NOT PUBLICLY RELEASED

POLICY ISSUE

(Notation Vote)

October 5, 1987

SECY-87-186A

For: The Commissioners

From: Victor Stello, Jr.
Executive Director for Operations

Subject: DISTRIBUTION OF RADIOACTIVE GEMS IRRADIATED IN REACTORS TO UNLICENSED PERSONS (FOLLOW-UP TO SECY-87-186)

Purpose: To answer the Commission's questions raised in response to SECY-87-186, and to request Commission approval of staff recommendations regarding the radioactive gemstone issue.

Category: This paper covers a minor policy issue regarding application and enforcement of NRC regulations. However, it relates to two major policy issues: de minimis quantities of radioactive material and regulation of radioactive consumer products.

Issue: What regulatory position should NRC take with respect to radioactive gemstones?

Background: In SECY-87-186, dated July 28, 1987, the staff informed the Commission of its plans to stop distribution of neutron-irradiated gems in the U.S. from both U.S. and foreign reactors. The Commission did not approve the staff's plans, and the Staff Requirements Memorandum dated August 25, 1987 requested a more comprehensive paper. This paper provides a more comprehensive analysis of the gemstone issue. Additional discussion of specific questions and concerns raised by the Commissioners is provided in Enclosure 1. Additional information recently received from the American Gem Trade Association on the gemstone industry is provided in Enclosure 2.

The radioactive gemstone issue was not raised internally by the staff. It was raised by reactor licensees and others. Some were interested in entering the business; others questioned whether NRC had authorized distribution of radioactive gemstones. On the surface, the issue appears to be trivial, but it has escalated into a significant regulatory dilemma. The issue relates to

)NTACT:
)hn Hickey, NMSS
?-74248

A-1

several difficult regulatory areas, including <u>de minimis</u> quantities, "frivolous" consumer products, imports from foreign countries, and economics. Because a multi-million dollar industry is involved, several interested reactor licensees and other parties have complained to the staff of unfair and inconsistent regulation, and insist on an expeditious resolution.

The staff has verified that two reactor licensees are irradiating topaz. The University of Missouri is distributing the gems in the U.S., and the University of Virginia is exporting the gems. The University of Missouri recently submitted a paper directly to the Commission explaining its position in favor of continued distribution; the University also recently applied for a distribution license. The staff has also received numerous reports of extensive imports of radioactive topaz from foreign suppliers, and reports of limited topaz irradiation in the past by other U.S. research reactors. We also have two applicants for distribution licenses, GA Technologies and Nuclear Theory and Technologies. Officials from these two companies complain that they are being economically penalized for complying with NRC requirements by requesting proper authorization prior to beginning distribution.

In attempting to resolve this situation, the staff has weighed the uncertainties in health risk and our strict policy against the use of even small quantities of radioactive material in jewelry, against economic considerations, apparent inconsistencies in policies among different countries, and the lack of <u>de minimis</u> regulations. The staff also recognizes that development of a comprehensive <u>de minimis</u> policy, revised consumer product policy, and appropriate rule changes cannot be accomplished in a short time. In the meantime, the staff seeks an expeditious solution to the complaint that licensees are being economically penalized for complying with NRC regulations.

<u>Discussion</u>: The staff has identified three options for addressing the gemstone issue. They are: (1) stop distribution; (2) suspend distribution while developing appropriate rules governing distribution; and (3) allow interim distribution by issuing licenses pursuant to 10 CFR §32.11, with an exemption from that portion of §32.11(c) which prohibits application to a human being, while developing more appropriate rules governing distribution. The "pros" and "cons" for each option are identified below. The second and third options each contain two identical subset options for how to proceed with rulemaking.

The subset options for rulemaking are to develop (a) a specific rule governing exempt distribution of irradiated gemstones as a consumer product, or (b) a Commission policy which establishes a generally applicable _de minimis_ dose which would provide a basis for developing a spectrum of rules governing its application, including irradiated gemstones.

Developing a specific "consumer product" type of rule for irradiated gemstones would be the more straightforward and less time-consuming way to proceed. However, it would not provide a basis for handling other similar proposals which the Commission is likely to receive.

The suboption for a policy statement concerning a generally applicable _de minimis_ dose followed by implementing rules was derived from several restrictive considerations. First, a rule on _de minimis_ dose alone rather than a policy statement followed by specific implementing rules would be difficult to administer and could lead to compliance problems for reasons which are described in Enclosure 1. Second, a policy statement alone, without being followed by implementing rules, would not accomplish the goal since there are overriding prohibitions in current rules which would prevent its application, including the prohibition contained in 10 CFR §32.11(c). Thus, the staff suggests a policy statement followed by specific implementing rules as the best option for pursuing the _de minimis_ issue. It is similar to the procedure followed for developing exemptions of certain low-level waste streams (See SECY-86-204 and 86-304). This suboption for rulemaking has the advantage of addressing a broad spectrum of potential applications for a generally applicable _de minimis_ dose. It has the disadvantages of being more time-consuming and resource-intensive than resolving the gemstone issue alone. Also, a policy which establishes a generally applicable _de minimis_ dose is likely to be controversial if the dose is to be sufficiently high to have much utility.

Alternatives:

1. Stop distribution of neutron-irradiated gemstones (deny pending license applications and take enforcement action to stop unauthorized distribution as proposed in SECY 87-186).

   Pro:
   - Maintains current Commission policy and international guidelines on unjustified use of radioisotopes in consumer products.
   - Provides a clear, unambiguous basis for dealing with similar proposals by making the decision turn on the issue of justification of dose no matter how small, rather than on the level of dose.

- o Enforcement is relatively straightforward because identification of unauthorized distribution is based on color of topaz rather than radioisotope concentration.

<u>Con</u>:

- o Imposes economic hardship on an established industry by prohibiting a practice which appears to have acceptably small radiological consequences.
- o Denies the public a product it appears to want.

2. Suspend action on present license applications and stop unauthorized distribution while:

   (a) developing a rule specifically related to exempt distribution of irradiated gemstones, or

   (b) developing a policy statement for a generally applicable <u>de minis</u> dose followed by a specific implementing rule for gemstones.

<u>Pro</u>:

- o Provides for orderly development of appropriate rules by holding the line on distribution until radiological and public policy issues are resolved thorough the administrative process.

<u>Con</u>:

- o Imposes an economic hardship and denies public access to a desirable product in a manner similar to Alternative 1 above.
- o Puts the NRC in an ambiguous position with respect to the future licensability of irradiated gemstones.
- o Opens the door for similar proposals of questionable justification where decisions would turn on level of dose rather than justification for dose no matter how small.

3. Issue interim licenses for exempt distribution of irradiated gemstones pursuant to 10 CFR §32.11, with an exemption from that portion of §32.11(c) which prohibits application of products to a human being, while:

   (a) developing a more appropriate rule specifically related to exempt distribution of irradiated gemstones, or

(b) developing a policy statement for a generally applicable <u>de minimis</u> dose followed by a specific implementing rule for gemstones.

<u>Pro</u>:

- o Circumvents the economic hardship issue for a product which is believed to have an acceptably small radiological hazard.

<u>Con</u>:

- o Permits the continuation of a practice where the radiological risk and environmental impact is not fully assessed.
- o Implies that the Commission is prejudging the acceptability of the practice ahead of the analytical and deliberative process of rulemaking.
- o Opens the door for similar proposals of questionable justification where decisions turn on level of dose rather than justification of dose no matter how small.
- o Difficult to enforce requirements for distribution because determinations would be based on radioisotope concentration of topaz rather than color.

