations.

After the appeal period, and determination of any appeals, the Minister consults with the other relevant ministers and agencies and then issues his decision about whether the proposal may or may not proceed. The Minister also announces the legally binding environmental conditions which might apply to any approval.

APPEALS

If you disagree with any of the assessment report recommendations you may appeal in writing to the Minister for the Environment outlining the environmental reasons for your concern and enclosing the appeal fee of $10.

It is important that you clearly indicate the part of the report you disagree with and the reasons for your concern so that the grounds of your appeal can be properly considered by the Minister for the Environment.

ADDRESS

Hon Minister for the Environment
18th Floor, Allendale Square
77 St George's Terrace
PERTH WA 6000

CLOSING DATE

Your appeal (with the $10 fee) must reach the Minister's office no later than 5.00 p.m. on 10 April 1992.

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1. Introduction

ICI Australia Operations Pty Ltd propose to import ammonium nitrate through Esperance. The referral of this proposal to the Environmental Protection Authority results from a requirement of the conditions set by the Minister for the Environment in 1990 on a similar proposal (two shipments of ammonium nitrate in August and September 1990) by the proponent.

The proponent referred the current proposal to the Environmental Protection Authority on 30 November, 1990. The Authority set the level of assessment at Consultative Environmental Review (CER), and issued guidelines for the preparation of the CER documentation to the proponent.

In 1990, the Environmental Protection Authority had recommended against the importation of the two shipments, because the individual fatality risk levels in the residential area from the importation were greater than the Environmental Protection Authority's criterion. The Minister for the Environment considered that the proposal could proceed subject to strict requirements and issued the environmental conditions referred to above.

The proponent provided the CER to the Authority on 21 November, 1991 and also distributed copies for public review to statutory authorities, the Goldfields-Esperance Development Authority, the Esperance Shire Council, the local and state libraries. The Authority sought comments on the proposal during a five-week public review period which ended on 3 January, 1992. During that period the proponent held an "open day" at the Esperance Port Authority building in Esperance and advertised the proposal locally. The "open day" provided the opportunity for members of the public to obtain further information on the environmental impacts of the proposal from the proponent and to lodge submissions with the Environmental Protection Authority (which was represented at the "open day"). The Authority has reviewed the submissions in this report.

2. Description of the proposal

The elements of the proposal are:

- there would be eight x 2000 tonne shipments per year
- ammonium nitrate would be imported in one tonne "bulka bags"
- some ammonium nitrate would be directly loaded from the ship to road or rail vehicles for transport to Kalgoorlie, and the remainder would be stored on an interim basis in the storage sheds at the Port of Esperance prior to such transport.

The ammonium nitrate in this proposal would be used in explosives manufacture, but is not itself explosive. The specification for this product is similar to that of NITRAM, and is a "prilled", high density 99.5% purity material.

The logistics of the transport operations will determine whether the ammonium nitrate is immediately transhipped by road or rail to Kalgoorlie and how much remains in interim storage.

3. Public submissions

The Authority received five submissions on the proposal.

3.1 Issues raised in submissions

Issues raised in submissions included:

- alternative ports;
- transportation risks;
- emergency response planning;

- informing the public on activities and emergency response plans; and
- assurance on assumptions used in the risk analysis.

3.2 Proponent's response to issues raised in submissions

Following the receipt of submissions the EPA formulated a set of questions to the proponent relating to the issues raised in submissions. These questions and the proponent's responses have been provided in Appendix 1. A list of those who made submissions is provided in Appendix 2.

4. Environmental assessment

The key environmental issue associated with the importation is that of the individual fatality risk level in the residential area. ICI engaged a risk consultant to determine the levels of risk associated with the proposal. The results were presented in the CER and its supplement (the Preliminary Risk Analysis). The results show that the level of individual fatality risk from the proposal to import 16,000 tonnes per annum of ammonium nitrate is less than the Environmental Protection Authority's criterion for acceptable levels of risk from industry on residential zones. The Authority's individual fatality risk criterion for residential zones is one in a million per year ($1 x 10^{-6} y^{-1}$). This criterion is that for residential zones given in the Authority's Bulletin 278, which was applicable at the time of the assessment, and is also the value which is used for residential zones in the Authority's recently published Bulletin 611.

The levels of risk for the current proposal are significantly less than those calculated for a similar proposal in 1990. Both analyses were by the same consultant. The reason for the difference is that in the earlier report the consultant considered that the issue of principal concern was the emission of the toxic gas nitrogen dioxide resulting from the decomposition of ammonium nitrate in the event of a fire on board the ship. In the latest risk analysis the risk consultant has used significantly lower values (than used in the earlier report) for the concentration of and the rate of emission of nitrogen dioxide in the event of such a fire.