In coordinating this paper with the appropriate NRC offices, no strong consensus emerged favoring Alternative 2 over Alternative 3. Alternative 1 did not receive significant support. The argument in favor of Alternative 2 relates to the significant policy issues involved and the precedents the NRC's action will set regarding public exposure through radioactivity introduced into consumer products. Alternative 2 would permit orderly development of rulemaking through appropriate analysis and public participation in the administrative process, while enforcing existing rules which were established through the same process. As noted in this paper, the staff is also concerned about establishing adequate methods of regulatory control in the interim until appropriate procedures are fully explored and developed.

Arguments in favor of Alternative 3 relate to concern that the long-standing policy against radioactive adornments does not address situations where radioactivity levels are so low as to be difficult to measure and that the potential health risk would appear to be very low. Therefore, the less disruptive approach would be to allow an established, multi-million dollar industry to continue operations while we review our policy and regulations in view of what appears to be a low risk.

The staff believes that the fundamental policy decision to be made in choosing Alternative 2 or Alternative 3 is whether or not the Commission is prepared at this stage to signal a departure from its present policy which clearly identifies as unacceptable certain types of consumer products containing radioisotopes widely available to the public.

Recommendation: That the Commission:

1. Approve Alternative 2 to stop current distribution of radioactive gems, while developing a generic de minimis policy statement and implementing regulations. The staff further recommends that if Alternative 2 is selected, option 2(b) should be followed; i.e., a policy statement on a generally applicable de minimis level of dose, followed by specific implementing rules. Although more time-consuming and resource-intensive, this would provide a firm basis for dealing with additional proposals of a similar nature.

2. Note that, if Alternative 2 is selected the staff would inform current applicants, interested licensees, and the jewelry industry of the decision to proceed with rulemaking and take action to stop unauthorized distribution in the interim.

3. Note that, if the Commission selects Alternative 3, there remain technical issues to be resolved before licenses could be issued which the staff has not yet pursued; e.g., proposals to distribute gemstones with radioisotope concentrations above those permitted by 10 CFR § 30.14, quality control, etc. (See Enclosure 3.)

4. Note that, if the Commission selects Alternative 3, the staff anticipates that, in addition to the three current applicants, other reactor licensees and importers will seek authorization to distribute irradiated gems.

Victor Stello, Jr.
Executive Director for Operations

Enclosures:
1. Staff Response to Commissioners' Questions
2. Data on Irradiated Gem Industry
3. Technical Issues Associated with Distribution of Radioactive Gems

Commissioners' comments or consent should be provided directly to the Office of the Secretary by c.o.b. Thursday, October 22, 1987.

Commission Staff Office comments, if any, should be submitted to the Commissioners NLT Thursday, October 15, 1987, with an information copy to the Office of the Secretary. If the paper is of such a nature that it requires additional time for analytical review and comment, the Commissioners and the Secretariat should be apprised of when comments may be expected.

DISTRIBUTION:
Commissioners
OGC (H Street)
OI
OIA
GPA
REGIONAL OFFICES
EDO
OGC (MNBB)
ACRS
ASLBP
ASLAP
SECY

ENCLOSURE 1

STAFF RESPONSE TO COMMISSIONER'S QUESTIONS ON SECY-87-186

A. Chairman Zech's Questions

QUESTION 1. What are the public health and safety risks that these gemstones present?

ANSWER.

The risk to the individual user is believed to be very small, assuming that the irradiated gems are held for decay and carefully monitored by the reactor operators prior to release to the public. Although data are sparse and subject to considerable uncertainty, measurements by the staff indicate surface dose rates of not more than 100 mrem per year based on a few samples. Assuming that the actual time an individual would wear an irradiated gemstone is substantially less than full time throughout the year, the dose to a small area of the skin would be considerably less than 100 mrem per year. The dose would be reduced during each subsequent year due to radioactive decay. Also, the effective whole body dose equivalent for such exposure would be much less than the dose to a small portion of the skin or organ irradiated. (See also SECY-87-186, Enclosure 1.)

Although the risk to the individual users is believed to be small in most cases, there are other considerations which bear on risks which require much additional information before a comprehensive conclusion can be reached as to health and safety risks. Radiation levels or radioisotopic content of irradiated gemstones are a function of trace elements in the mineral content which are subject to wide variation. The staff has received data from one licensee on the analyses of a total of 53 neutron-irradiated topaz. According to the licensee, some of these stones were irradiated at a U.S. facility and others at European facilities.

The principal radionuclides and their respective maximum concentrations are shown in the table below. Each group of stones counted contained at least two of the radionuclides in the table.

Radionuclide	Maximum Concentration (pCi/g)
Sc-46	550
Mn-54	350
Zr-95	93
Nb-95	200
Ru-103	14
Sn-113	90
Sb-124	41
Sb-125	23
Cs-134	100
Ce-144	160
Ta-182	4000

This raises issues of control because of difficulties associated with counting techniques at low radiation levels. Because of the length of time involved, in many cases batches of gemstones, rather than individual stones, are counted for control purposes. It is not clear that individual stones, with relatively high dose rates (e.g., 10-100 times a given limit), would be identified and withheld from release to the public using batch counting techniques.

In some instances, unfinished gemstones may be irradiated rather than finished products. In these cases, there is an additional unevaluated risk to workers who, while cutting, grinding, or polishing irradiated gemstones, may inhale or ingest particulates. The staff presently has no information which would enable it to reach a definitive conclusion that there is no significant health risk associated with these activities. However, the staff might address this issue in the near term by allowing irradiation and distribution of finished gems only.

In addition to the risk to the individual who wears gemstones, evaluation of population risk, as might be established through collective dose assessment, would be useful. While neutron irradiation of gemstones is apparently wide-spread, the staff has no definitive information which would enable it to make a collective dose assessment. It would be necessary to know distribution patterns of use and typical dose ranges to undertake a collective dose assessment.

In summary, while the staff believes that the risk to the individual owners of properly controlled gemstones is very small, the total risk is uncertain because of lack of information. Additional information collection would require a significant investment in resources and time.

QUESTION 2. What is involved in establishing *de minimis* levels of gemstones?

ANSWER.

The first issue in establishing a *de minimis* level for gemstones would involve a review of our application of the fundamental radiation protection principle that no practice involving radiation exposure should be authorized unless there is a positive net benefit. The review would encompass numerous policies and regulations both inside and outside NRC, including the international community. The 1965 Commission Policy Statement on the use of radioisotopes in consumer products, takes the position that use of radioactive material in adornments, such as jewelry, is of marginal benefit and unjustified. This position is also reflected in international guidelines on consumer products containing radioisotopes adopted by the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency (NEA), and the World Health Organization (WHO). (Ref. Section 4.2.3. of "A Guide for Controlling Consumer Products Containing Radioactive Substances," revised in 1985 by the NEA of the Organisation for Economic Co-operation and Development.) The rule (10 CFR Section 32.11) under which persons have applied for exempt distribution of irradiated gemstones encompasses this policy position by specifically prohibiting the transfer of byproduct material to exempt persons for purposes of "...application to a human being." Note that the Commission took action in 1983 by amending 10 CFR Part 40 to prohibit the use of uranium frit in cloisonne jewelry (48 FR 33697, July 25, 1983). Also, in 1986 the Commission denied (without prejudice) a Department of Energy petition, which requested an exemption from NRC regulations to allow recycle of smelted alloys containing technicium-99 and enriched uranium (51 FR 8842, March 14, 1986). The Commission noted the need to work with the Environmental Protection Agency on an integrated federal policy on contaminated materials, and that 3700 public comments were received on the proposal, most of which opposed the introduction of radioactive material into consumer products.