The change in these values were supported by experimental testwork conducted by ICI in their laboratories in Ardeer, Scotland. As these changes significantly affect the risk levels, the Authority sought and received independent verification of these values from the Dutch organisation TNO. The Department of Mines has reviewed the risk assessment and, taking into consideration TNO's advice, has found it to be technically sound.

The risk contours from the analysis of the present proposal are presented in Figure 1 and the risk contours from the analysis of the two shipments that occurred in 1990 are presented in Figure 2.

State and Commonwealth agencies will control the safety of shipping, storage, road and rail transport through relevant codes and regulations. The Esperance Emergency Management Plan, which includes a specific plan for the handling of ammonium nitrate, will provide an emergency response plan for the residual risk .

The Authority considers that the above controls provide adequate assurance that the importation will be managed in an environmentally acceptable manner.

The Environmental Protection Authority therefore considers the proposal to be environmentally acceptable.

Recommendation

The Environmental Protection Authority concludes that the proposal by ICI Australia Operations Pty Ltd to import 16,000 tonnes per annum of ammonium nitrate through Esperance, as detailed in the Consultative Environmental Report, its supplement and responses to questions resulting from the assessment process, is environmentally acceptable and recommends that the proposal could proceed.

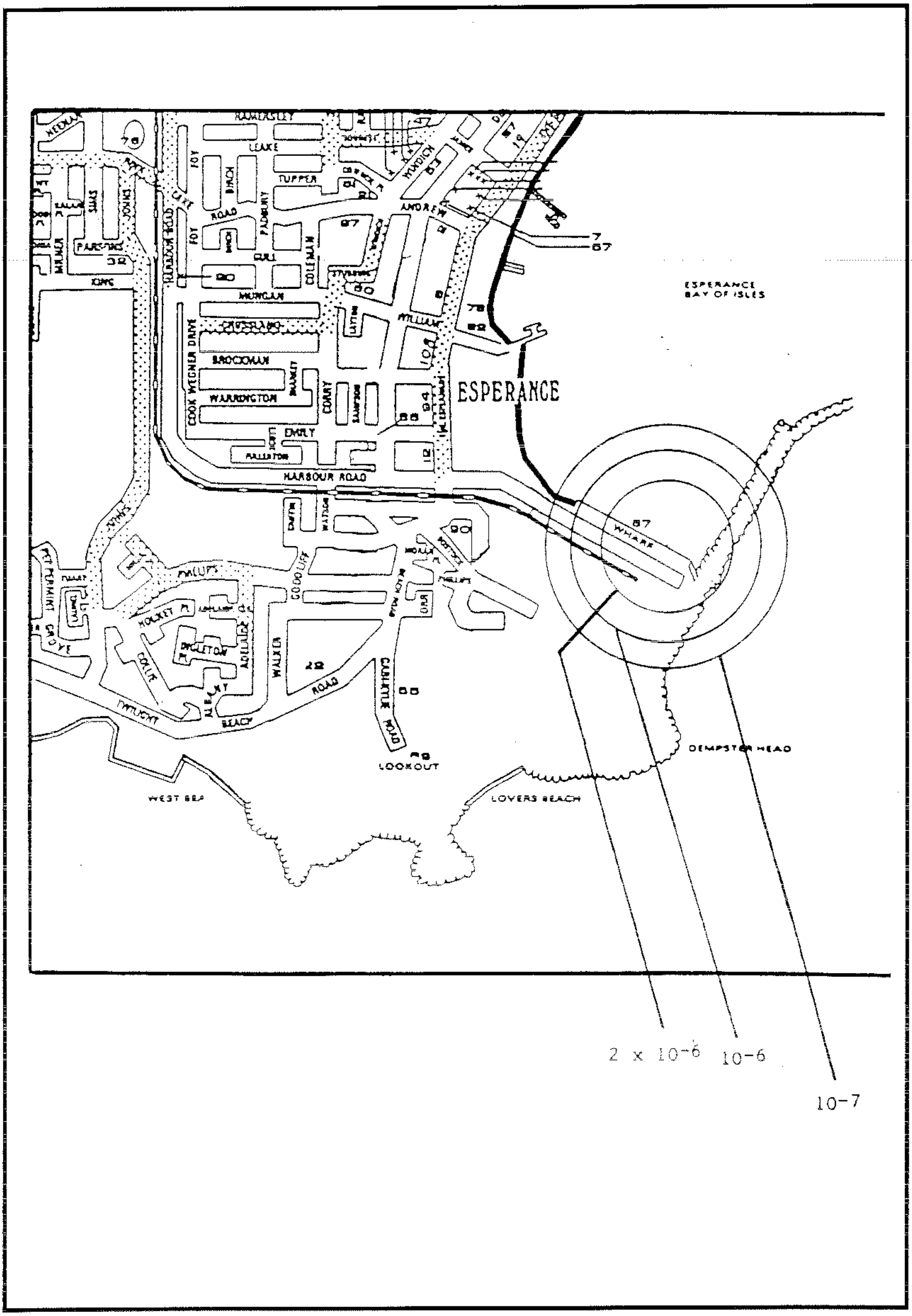

Figure 1. Risk contours from the analysis of the present proposal (Bureau Veritas, October, 1991)