If a fundamental policy decision were made to allow the use of jewelry containing byproduct material, the remainder of the problem of establishing regulations for distribution of gemstones at some de minimis level is largely technical. The models used to establish the exempt concentrations in 10 CFR 30.14 and 30.70 are not definitive, because the concentrations were conservatively based on dose resulting from inhalation or ingestion and were intended to keep doses at a small fraction of 500 mrem per year. A maximum external radiation level is more appropriate for a de minimis gemstone rule. To establish an appropriate radiation level, the staff would need to collect information which would enable it to assess risk to the individual user, gemstone workers, collective population risk, and practical methods of quality control. This last element would include a substantial effort to identify reliable counting techniques and standards, to measure radiation levels in irradiated stones. Once the range of risks and their interrelationships are understood, then it should be possible to develop an appropriate maximum radioactivity limit for gemstones.

QUESTION 3. What is the impact on NRC of proceeding to establish a *de minimis* regulation?

Development of such a rule will be a complex, time-consuming process. Many attempts have been made over the past three decades to develop generic *de minimis* dose limits. These have failed mainly because of practical problems with implementation. An attempt to develop a policy or rule on a generally applicable *de minimis* dose limit would likely be as resource-intensive as it was for the Safety Goals Policy and success would not be assured. Earlier attempts at establishing a dose limit did not have broad Agency support and were abandoned because of the level of difficulty in treating many of the policy issues and practical problems associated with the endeavor. With a broad agency commitment it might be feasible to establish such a policy or rule.

The acceptable level of risk represented by a *de minimis* dose limit, while controversial, would not be too difficult in itself to establish since there are precedents. The preponderance of thought on an appropriate level of risk is in the range of 10^{-8} to 10^{-6} annual risk of radiation-induced cancer leading to death or a dose of 0.1 mrem/yr to 10 mrem/yr. The National Council on Radiation Protection and Measurements (NCRP) recently issued Report No. 91, "Recommendations on Limits for Exposure to Ionizing Radiation," which recommends a negligible individual risk limit (NIRL) of 10^{-7} per year or 1 millirem per year. The rationale for this NIRL value appears to be a synthesis of many papers on this subject. More difficult to address are the issues relating to the practical application of a *de minimis* policy or rule. For example:

1. How is the source or practice which is permitted to deliver a de minimis dose defined? In the case of gemstones, for example, should the dose limit apply to a single gemstone or multiple gemstones worn on a person? If it is the former and there is a desire to limit total risk to the individual, then it can drive the de minimis limit sufficiently low to be of little practical value. If it is the latter, then control must be exercised at the jeweler level where the dose from combinations of gemstones can be evaluated rather than at the reactor doing the irradiation where control is placed on individual gemstones. This is a rather simple example. The problem of defining a source or practice for other activities such as waste disposal becomes much more difficult.

2. Who determines that a source or practice is within the de minimis dose limit? The dose to an individual will be a function of dose rate, occupancy times, and pathways of exposure. Depending on the assumptions made, dose estimates can often vary by a factor of 100. Complex calculations and many assumptions are often needed to establish the relationship of dose to dose rate or to radioisotope concentration of the source. If such a determination is the responsibility of the persons causing the dose, how does a regulatory agency determine that its policy or rule is being met? In light of this uncertainty, it would necessarily be the responsibility of the regulatory agency to assess and control dose. This would most likely be accomplished through a series of rules dealing with specific practices. This is the course anticipated in the Commission's Policy Statement on radioactive waste (51 FR 30839, August 29, 1986). It is also similar to what has been done in the past for consumer product exemptions.

3. Should caps be placed on one or more of the following: individual risk from multiple sources and practices, collective population dose resulting from multiple sources and practices, or the number and type of sources and practices approved? If so, how would the caps be assessed and regulated?

Unless these and similar matters are addressed in a policy or rule which establishes a generally applicable de minimis dose, we are likely to experience many radiation control problems through lack of knowledge in its proper application or through abuses. Although NCRP Report No. 91 suggests that any single person could be subject to as many as 10 "negligible individual risk limit" sources per year, and still be within an acceptable risk level of 10^{-6}, it does not address, nor should it necessarily address, the difficult regulatory problems associated with implementing a de minimis dose value. An attempt is underway at the IAEA and NEA to come to grips with some of these problems such as definition of a source or practice for application of a de minimis dose. These—are not insurmountable problems, but they would require a dedicated and resource-intensive effort to analyze and resolve.

QUESTION 4. Who is in violation of NRC regulations?

ANSWER.

Anyone who distributes irradiated gemstones containing byproduct material to members of the public (or irradiates gems with intent to distribute) and does not have an NRC license authorizing this distribution is in violation of NRC regulations [10 CFR 30.14(d)]. (No licenses have been granted authorizing such distribution.)

Under strict interpretation of the regulations, the University of Missouri is in violation of 10 CFR 30.14(d), even though after a 1986 inspection by Region III, distribution was restricted to those gems which the licensee says contain radioactivity statistically indistinguishable from background.

The staff has received reports that a few other U.S. research reactors have irradiated gems in the past. The University of Virginia is currently irradiating gems for export only. There are also numerous reports of imports of irradiated gems. The staff has delayed committing additional inspection resources to follow up on these reports pending additional guidance from Headquarters.

QUESTION 5. Should we take enforcement action?

ANSWER.

SECY-87-186 recommended that we should take enforcement action (i.e., appropriate action to stop the unauthorized distribution of irradiated gemstones). In developing this recommendation, the staff considered the following:

1. A clear violation of an NRC regulation [10 CFR Sections 30.14(b) and (d)] is involved.

2. The issue was not raised internally by the staff, but rather by allegations and inquiries from other reactor licensees and members of the public.

3. Two organizations who have applied for distribution licenses have complained that they are being economically penalized for complying with NRC requirements. On the other hand, the University of Missouri and foreign suppliers have entered into an unauthorized activity, without obtaining the required license, and derived significant profits from the activity.

4. Various jewelry retailers and others have expressed concern that a radioactive consumer product is on the market which is unlabeled and unauthorized by NRC.

5. Even if the staff were to allow restricted distribution of gems, there are practical problems for both the suppliers and NRC in assuring compliance. The industry might continue to press NRC for less restrictive procedures, through petitions for rulemaking or requests for exemptions from the regulations.

6. Even in cases where the health hazard associated with a violation appears to be small, the agency should require compliance in order to maintain integrity and consistency in its regulatory program, particularly where significant economic benefit is gained from the violation.

7. Although the staff believes that foreign reactors are in most cases holding gems for decay to low radiation levels, there is currently no assurance that gems are not and will not be shipped to the U.S. containing much higher radiation levels.

QUESTION 6. Do the regulations make sense and are they enforceable?

ANSWER:

As recognized by the Commission and the staff, the regulations do not "make sense" in that they do not reflect a comprehensive policy on the *de minimis* issue. However, with respect to the gemstone issue, the current Policy Statement and rules governing byproduct material in consumer products make sense and are enforceable. They are based on the sound regulatory principle that members of the public should not be deliberately exposed to even small doses of radiation without a compensating benefit. The 1965 Policy Statement which identifies the use of byproduct material in toys, novelties, and adornments (such as jewelry) as a frivolous and unjustified use is unambiguous. Rules authorizing exempt distribution of consumer products reflect this policy; they are also enforceable. Domestic irradiation of gemstones can be stopped at the source. Commercial import of irradiated topaz can likely be controlled because it can be identified by color. Therefore, it would not be necessary, as a routine matter, to measure for radioactivity to control import. Very little, if any, NRC resources would be needed to assist Customs. Gemstones brought into the country by private individuals for personal use would not be controlled, but this is a minor part of the problem.

Note that changing the Policy Statement and regulations which prohibit use of byproduct material in toys, novelties, and adornments would raise policy questions about justification of doses associated with such products, and would not necessarily make the regulations more enforceable. Based on past experience, we could expect a number of proposals for use of byproduct material in toys, novelties, and jewelry, in addition to gemstones. Control of gemstones and other products would require extensive quality assurance controls and monitoring of domestic suppliers. In the case of imported topaz, Customs would need to exercise control through measurement of radiation levels rather simply identifying the product by color. Radiation measurements at very low dose rates require sophisticated and time-consuming techniques which are not practical to undertake on a large scale. Customs would undoubtedly need substantial NRC assistance to implement an effective control program.

QUESTION 7. How is this matter treated in other countries?

ANSWER.

The staff is aware that gemstones are being irradiated in several countries in Europe and elsewhere. In West Germany, one reactor has been specifically licensed to release irradiated gems below 2 nanocuries per gram. Through informal communication with Richard E. Cunningham, we understand that a reactor in Switzerland is irradiating about 10 kilograms of topaz per month with release limits set at less that 5 nanocuries per gram. However, we do not know the full extent to which such practices have been authorized nor the types of controls applied in all countries. Because of the international character of the problem of effective control, Mr. Cunningham raised the issue in the March 1987 meeting of the NEA's Committee on Radiation Protection and Public Health. The meeting was also attended by representatives from the International Atomic Energy Agency (IAEA), the International Commission on Radiological Protection (ICRP), the World Health Organization (WHO), and the Commission of the European Communities (CEC).

Mr. Cunningham posed three questions for the Committee:

1. Should irradiated gems containing low-level radioactivity be excluded from the consumer products prohibition under Section 4.2.3 of the 1985 NEA guide on consumer products, which cites articles of personal adornment as an example of an unjustified use?

2. If irradiated gems are acceptable as a consumer product, should appropriate international guidance be developed for assuring that gems are held for decay and properly monitored prior to distribution?

3. Since countries outside NEA membership are involved, is NEA the appropriate organization to address this problem? Should the matter be referred to IAEA?

From the discussions which followed, it appeared to Mr. Cunningham that few, if any, Committee members knew in detail the extent of gemstone distribution or controls exercised in their respective countries.

There was divided opinion as to whether an exception should be made to the international guidelines which cite articles for personal adornment as an example of an unjustified use of radioactive material. However, opinions on this point were very preliminary because Committee members expressed the need for further information before reaching a final conclusion. Certain Committee members said that they would look into practices being conducted in their countries.

There seemed to be a consensus that, as a minimum, international guidelines are needed which assure that the radioactivity content of (or the dose from) irradiated gemstones released for public use is maintained below an established standard. Follow-up is planned through NEA and IAEA.

QUESTION 8. How is this viewed by NRC and Agreement States licensees?

ANSWER.

There is a clear commercial interest and market for irradiated gemstones, assuming the activity is approved by NRC. While the number of licensees engaged in this activity would likely be small, it is of high interest to those involved as well as to segments of the jewelry industry. Two pending applications for exempt distribution of irradiated gemstones are from organizations located in California, an Agreement State. (The University of Missouri also submitted an application on August 20, 1987.) Under the provisions of 10 CFR 150.15(a)(6), the NRC retains jurisdiction over reactors and all licensing of exempt distribution of byproduct material in consumer products within Agreement States. Therefore, there is no distinction between requirements for licensees located in Agreement States and those in non-Agreement States.

Industrial sources have reported to NRC that gems are also irradiated in accelerators, which are regulated by the States, not NRC. Information available to the staff indicates that the potential for inducing radioactivity in gems by accelerators is much less than for reactors. In any event, the staff anticipates that most States will look to NRC for policy guidance regarding radioactive gems.

B. Commissioner Bernthal's Comments

COMMENTS. Staff should also strengthen its "Radiological Assessment," should evaluate the feasibility and/or impact of storage for decay and should provide, for purposes of comparison, a discussion of the range of natural radioactivity in precious and semi-precious gemstones routinely used as "adornments."

ANSWER.

Additional information on the health risks associated with the radioactive gems is provided in response to Chairman Zech's Question No. 1.

The staff has considered the feasibility of storage and decay, and in fact the gems currently being distributed are held for decay prior to release. However, because the principal radionuclides range in half-life from 84 to 303 days, the radioactivity does not decay away completely, and is still measurable after several years. Therefore, storage for decay is only feasible if a limit is established below which gems may be released. Note that the release limits proposed by industrial sources, ranging from 0.6 to 10 nanocuries per gram, are above the exempt concentrations specified in 10 CFR Section 30.70. In other words, the industry is proposing to release licensable, measurable quantities of radioactive material to unlicensed consumers.

It is difficult to summarize the quantities of natural radioactivity in minerals because of the large variation. The range is from a few picocuries to several thousand picocuries per gram, or even higher if a substantial percentage of uranium is present. Certainly the natural radioactivity in topaz is much less than the reactor-induced radioactivity (thousands of picocuries per gram). On the other hand, blue topaz is less radioactive than some uranium cloisonne jewelry. Therefore, it can be stated that the hazard from blue topaz is in some cases less than the hazards from certain other naturally occurring radiation sources.

C. <u>Commissioner Roberts' Comments</u>

COMMENTS. I would like to know: 1) the details of the enforcement action halting the import of radioactive topaz gems from Brazil, 2) the current position of the Nuclear Energy Agency in this matter and 3) the NRC resources allocated to cooperate with the U.S. Customs Service.

ANSWER.

In October 1981, Region I was informed that radiation had been detected from blue topaz gems believed to have been imported from Brazil. Region I obtained samples of the gems and surveyed them, finding about 0.2 mrem per hour per gem and 12 mrem per hour on a bag of 100 gems. Gems received from two jewelers were analyzed and found to contain scandium-46 and tantalum-182 (Ta-182), with a maximum concentration of about 3 nanocuries of Ta-182 per gram.

NRC sought more information on this matter from the Brazilian government. In several cables beginning in December 1981, the United States (NRC/IP through the U.S. State Department) informed Brazil of its findings and asked for further information including whether gems were being irradiated with neutrons in Brazil. Later, CNEN (Brazil's equivalent to NRC) confirmed that gems were being irradiated at the IPEN Research Facility in Sao Paulo. CNEN suspended IPEN's neutron irradiation of gems and ordered IPEN to provide additional information on the project to CNEN.

This matter was handled through diplomatic channels and the United States relied on the Brazilian government's assurance that it had put a stop to the practice. NRC did not take any formal enforcement action against any person or organization that had imported radioactive blue topaz from Brazil. The use of the phrase "enforcement action" in connection with Brazilian blue topaz was somewhat misleading since halting the import of the gemstones in this case was not similar to the type of action which would be followed in a domestic case.

The position of the Nuclear Energy Agency is discussed in the response to Chairman Zech's Question No. 7.

The staff has not allocated special resources to cooperate with the U.S. Customs Service. It is anticipated that the gemstone problem can be addressed with existing staff resources assigned to international programs, inspection, and enforcement.

D. Commissioner Carr's Comments

COMMENTS. The staff should consider guidance recently issued by NCRP on this matter. Also...advise the Commission as to how NRC activities on limits for unrestricted use, de minimis, and below regulatory concern are related.

ANSWER.

The recent NCRP guidance is discussed in the answer to Chairman Zech's Question No. 3.

The terms de minimis and below regulatory concern (BRC) are often used synonymously. "De minimis non curat lex," or "the law does not concern itself with trivialities," is a definition which expresses the issue for regulatory purposes. NRC subscribes to the linear, non-threshold theory of dose and effect for planning radiation protection and assessing radiation dose consequences. The theory implies that any radiation dose, no matter how small, has some corresponding effect. However, there is some point at which the effort to regulate very low doses exceeds the benefit derived from such regulation. The term below regulatory concern is employed to recognize that there is, at least in theory, some health effect associated with a trivial dose, but it is so small that it is not worth the effort to regulate.