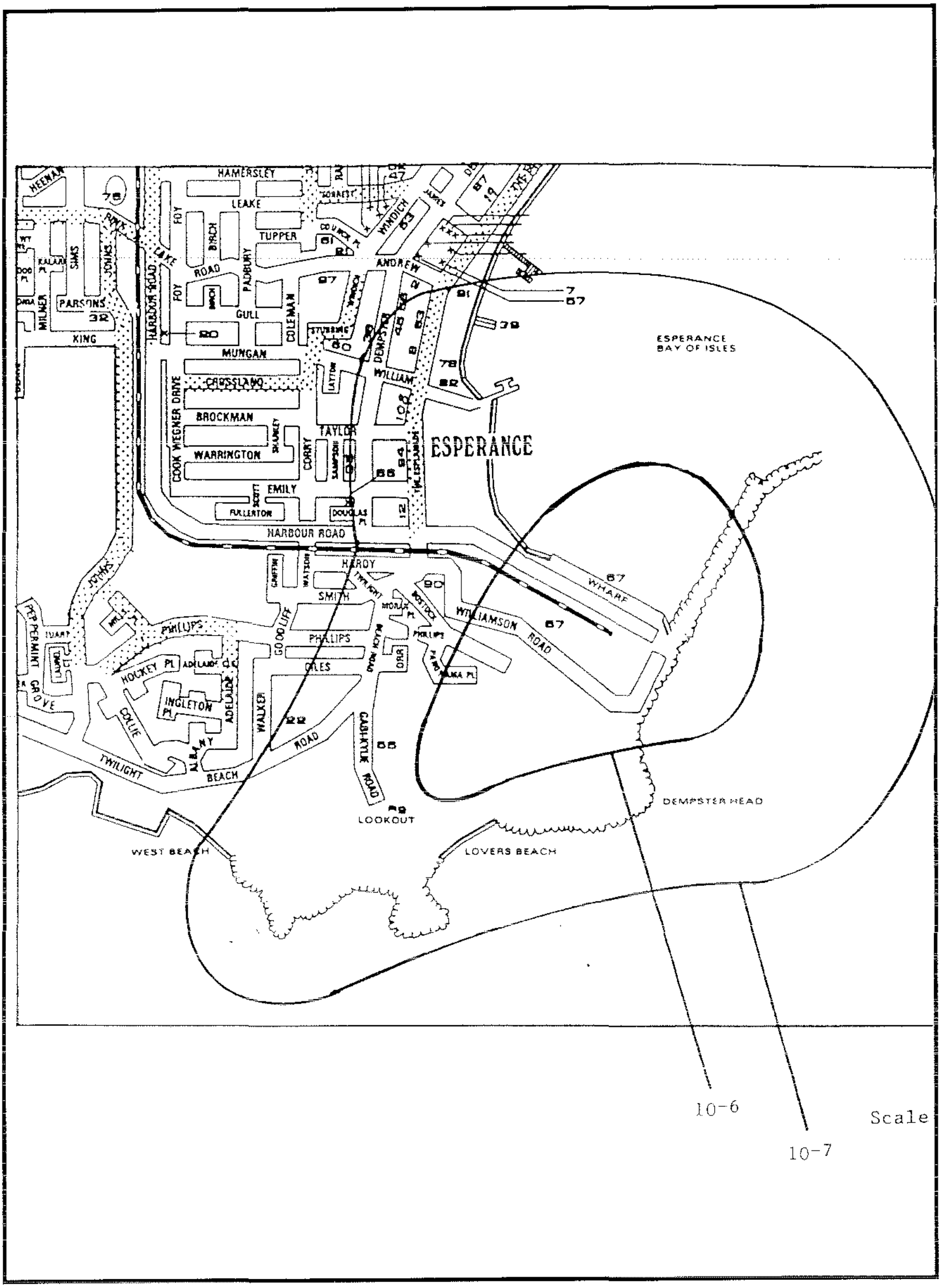

Figure 2. Risk contours from the analysis of the two ammonium nitrate shipments in 1990 (Bureau Veritas, June, 1990)

5. References

Bureau Veritas, *Quantitative assessment of the risks associated with the shipping and handling of ammonium nitrate through the Port of Esperance (1 ton bulka bags packaging)*, June 1990.

Environmental Protection Authority, *Environmental Protection Authority Guidelines, risks and hazards of industrial developments on residential areas in Western Australia,* Environmental Protection Authority Bulletin 278, May 1987.

Environmental Protection Authority, *Ammonium nitrate importation through the Port of Esperance,* Environmental Protection Authority Bulletin 443, July 1990.

Environmental Protection Authority, *Criteria for the assessment of risk from industry,* Environmental Protection Authority Bulletin 611, February 1992.

ICI Australia Operations Pty Ltd, *Consultative Environmental Review, import of ammonium nitrate through Esperance*, 1991.

ICI Australia Operations Pty Ltd, *Supplement to Consultative Environmental Review, Preliminary Risk Assessment, import of ammonium nitrate through Esperance,* 1991.

Appendix 1

Questions and issues raised in submissions and the proponent's responses

QUESTIONS

1 Heavy road traffic increases during the harvesting season. Has the proponent considered the increase in risk resulting from this traffic during the period of ammonium nitrate import?

2 Has the proponent considered the rail transport option. If yes, what was the conclusion and if, is it prepared to do so?

3 Has the proponent presented its emergency response plan for potential emergencies during unloading at the port or transport, including truck accidents?

4 Is the proponent willing to keep the people of Esperance informed about ammonium nitrate activities in its area, and if so, how will proponent do this?

5 Is the proponent prepared to review its activities after a one year period in consultation with the people of Esperance?

6 What impact would ammonium nitrate spillage have on waters in the Port or land if spillage were to occur, and how would spillage be cleaned up?

7 Why does the CER not contain a risk analysis for accidents outside the Port facility? Why does it not also carry a risk study for transport of ammonium nitrate through the Town of Esperance.

8 Why was the Port of Esperance chosen for off loading when other ports are available in the State which carry a lesser risk?

9 There is a Draft Esperance Emergency Management Plan for Esperance. Has the proponent consulted with the Esperance Emergency Management Committee? Why has the proponent not incorporated its emergency procedures on fire and explosion into the plan.

10 What assurance can the proponent provide that the assumptions for the risk analysis on temperature, toxicity, fume buoyancy and fume composition are accurate?

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ENVIRONMENTAL PROTECTION AUTHORITY
23 MAR 1992
File No 103/90 Initials GPE

FAX TO	:	Mr Geoff Penno Environmental Protection Authority PERTH WA
FAX NO	:	09 322 1598
FROM	:	Richard Morony
REPLY FAX NO	:	418 5596
DATE	:	19 March 1992
RE	:	AMMONIUM NITRATE SHIPMENTS THROUGH ESPERANCE

Geoff,

Following is an amended copy of my answers to the questions posed by the EPA after consideration of ICI's CER.

If you have any queries I am of course available.

Regards,

Richard Morony

Richard Morony
TECHNOLOGY MANAGER, NITRATES

54772

RESPONSES TO QUESTIONS FROM EPA - 15.1.92

1. ICI has no wish to compete for transport resources in the harvest season and would aim to schedule shipments to avoid arrival during the harvest season. See Q2 answer below.

2. ICI has considered the rail transport option and envisages future shipments will be handled in a similar manner to the two shipments which arrived in August 1990. Handling logistics will determine the precise percentage of product forwarded by road or rail, ie. approximately 70% of the product was railed to Kalgoorlie. All relevant transport Codes and Regulations will be adhered to by ICI

3. The preparation of an emergency response plan is the responsibility of the Port Authority and local emergency services.

   ICI have assisted with the drafting of the Esperance Emergency Plan with particular reference to the behaviour of ammonium nitrate under stress. ICI understands that the final draft is awaiting Mines Department review.

4. It is routine practice for ship movements to be advertised in the 'Esperance Express'. These advertisements are placed by the Port Authority and routinely advise the nature of the cargo.

5. ICI has already consulted with the people of Esperance and has found a high level of support for its proposal to import ammonium nitrate.

   In view of the amount of work and consultation which has gone into the environmental assessment of this proposal ICI is firmly of the view that a review after 12 months is not necessary. Should, however, any incident involving UN2067 grade ammonium nitrate occur <u>anywhere in the world</u> over the first 12 months ICI would consult with the people of Esperance in an appropriate manner (in consultation with the EPA).