Limits for unrestricted use, on the other hand, are quite different in concept from BRC dose levels. Such limits are based on consideration of the overall recommended limit for public exposure and the application of ALARA below that limit. Derived dose limits for unrestricted use should be a fraction of the overall public dose limit, so that when combined with other sources of public exposure, the latter will not be exceeded. Derivation of the limits is also coupled with the ALARA principle which takes into account the technology for dose reduction and the cost of further reduction. Limits for unrestricted use will vary depending on the situation under consideration and will often be greater than would be the case for a generally applicable BRC limit. Limits for unrestricted use are normally expressed in terms of radioisotopes concentrations or radiation levels which depend on the type of equipment, facility, site, waste stream, etc., under consideration as well as the radionuclides involved, pathways of exposure, occupancy times, and other parameters affecting projected dose. Derived limits for unrestricted use are contained in license conditions, guides, and staff technical positions. In the latter two instances, a licensing action is normally involved before a licensee can take advantage of the derived limit. A derived limit for unrestricted use as applied to specific cases generally reflects a practical level of dose where further regulatory control does not result in significant dose reduction. Once released for unrestricted use, no further regulatory control is exercised.

Enclosure 2

AGTA
AMERICAN GEM TRADE ASSOC. INC.

Mr. Richard E. Cunningham
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

August 19, 1987

Dear Mr. Cunningham,

Enclosed please find a comprehensive report on the current state of the irradiated blue topaz market. This overview was requested by Mr. Stanley Lasuk of the Nuclear Regulatory Commission Region 3 during a phone conversation last month with Mr. Ray Zajicek, former president of the American Gem Trade Association.

Mr. Zajicek completed the drafting of this report and left it at our Dallas Headquarters for typing on the day he was leaving on a two week vacation. He has given me instructions and authority, as Executive Director of AGTA, to sign the report for him and forward a copy on to you.

Thanking you in advance for your most immediate attention to this important and timely information.

Sincerely,

Peggy R. Willett,
Executive Director
American Gem Trade Association

AGTA

AMERICAN GEM TRADE ASSOC. INC.

Mr. Stanley Lasuk
Nuclear Regulatory Commission
Region Three
799 Roosevelt Road
Glen Allen, IL 60137

August 18, 1987

Dear Mr. Lusak:

Please excuse the delay in sending this report on the domestic and international irradiated blue topaz market. When we spoke a few months ago it seemed a relatively simple task to compile a few facts and figures about one small facet of the gemstone industry.

As I began asking questions and following suggested leads, however, the global picture focused into an entirely different perspective. It became apparent that over the last four to five years irradiated blue topaz has become a major factor, possibly even a mainstay of today's gemstone and jewelry industry.

In fact it may be more accurate to describe blue topaz as a sub-industry within the international colored gemstone and jewelry industries.

This letter would still be weeks away from completion had it not been for the fact that I was assisted by Roland Naftule, President of the International Colored Gemstone Association (ICA), an organization representing the major gemstone suppliers and exporters throughout the world.

Our job was facilitated greatly by our attendance at the Jewelers of America trade show in New York last month. There we had the opportunity to survey producers, distributors, and manufacturers from around the world who were exhibiting at the show. Also entailed in this research project were numerous telephone conversations, both domestic and international. Our interviews included:

MINE OWNERS and ROUGH EXPORTERS from Africa and Brazil.
OWNERS OF CUTTING FACTORIES in Asia and Brazil.
IRRADIATION PROCESSORS from Europe and North America.
WHOLESALE DIESTRIBUTORS and JEWELRY MANUFACTURERS from Asia, Brazil, Europe and North America.
MAJOR RETAILERS from America, Brazil, and Europe.

A non-profit Association Serving the Precious Gem Industry Since 1981

The figures resulting from our survey are mind-boggling. In trying to theorize the "why" of the blue topaz market phenomena, one must have a broader understanding of the colored gemstone industry.

Natural blue topaz has been on the market for many decades. Occuring in areas with high concentrations of uranium or other radioactive minerals, its light blue color is the result of natural low-level irradiation.

With the discovery in the late 1970's that man-induced high-level radiation could impart various shades of blue to most white topaz, an enormous potential market opened up.

Traditionally, blue is one of the most popular colors in fashion from clothes to cars to jewelry. Previously, however, there was limited availability and accessibility for blue gemstones;

AQUAMARINE - generally a medium to light pastel color, almost colorless in smaller sizes. Darker and larger stones are rare and very expensive.

NATURAL BLUE TOPAZ - only available in the same lighter colors as aquamarine. Less expensive than aquamarine but also so rare that there was not sufficient supply to establish a market.

INDICOLITE (BLUE TOURMALINE) - fine shades of blue are found in small and large sizes, but this gemstone is so rare as to be almost unknown in the world market. In the nicest blue tones it is very expensive due to the limited supply.

IIOLITE - also known as "water sapphire," this gem type offers little consistance of color and generally occurs in very small sizes.

SAPPHIRE - the most reknowned and popular of all blue gemstones, but prohibitively expensive for the general public.

SPINEL - this gem occurs natually in almost every color of the rainbow. Pure blue, however, is one of the scarcest of its varieties and is almost non-existant in sizes over 1 carat. Fine blue stones are collectors items and are as expensive as they are unique.

ZIRCON - a very soft stone, it is easily scratched when worn as jewelry. Certain types of brown zircon can be heat treated to a pleasant light to medium blue color. Unfortunately the results from heating are very erratic and unpredictable. No one has ever been able to produce a dependable enough supply to create a solid market.

Enter IRRADIATED BLUE TOPAZ - a durable gemstone which offers the market virtually unlimited quantities of every shade of blue imaginable in sizes ranging from 0.10 carat to 1,000 carats at extremely affordable prices.

It works perfectly for the price-point concious catalog companies using smaller sizes of the gemstone for inexpensive mass-produced jewelry and it is just as attractive to the "carriage trade" manufacturers who use enormous quantities of 10 to 20 carat standard sizes for their high-fashion but affordably priced lines.

With these considerations it is not really such a mystery that this product has become such an international hit so quickly. For the gemstone and jewelry industry the timing of blue topaz's market entry could not have been better.

In the early 1980's the production increased dramatically. The resulting popularity and growing public consumption came at a time when the jewelry industry was in the depths of economic depression. Many wholesalers and manufacturers even allude to the fact that blue topaz was their "salvation" during the hard times.

Today, with the market recovering to a reasonably healthy state, blue topaz continues to flourish. It surpasses almost every other gemstone in retail jewelry sales (see enclosed National Jeweler article.)

Even corundum dealers, who heretofore worked exclusively with ruby and sapphire, are now becoming a force in the blue topaz market because it has proved itself to be an extremely liquid commodity that can be sold worldwide in enormous quantities.

Obtaining prices and accurate information for this overview was impeded somewhat by the competitive and proprietary nature of the industry. Rough sources and prices, irradiation facilities, formulas, costs, quantities, and customers are all closely guarded pieces of information that each producer believes gives the advantage over the competition. Thus we compiled our facts and figures from various sources at each level of production and calculated by consensus and averages.