6. ICI cannot envisage any circumstances other than a ship sinking which would cause ammonium nitrate to be spilt into the waters in the port. ICI's CER draws particular attention to the fact that ships chartered for this traffic will be required to enter Esperance Harbour through the main shipping channel and <u>not</u> take the type of 'short cut' which caused the 'Sanko Harvest' to founder.

   Any spillage occurring at the port will be shovelled into spare empty Flexible Intermediate Bulk Containers - a supply of which will be on hand for the product arrival.

7. The Risk Analysis required by the Environmental Protection Authority did not include transport risks.

ICI will adhere to all relevant transport regulations and codes for the rail and road transport of its products.

8. ICI has not and will not accept claims that ammonium nitrate importing is a particularly risky operation. On the contrary ICI has expended a major technical effort to prove this claim in unambiguous terms.

Having expended this effort and provided the proof ICI considers it should be free to choose its import location(s) on commercial criteria.

9. As mentioned in its response to (3) above, the emergency plan is not an ICI document. However, as noted in the response to Question 3, ICI has assisted with the drafting of this document and understands the final draft is now awaiting Mines Department review.

ICI is prepared to undertake that no ammonium nitrate shipments will be imported through Esperance until these procedures are in place.

10. In the Risk Assessment the Probit Concentrations for toxicity are those used by professional Risk Consultants.

For Fume Composition, actual verified gas compositions from laboratory scale tests have been quoted in the CER document and its supplement.

The fume modelling has been done by a professional consultant using best estimates of temperature and actual meteorological data for Esperance.

The fume plume toxicity is so low it makes very little contribution to the risk contour.

ICI has provided proof from:

- the technical literature
- actual experiments on the product
- independent verification of these experiments

and understands the EPA is retaining the TNO to further review ICI's work.

R J Morony
January 1992

Appendix 2

List of those who made written submissions

List of organisations and individuals who made submissions

Department of Mines

Western Australian State Emergency Service

Esperance Emergency Management Committee

Local Environmental Action Forum

Rogers, R

Thornton, T

Appendix 3

TNO report on the ICI testwork undertaken to determine parameters used in the risk assessment

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TNO Defence Research

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Date
March 9, 1992

Our ref.
92 TR 317

Subject
Ammonium Nitrate shipping Esperance

Your letter
103/90

Please find enclosed my report concerning the review of test work and experimental data used in the supplement to consultative environmental review preliminary risk assessment by ICI.

Dr. A.H. Heemskerk
Explosion Safety Department

54759

Enclosures

1. INTRODUCTION

The Environmental Protection Authority in Perth, Western Australia requires proponents for proposals which are hazardous and likely to impose a risk on surrounding land uses, to undertake a quantitative risk assessment. A proposal was made by ICI for the importation of about 8 by 2000 tonne shipments of ammonium nitrate (AN) per annum into the Port of Esperance in stead of the presently approved 400 tonne per shipment. The proposal, thus, implies a change in packaging and in quantity.

On behalf of ICI a risk assessment was undertaken by Bureau Veritas. The findings of the report in question were refined in a supplement (report no. PER 491238, October 1991 [1]). The refinements included a reduction in the NO_2 emission rate and concentration, a smaller decomposition rate and an increased temperature range in the AN.

A basis for these changes was report no. 894 [2] provided by ICI, Scotland which presented the results of experimental work on the AN in question. EPA of Western Australia requested TNO-PML to review both the ICI report no. 894 with respect to techniques and methodology and the implications of this report for the large-scale handling conditions.

2. ICI REPORT NO. 894

2.1 EXPERIMENTAL TECHNIQUES AND METHODOLOGY

Four main techniques were used in ICI report no.894:

- a DSC scanning technique,
- a Dewar technique,
- a burning test technique,
- an explosion test technique.

2.1.1 DSC TECHNIQUE

The DSC scanning technique is widely used and well recognized. Its application is primarily useful to obtain a general impression of the stability of a chemical compound by indicating both the temperature ranges during which heat effects are encountered and the amount of heat involved, and to detect whether or not combinations of materials are incompatible.

Neither the temperature ranges nor the heat effects obtained by DSC can be used for scaling purposes because of the small mass of the sample, the scanning procedure and the deviation in the DSC operating conditions as compared with plant/handling conditions. The incompatibility of materials is well shown by changes in the combination of onset temperature and heat of reaction.

A number of conclusions can be drawn from the DSC traces as provided in ICI report no. 894. By comparing the DSC traces of CPAN and NITRAM it appears that both traces are similar. Both show transformations in the solid-phase at approximately equal temperatures and depending on water traces in the AN compounds. The transformations are conform expectations as the main difference in both compounds is the physical structure (powder, prills). This affects reaction rates in the solid-phase (contact areas). In the liquid-phase they are expected to show similar properties. TNO-PML DSC traces of AN are comparable to the traces in the document [3]. Moreover, AN phase transitions in the solid phase correspond to tests in other types of equipment.