To quickly review the results of our study we have prepared a chart summarizing the more salient information:

Summary chart of information about the blue topaz industry

	est. number of people involved	est. % of yearly income	est. int'l yearly weight volume	est. int'l. yearly dollar volume	approx. U. S. market share
MINING	4,000	95%	200 Tons	$15 Million	not applicable
CUTTING	10,000	95%	6,000 Kg	$20 Million	not applicable
COLOR PROCESSING	200	75%	6,000 Kg	$15 Million	40% •
WHOLESALE BLUE TOPAZ DISTRIBUTION	1,000	30%	5,000 Kg	$125 Million	35% •
WHOLESALE JEWELRY MANUFACTURING AND SALES	10,000	30%	4,000 Kg	$200 Million*	40%
RETAIL SALES	10,000	15/20%	3,000 Kg	$300 Million*	80%

* blue topaz only ; gold and diamonds not inlcuded

• until last year these figures exceeded 95%

The vertical classifications describe each phase of production to which any piece of topaz is subjected from digging it out of the ground until it is surrounded by gold and diamonds and purchased for the happiness and pleasure of the consumer.

To give an idea of the global nature of this market, below are listed the countries which play the largest part in each respective stage of the product's development:

MINING - Australia, Brazil, India, Nigeria, and Sri Lanka
CUTTING - Brazil, China, Germany, Hong Kong, Korea, Sri Lanka, Taiwan, and Thailand
COLOR PROCESSING - Australia, Brazil, Canada, China (?), England, Germany, India (?), Sweden, Switzerland, and U. S. A.
(Note: (?) indicates strong possibility, but no hard evidence.)
BLUE TOPAZ WHOLESALE DISTRIBUTION - England, Germany, Hong Kong, Thailand, and U. S. A.
WHOLESALE JEWELRY MANUFACTURING AND SALES - Brazil, France, Germany, Hong Kong, Italy, Japan, Taiwan, Thailand, and U. S. A.
RETAIL - all countries that sell retail jewelry

The time frame concerning this production cycle varies greatly depending on the season, the size of the operation and whether the goods are for general stock or to fill special orders. For your purposes the most important consideration must be the time between the gemstones' release from the reactor facility to the time a piece of blue topaz jewelry becomes an adornment for the consumer.

We assume that the topaz is color-treated in its finished faceted and polished state, as we understand is the case at American and European facilities. Obviously, if the material were irradiated in its rough or preformed state there would be added complications in terms of quantities handled and residual waste and sludge during the cutting.

Once the topaz has been irradiated it is held by a licensed facility to cool down to the appropriate levels of activity for release to the producer according to the regulations to which that facility is subject. Depending on the material and the process used the holding period could be from six weeks to two years.

Generally producers wait for enough material to cool so that they can receive between one and five kilograms per batch. Then the stones are sorted for breakage, size, shape, and color quality. Finally, they are packaged for distribution. On the average we estimate that between 250 and 400 carats per day can be properly sorted, classified, and packaged by each employee. A given kilogram of irradiated blue topaz will stay with the producer a <u>minimum</u> of ~~eight to 8~~ to 14 weeks for preparation and sale. 7

The next level of distribution is the wholesale gem dealer. Depending on the company's size and the time of year, blue topaz purchases are made in the range of 0.25 to 5.0 Kg per month in addition to numerous other gems types with which they work. Small quantities of the stones are carried out on the road as samples, but the bulk of the wholesaler's inventory is kept locked in the office vault awaiting orders for specific sizes and shapes from the manufacturing customers. On the average, a kilogram of blue topaz takes <u>at least</u> 6 to 12 weeks for a good wholesaler to distribute.

Typical blue topaz mail shipments to manufacturers are from 0.01 Kg to 0.5 Kg. When the goods are received they are dispensed, along with other gem types used in the same line, to the goldsmiths and setters for fashioning into the finished pieces of jewelry. A good setter might handle between five and fifty gemstones a day (not necessarily all topaz) according to the stone's size and shape and the type of mounting. Completing this evolution from gemstone to jewelry, a topaz will finally be sent out to fill a retailer's order about 4 to 10 weeks after being purchased by the manufacturer.

Once the piece has arrived at the retailer's, the turnover rate is extremely sporadic. During the Christmas season the blue topaz treasure may be sold within a week or two. If it sits in the off-season showcase, however, the same topaz might not find its permanent home from 6 to 9 months or more.

Between each of these stages we must add a conservative one week shipping and handling time. By averaging the time periods required during each phase of production, we estimate that the typical delay required for an irradiated blue topaz to reach a retail jeweler's showcases after being released from a laboratory is approximately 30 weeks. Then from the showcase to the consumer could take from 1 week to 1 year.

Referring back to the chart, the horizontal headings demonstrate a quantitive idea of the magnitude and economic impact of the irradiated blue topaz market:

ESTIMATED NUMBER OF PEOPLE INVOLVED - these figures do not overlap. Miners do not do cutting, cutters do not do color processing, etc. To summarize, our best estimates indicate that the international blue topaz industry significantly affects the livelihood of approximately 35,000 people.

ESTIMATED % OF YEARLY INCOME - shows to what extent the participants in each phase of production depend upon the topaz industry for their subsistance. The most notable figures are at the mining and cutting level where approximately 14,000 people would effectively have no means of support without this market. By extending these figures to include the miners' and cutters' immediate families there are in excess of 56,000 lives fully dependent on the topaz industry.

ESTIMATED WEIGHT VOLUME - The weights diminish from one stage to the next because we have allowed for breakage, loss and unsold inventory during a twelve month period. The yearly volumes also take this into account.

ESTIMATED YEARLY DOLLAR VOLUME - these figures do not overlap at any stage. New money is being exchanged between the countries as the topaz passes through each stage of production. Therefore, considering only the gemstones, excluding the diamonds and gold used in the mountings, this is a $675 million per year industry.

ESTIMATED U.S. MARKET SHARE - until recently American knowhow and technology allowed U.S. producers to control almost 100% of the processing and wholesale distribution of blue topaz. Last year most domestic irradiation facilities were forced to interrupt the release of irradiated topaz while the NRC decides its official position on the subject. Fearing possible fines and/or penalties, many laboratories stopped production altogether. To protect their heavy long-range investments and commitments most producers took their technology abroad and began working with foreign irradiation facilities and wholesalers.

Today the tables have turned. American gem dealers and manufacturers must buy 60 to 70% of their blue topaz from foreign partnerships while U.S. producers have very little product to sell at home or abroad.

The decline of America's share of this immense market is tangibly accelerating at an astonishing rate. As the U.S. sales figures are now decreasing on a weekly basis, there is one glaring question that greatly concerns the AGTA and the American jewelry industry as a whole: why is the NRC taking so long in arriving at a responsible decision to give us guidelines whereby our industry can act and compete internationally?

The U.S. production advantage is history as our technology and knowhow has been sold out. However, if this government agency continues to delay its decision our own producers and wholesalers will no longer even maintain an equal hand in the world market.

I have been told that the NRC feels no urgency to take a favorable position because it considers the color enhancement of gemstones a "frivolous" use of energy. If the hard line negative position is taken, perhaps someone at the NRC would like to explain that attitude to the 14,000 families who depend on a healthy blue topaz market for their survival.

Considering that this industry generates in excess of one-half billion dollars per year, this indecision is actually adding to our country's current trade deficit problem. We are forfeiting what was once a lucrative source of foreign money while losing precious U. S. dollars by leaps and bounds to an overseas market which American ingenuity invented, developed and dominated for years. Where is the logic?

Public safety <u>cannot</u> possibly be the issue being considered in Washington. For more than 18 months the NRC has tacitly approved Region Three's guidelines for the wholesale release of irradiated topaz. This was admitted at our November meeting with Mr. Hickey, Mr. Cunningham, et al.

So the NRC has for quite some time, and without enforcing any specific licensing requirement, <u>knowingly</u> allowed the release of massive quantities of this irradiated by-product for domestic distribution and public consumption. Clearly Washington must have decided that your region's criteria for release presented so little public safety hazard that a special license was not even necessary.

On the other hand I am told that all research reactors have been directly prohibited from releasing <u>any</u> irradiated blue topaz without a specific license which as never been issued. Apparently there is some major confusion in Washington at the expense of our industry.