The compatibility scans with polyethylene and woodshavings show that an exotherm is introduced at about 200 °C. The (DSC) onset temperature of the exotherm reduces at the introduction of woodshavings. Thus, neither NITRAM nor CPAN are compatible with organic (combustible) material. The amount of combustible material in the AN compounds has to be restricted. Therefore, when transporting under the UN 5.1 no. 2067 classification the amount of combustibles is restricted to 0.2% (the NITRAM consisting of more than 90% AN).

It is concluded from the DSC measurements that CPAN and NITRAM are fully comparable. (Involuntary) mixing with other materials amongst which combustible matter must be carefully avoided. This implies segregate transport and storage and careful handling to this aspect.

2.1.2 DEWAR TECHNIQUE

Dewar testing is a well recognized possibility to investigate run-away conditions. This kind of technique is applied at a number of specialized laboratories. The amount of material implies that plant material is better represented. The size of the vessel allows scaling to a volume of some cubic meters depending on the properties of the Dewar vessel.

The Dewar technique showed a long stability of AN upon melting. This is supported by our own observations in which no run-aways were observed as long as overpressure could be avoided even at temperatures up to about 240 °C. These PML tests were performed on a scale up to about 400 grams in insulated and heated vessels. The trace at fully confined conditions shows a run-away. Onset temperatures of the run-away decrease strongly at contamination by combustible matter. This indicates that full confinement and contamination must be avoided.

already decreases the stability of the AN beyond acceptation. The confined Dewar experiments, for instance, show bursting of the rupture disk at temperatures as low as about 130 °C. This feature is behind the reasoning why AN may only be transported in class 5.1 UN no. 2067 (more than 90% AN) if it contains less than 0.2% organic material calculated as carbon. In case of aliphatic chains this will, indeed, be approximately 0.3% in weight. The carbon content may be increased to 0.4% if the UN no. 2067 contains between 70 and 90% of AN (which is not the case in the discussed shipments). The content of combustibles is a very sensitive parameter. The organic contents is based on a homogeneous distribution (i.e. intimately mixed).

Non-homogeneous distribution (i.e. poorly mixed) will affect initiation properties. Burning properties in the liquid AN are less depending on initial distribution because of the resulting improved mixing. Non-homogeneous distribution will introduce a more local burning which will not spread as fast in comparison with homogeneous distribution.

As contamination has to be avoided this has to be reflected in the handling and management procedures. The possibility of contamination is minimum if the AN is transported in the FIBC's.

2.4 COMPATIBILITY WITH FIBC MATERIALS

The FIBC material consists of polypropylene (strength) with a polyethylene inner liner (water proofness). The compatibility properties of polypropylene and polyethylene to AN are similar. The contact area with the polyethylene inner liner is small. It is an example of non-homogeneous distribution. It is not expected that both compounds will initiate or accelerate the low-temperature decomposition. Only if the FIBC is subjected to flames or very high temperatures melting and subsequent mixing with small (local) volumes of AN is expected, thus, reducing a propagation of the burning through the AN bulk. Furthermore, the FIBC tends to reduce spreading of molten AN. All these features are reflected by the burning tests that were performed by ICI on FIBC's with AN. These burning tests show that one-sided exposure to high temperature didn't invoke burning of adjacent FIBC's.

2.5 CONFINEMENT

Tests in the confined Dewar vessel show a fast decomposition reaction. The run-away into a fast decomposition is facilitated if combustible matter is mixed with AN. The Dewar experiments show that the gas production rate is such high in this case that venting of a large storage of AN will not be successful. Thus, similar conditions in storage are to be avoided by eliminating ignition sources, by avoiding contamination and by providing vent lines.

2.6 CONCLUSIONS

Basic conclusions from the experimental results are, that

- NITRAM has no detonation properties,
- NITRAM does only burn at extreme temperature and pressure conditions,
- the AN is stable at low temperatures,
- NITRAM does readily decompose in contact with combustible matter at only slightly elevated temperatures.
- contamination of the NITRAM has to be avoided,
- the main hazard from NITRAM follows from the decomposition reactions,
- the decomposition only occurs at elevated temperatures higher than the melting-point,
- The decomposition reaction may lead to vigorous gas productions which are to be adequately vented.

3. LARGE-SCALE CONSEQUENCES

3.1 TRANSPORT HAZARD SOURCE

The NITRAM as transported is characterized as UN class 5.1 no. 2067 material. Moreover, it was tested according to EC 87/94. The criteria for both these test methods are aimed to exclude detonation properties of the AN tested. As NITRAM is stated to meet both types of classifications, it is regarded not to detonate. This item is further supported by the Henkin test. In view of the criteria mentioned the NITRAM may not contain more than 0.2% organic material calculated as carbon as the transported composition contains not less than 90% AN. The classification changes to class 1 if it does contain more than 0.2% organic material.

Self-heating into burning is not to be expected under transport conditions. Fire in the hold itself can be excluded on ground of transport rules for oxidizing chemicals. Thus, the only potential reason for a run-away can be an exposure to a hot wall (or bottom) of the hold.

If the AN is subjected to a hot wall it will start to heat, to melt and to decompose slowly. In practice, the gas generated during this process can be vented from both the FIBC and from the hold by the ventilation shafts. In case of the slow heating process under ventilation it appears that the temperature steadies between 230 and 280 °C. Higher temperatures are unlikely unless heat is continuously input into the AN. In case of the FIBC's the heated area is local and relatively small. The effect of the PP and PE clothing is limited as a local effect. In fact, the bulk of AN will rather be shielded from the high wall temperature.

3.2 THE DECOMPOSITION RATE

The decomposition rate was not based on the experiments report in ICI report no. 894 but on literature [4]. A number of rate equations is available in literature. These equations (including TNO rate data) are summarized in figure 1 [4]. It appears that all rate data match within a factor of about 10. The Keenan reaction rate is somewhat low at temperatures up to 250 °C. However, this rate becomes a good average at higher temperatures because of its high slope. The calculations based on Keenan, thus, are acceptable. Moreover, a safety factor of 15 was included, which accounts for the whole range of rates available in literature. It does account for a small pressure built-up as well, but definitely will not account for the reaction rates encountered if extremely high pressures are achieved (i.e. fully confined conditions). However, the occurrence of such high pressures is not expected as discussed above.

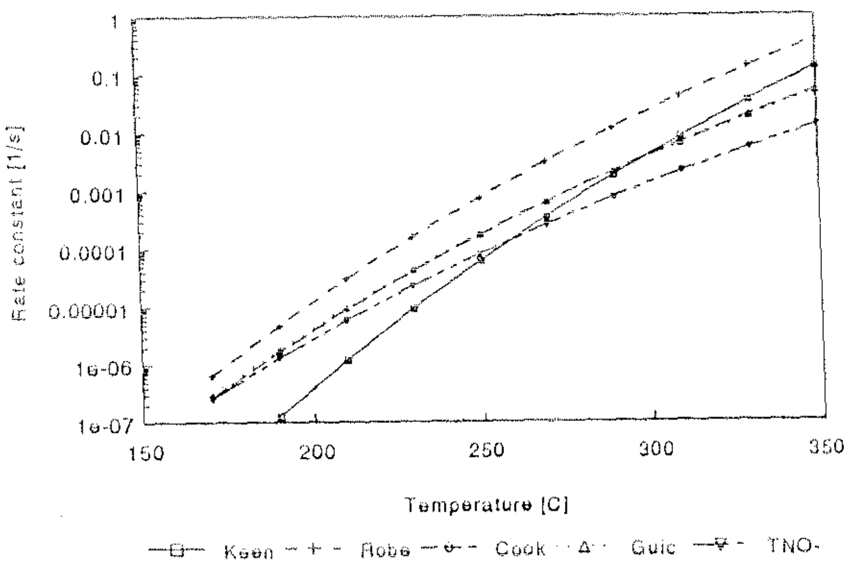

Figure 1: Comparison of decomposition rate data.

3.3 THE GAS PRODUCTION RATE

The gas production rate and composition depends on temperature and on the AN decomposition rate. The gas composition is estimated to contain amongst others HNO_3, NH_3, N_2, N_2O, NO and N_2O_4 (NO_2) and H_2O. The lower oxides of nitrogen will be further oxidized in air. The concentrations in air will depend on the burning rate of the source. The burning rate in the ICI supplement report was assumed to be caused by exposing a one-tonne FIBC bag to a wall subjected to a fire at the other side of the wall.
The composition of the produced gas was recalculated to a production of NO_2 (N_2O_4) only, being the most toxic gas component. This is estimated to be a conservative approach, and thus, acceptable.
My conclusion to the basic data and formulae as used in the ICI supplementary report for preliminary risk assessment is that they are acceptably conservative in view of the present know-how.

3.4 CUMULATIVE FACTORS

Impressive discussions amongst experts on toxicity have not yet revealed a more or less unanimous approach to the issue of cumulative factors (such as an approach in case of mixtures of toxic gases). Therefore, there is no procedure to treat mixtures of toxic gases at this moment. The present procedure applied by TNO is to treat each of the gases individually and to apply the worst case to the risk contours.