Over the last five years, American entrepreneurs have invested tens of millions of dollars in the R&D and production of blue topaz. This money would never have been spent if there were any question of public safety or any inkling that production could be prohibited.

The NRC's long standing implied approval of Region Three's release guidelines reassured American producers that their investments were protected. There was no threat felt even by those working at facitilites that were temporarily restrained from releasing irradiated topaz while the NRC studied and drew up its official position. The producers understood delays with government agencies, but considering Region Three's approved activity, there was no doubt that the eventual outcome would be favorable. Therefore the long-range investments continued.

Today the NRC's prolonged decision making is already becoming costly to our American producers in terms of lost profits. Hopefully, these delays do not indicate the possibility of an unfavorable decision. This eventuality would unquestionably force many U. S. tax paying business, large and small, into bankruptcy.

This survey makes it obvious that blue topaz is not a "flash in the pan" fad...it is here to stay. Whether the NRC makes up its mind now or in ten years, blue topaz will continue to be produced somewhere in the world.to supply the enormous demand.

As long as our American producers' hands are tied a different but very serious safety risk is increased. Eventually the technology will spread to underdeveloped countries (if it has not already), where there is much less control over release criteria. The NRC, in its current mode of operation, is actually forcing this to happen.

If, as the rumors go, the NRC makes the mistake of halting all domestic topaz irradiation they might compound that error by banning the import of all blue topaz. Considering the variety of other blue gemstones on the market, customs would have to open and check every package containing gemstones to make sure they weren't topaz in disguise.

In fact this course of action would simply drive the industry underground, thereby drastically increasing the risk to public health beyond any acceptable level.

If the NRC has the public's help in mind it is the immanent responsibility and obligation to make a timely decision and to issue relevant and safe guidelines within which our industry can operate.

The leading wholesalers and manufacturers are already aware of the safety considerations. Most of them have in-house survey meters to check all blue topaz that enters their office. Unfortunately, there is no standardization to the equipment and no established guidelines with which they can work.

I am enclosing a copy of "The Jewelry Industry Gemstone Enhancement & Man-Made Product Information Guide" and a recent article from the L. A. Times business section. As these enclosures indicate, our associations are extremely concerned with and supportive of full disclosure of any and all gemstone color-enhancement techniques.

AGTA members are already coding invoices to specify gemstones that have been treated in any way to ensure that the wholesale buyer <u>and</u> the consumer know exactly what they are getting.

As we have stated in our October, 1986 letter to John Davis, Director of NMSS, and as we reiterated during subsequent correspondence and phone conversations to other NRC officials, the AGTA and ICA stand ready and eager to monitor the market here and abroad. We have the means to make sure that all producers, importers, and wholesalers work within NRC standards and regulations. Both of these organizations were conceived and founded for the specific purpose of bringing a new stability, responsibility, and professionalism to the gemstone industry.

Now we look to you and the Washingon headquarters to give us something by which to accomplish these goals as they pertain to irradiated blue topaz.

With best regards,

Peggy Willett
Executive Director
American Gem Trade Association
signing for
Ray Zajicek
Immediate Past President
American Gem Trade Association

cc: Mr. Robert Bernero
Mr. Richard E. Cunningham
Mr. John W. Hickey
Mr. John G. Davis
Hon. Lando W. Zech, Jr.
Hon. Frederich M. Bernthal
Hon. Thomas M. Roberts
Hon. Kenneth M. Carr
Hon. Kenneth C. Rogers

Hon. Alan Cranston
Hon. Pete Wilson

THE JEWELRY INDUSTRY

GEMSTONE ENHANCEMENT

&

MAN-MADE PRODUCT

INFORMATION GUIDE

Foreword

This information guide has been developed by a coalition of jewelry industry leaders representing the associations listed below. Should you require any further information, please contact:

American Gem Society (AGS)
5901 West Third Street
Los Angeles, CA 90036-2898
(213) 936-4367

American Gem Trade Association (AGTA)
Post Office Box 581043
Dallas, Texas 75258
(214)742-4367

Jewelers of America, Inc. (JA)
1271 Avenue of the Americas
New York, New York 10020
(212)489-0023

Jewelers' Vigilence Committee (JVC)
1180 Avenue of the Americas, 8th Floor
New York, New York 10036
(212)869-9505

Manufacturing Jewelers and Silversmiths of America, Inc. (MJSA)
The Biltmore Plaza
Providence, Rhode Island 02903
(401)274-3840

ACKNOWLEDGEMENTS:

We wish to thank the following people for their time and effort:

Stephen Alie
William Boyajian
Richard Krementz, Jr.
Herbert Levine
Roland Naftule
William Preston, Jr.
Stuart Robinson
Michael Roman
Mathew Runci
Joel Windam
Ray Zajicek

Special thanks to *C.R. Beesley and Robert Crowningshield* for their technical assistance in preparation of these guidelines. Finally, we wish to recognize the important contribution of *David Federman* whose initial work provided the format for this project.

First Edition - January 1987
Printed in the United States of America

Note: A Review Board, consisting of association representatives and laboratory technical advisors will meet from time to time to make necessary modifications to this industry guide.

TABLE OF CONTENTS

INSTRUCTIONS

To obtain copies of The Jewelry Industry Gemstone Enhancement and Man-Made Product Information Guide or consumer information cards, please place your order, in writing, to any of the National Associations listed on the preceding page.

Consumer information cards are presently available for the following gemstones:

Alexandrite	Lapis-Lazuli
Amber	Nephrite
Amethyst	Onyx
Aquamarine	Opal
Cats'-Eye	Pearl (Cultured)
Chrysoberyl	Peridot
Citrine	Ruby
Colored Diamond	Sapphire
Coral	Spinel
Diamond	Star Corundum
Emerald	Tanzanite
Garnet	Topaz
Iolite	Tourmaline
Ivory	Tsavorite
Jadeite	Turquoise
Kunzite	Zircon

Gemstone Enhancement & Man-Made Product Information Guide

Following is a proposal to implement at the point of sale, a system whereby information regarding *man-made product and the enhancement or non-enhancement of each gemstone is made known to the buying public. It is a system which is expandable based on future needs and discoveries. The tagging code, made up of one or two parts, is to be used by all wholesale suppliers and retail merchants.

DEFINITION

ENHANCEMENT: Any process other than cutting and polishing used intentionally to improve appearance (color/clarity), durability or availability of a gemstone.

The general category (tag code column #1) requires that the supplier provide one of three basic designations in order to satisfy the minimum standard for the disclosure of enhancements.

A - The A symbol used alone indicates either a gemstone that is not currently known to be enhanced (alexandrite, garnet, etc.), or one that is so rarely enhanced, that to give it an E symbol would mislead the public (i.e. colorless or near colorless diamonds that have not been laser drilled).

E - The E symbol indicates the gemstone is one that is often enhanced. The method and frequency are listed on the chart. Sellers specifically responsible for the enhancement must use the tag code listed in column #2.

*Man-Made when used in this guide refers to synthetic, imitation, or assembled stones.

N - The N Symbol in tag code column #1, for a gemstone that would usually have an "E" designation, indicates that the gemstone is accompanied by documentation to support the fact that the stone is NOT enhanced. The supporting documentations could be supplied by an independent source, such as a laboratory, or provided by the seller of the gemstones as a personal guarantee of authenticity.

Example

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method
GARNET	A		Not currently known to be enhanced.
SAPPHIRE (Blue)	E		Often enhanced.
		H	Heated to modify color.
	N		No enhancement with supportive documentation.