Calculating an equivalent concentration of NO_2 on basis of NO_2, NH_3 and HNO_3 can only be regarded as a conservative approach in the sense that the concentration value used in the calculations, is higher. However, there is no factual evidence concerning the representativeness of this approach with regard to toxicity: real effects might be both worse and less.

3.5 IGNITION SOURCE

Fires do often occur on board of ships. Most fires can be attributed to either self-heating (shipping of unstable materials such as coal, oily seeds, etc.) or ignition (undesired ignition of flammable materials on board). The transport of potentially self-heating materials in adjacent holds is not recommended (within the hold with AN is forbidden!).

The main source of external fire remains the ignition of flammable materials: for instance, a fire in the engine-room. In contrast to fires in bulk, fires in engine-rooms can be extinguished in a restricted period of time. Temperatures in such a fire are high but the heat load on engine-room walls is limited in time. The temperature in an FIBC adjacent to the hot spot of the wall will start to rise locally. The temperature of the decomposing AN will remain below about 280 °C as long as the generated gas can be vented by the ventilation shafts. In practice, temperatures exceeding about 350 °C will hardly occur. Basing the decomposition rates on temperatures up to about 350 °C is an acceptable approach. The data as provided by the ICI report no. 894 are sufficient in this respect, the more so as all gas generated is recalculated as the most toxic component NO_2 (N_2O_4).

3.6 RUN-AWAY CONDITIONS IN THE SHIPHOLD

Pressure (confinement) may affect the decomposition rate. Pressure effects are not expected as long as the produced gas can be vented. According to FIBC tensile and melting properties (loosening tensile strength at about 150 °C and melting at about 165 to 175 °C) the FIBC itself will not withstand high internal pressure. Moreover, gas is likely to be vented by the FIBC filling opening thus further reducing the maximum possible internal pressure. As a consequence pressure rises in the FIBC's are not expected.

A pressure rise in the shiphold will only take place if the generated gas cannot be vented from the hold. Most holds have ventilation shafts to each hold. These shafts should be sufficient to vent the generated gas. Only in case of a high temperature, fast decomposition reaction the shafts may be incapable to vent the generated gas. The venting capacity in case of open hatches is sufficient.

As point of concern is mentioned the polyethylene/polypropylene material of the FIBC. The percentual amount of PE/PP with respect to the AN contents is low, but it is "highly concentrated" because of its distribution. The distribution implies that the initiation reaction may be more fierce, but that the propagation of a burning front will not be stimulated. The small scale testing is not fully representative for this case. The large scale tests on FIBC's as mentioned in the ICI supplementary report are more representative. These experiments, indeed, show that adjacent FIBC's are shielded from the fire.

4. CONCLUSIONS

- NITRAM and CPAN show similar properties.
- NITRAM doesn't show detonation properties.

- The small-scale experiments imply that contamination of the AN by combustible matter must be avoided.
- Management procedures should reflect procedures by which such a contamination can be avoided.
- The main hazard from NITRAM follows from the decomposition reaction.
- The decomposition rate equation used in risk assessment document sufficiently reflects the decomposition properties.
- Recalculation of the produced gas into NO_2 results in a conservative NO_2 concentration.
- The present treatment of mixtures of toxic gases is based on the individual risks of the components. The risk contours reflect the contours of the worst component.
- Self-heating of AN into decomposition is not a feasible scenario.
- Exposure to external heat sources is the main hazard for decomposition of AN.
- Temperature rises up to about 280 °C can readily be expected as long as the produced gas can be vented.
- The effect of PE/PP material of the FIBC is expected to remain within the internationally accepted regions.
- The basic data as used in the ICI supplement to the assessment report are acceptable.

REFERENCES

1. ICI report no. PER 491238: Supplement to consultative environmental review.
2. ICI report no. 894: Study of the effect of contaminants on the thermal decomposition of AN, W. Craig.
3. The thermal decomposition of ammonium nitrate, TNO-PML, C.M. Vermeulen, 1967.
4. IFA Technical conference: Investigations into the detonation of molten ammonium nitrate by falling objects., 1988, A.H. Heemskerk, Th.M. Groothuizen.
5. 6th Int. Symp. on Loss Prevention: Investigations into the initiation of detonation of molten ammonium nitrate by falling objects, 1989, P. Schuurman, A.H. Heemskerk.
6. Critical shock initiation parameters for molten ammonium nitrate, A. Bauer, Queens University.
7. TNO-PML Research Programme on behalf of IFA-APEA.