Designations

A. Frequency Designations

1. Rarely (0 - 10%)
2. Occasionally (10 - 25%)
3. Commonly (25 - 50%)
4. Usually (50 - 95%+)
5. Always (100%)

B. Stability Designation

1. Excellent
2. Very Good
3. Good
4. Fair
5. Poor

C. Care Designations

1. Normal
2. Special

D. Multiple Enhancement Techniques are sometimes applied to the same material. The most significant process should be listed first.

Example:

1. Diamond — R - Irradiation; L - Lasering
2. Topaz (Blue) — R - Irradiation; H - Heat

GEMSTONE ENHANCEMENT INFORMATION GUIDE

Every tag, stone paper, container, invoice and memorandum must have at least one letter.

Column #1 Entries (general):

A - Indicates gemstones that are not currently known to be enhanced, or that are very rarely enhanced.

N - Indicates that a specific gemstone has Not been enhanced and there is documentation to support it.

E - Indicates the gemstone is one that is often enhanced. The method and frequency is listed on the chart. Sellers specifically responsible for the enhancement must use the tag code listed in Column #2.

Column #2 Entries (specific):

B - Bleaching: The use of chemicals or other agents to lighten a gemstone's color.

C - **Coating**: The use of such methods as lacquering, enameling, inking, foiling, sputtering of films to improve, provide color or add other special effects.

D - **Dying**: The introduction of coloring matter into a gemstone to give it a new color, intensify present color or improve color uniformity.

F - **Filling**: The masking of surface cavities usually with molten glass or plastic to improve appearance.

H - **Heating**: The intentional use of heat to effect desired alteration of color and/or clarity.

I - **Impregnation**: General infusion of a substance such as colorless paraffin or wax into a porous material.

L - **Lasering**: The use of a laser and chemicals to reach and alter objectionable inclusions in diamonds.

O - **Oiling**: The penetration of colorless oil into voids and faults to improve overall appearance.

P - **Stabilization**: The use of a colorless bonding agent within a gemstone to improve durability and appearance.

R - **Irradiation**: The use of high energy or sub-atomic particle bombardment to alter and improve a gemstone's color. Often followed by a heating process.

U - **Surface Diffusion**: The use of high temperature and chemicals resulting in the shallow penetration of near surface coloration and/or asterism in a gemstone.

GEMSTONE ENHANCEMENT INFORMATION GUIDE

GEMSTONE	Tag Code		ENHANCEMENT			CONSUMER CARE	
	1	2	Method	Frequency Used	Stability	Care Required	Special Advice
ALEXANDRITE	A						
AMAZONITE	E						
		I	Waxed or oiled to improve appearance.	Commonly	Good	Special	Avoid heat, chemicals and ultra-sonic.
AMBER	E						
		H	Heated to improve appearance, add "sun spangles" or deepen color.	Occasionally	Good	Normal	Avoid chemicals and ultra-sonic.
		D	Dyed or surface treated to add color.	Rarely	Good	Normal	Avoid repolishing surface.
AMETHYST	A						
		H	Heated to lighten color.	Rarely	Excellent	Normal	
ANDALUSITE	A						
AQUAMARINE	E						
		H	Heated to improve color.	Commonly	Excellent	Normal	

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	Frequency Used	Stability	CONSUMER CARE Care Required	Special Advice
BERYL							
"Maxixe" Type	E	R	Irradiated blue from pale pink.	Rarely	Poor	Special	Color fades in light.
Pink	E	H	Heated from orangy colors.	Occasionally	Excellent	Normal	
Yellow-Green	A						
Red	A						
Yellow	E	R	Produced by irradiation.	Occasionally	Good	Normal	
CHALCEDONY							
Agate	E	D	Dyed	Usually	Excellent	Normal	
Onyx (black)	E	D	Dyed	Usually	Excellent	Normal	
Carnelian	E	H,D	Heated or dyed to produce color.	Commonly	Excellent	Normal	
Jasper	A						
Chrysoprase	A						
CHRYSOBERYL							
Cats'-Eye	A						
Transparent Varieties:							
Yellow	A						
Brown	A						
Green	A						
CITRINE	E	H	Produced by heating various quartzes.	Usually	Excellent	Normal	

— — — —

GEMSTONE ENHANCEMENT INFORMATION GUIDE

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	Frequency Used	Stability	CONSUMER CARE Care Required	Special Advice
CORAL							
Black	A					Special	Avoid chemicals, abrasives and cosmetics.
White	E	B	Bleached	Commonly	Excellent	Special	Same as above.
Pink	A					Special	Same as above.
Orange	A					Special	Same as above
"Gold"	E	B	Bleached from black coral.	Commonly	Excellent	Special	Same as above.
Red	E	D	Dyed	Rarely	Good	Special	Same as above.
DIAMOND							
Colorless	A						
		L	Laser drilled to improve appearance.	Occasionally	Excellent	Normal	
		C	Coated to disguise off color.	Rarely	Fair to Good	Special	Will lose color with recutting.
DIAMOND							
Colored	E						
		R	Irradiated and/or heated to induce fancy colors.	Occasionally	Excellent	Normal	Avoid heating treated greens as they may fade.

GEMSTONE ENHANCEMENT INFORMATION GUIDE

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	Frequency Used	Stability	CONSUMER CARE Care Required	Special Advice
EMERALD	E						
		O	Oiled to improve appearance.	Commonly	Good	Special	Avoid temperature changes, chemicals, and ultra-sonic.
		D	Dyed with colored oil.	Occasionally	Good	Special	Same as above.
GARNETS							
Almandite	A						
Demantoid	A						
Grossularite	A						
Pyrope	A						
Rhodolite	A						
Spessartite	A						
Tsavorite	A						
HEMATITE	A						
IOLITE	A						
IVORY & BONE	E						
		B	Bleached to whiten and remove discoloration.	Commonly	Very Good	Special	Avoid chemicals and ultra-sonic.
		D	Dyed for artistic purposes.	Occasionally	Good	Special	Same as above:

GEMSTONE ENHANCEMENT INFORMATION GUIDE

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	Frequency Used	Stability	CONSUMER CARE Care Required	Special Advice
JADE							
Jadeite	E	D	Dyed to imitate natural colors.	Commonly	Good	Special	Avoid strong light, chemicals and ultra-sonic.
Nephrite	A	D	Dyed to alter color or for artistic purposes in carving.	Rarely	Good	Special	Avoid chemicals.
KUNZITE	A						
LAPIS-LAZULI	E						
		D	Dyed to provide color and uniformity.	Occasionally	Good	Special	Avoid chemicals and ultra-sonic.
		I	Impregnated with wax or oil to improve appearance.	Occasionally	Good	Normal	
MALACHITE	A					Special	Avoid chemicals and abrasives.
MOONSTONE	A						

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	ENHANCEMENT Frequency Used	ENHANCEMENT Stability	CONSUMER CARE Care Required	CONSUMER CARE Special Advice
OPAL Black or Gray	A						
		O	Oiled to hide crazing.	Rarely	Fair	Special	Avoid heat, chemicals and ultra-sonic with all opals.
		I	Impregnated with plastic to hide crazing.	Rarely	Good	Normal	Same as above.
Boulder	A						
		O	Oiled to hide crazing.	Rarely	Fair	Normal	Same as above.
		I	Impregnated with plastic to hide crazing.	Rarely	Good	Normal	Same as above.
White	A						
		D	Dyed with colored plastic.	Rarely	Good	Normal	Same as above.
		O	Oiled to hide crazing.	Rarely	Good	Special	Same as above.
		I	Impregnated with plastic to hide crazing.	Rarely	Good	Normal	Same as above.

GEMSTONE ENHANCEMENT INFORMATION GUIDE

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	ENHANCEMENT Frequency Used	ENHANCEMENT Stability	CONSUMER CARE Care Required	CONSUMER CARE Special Advice
OPAL (continued) Matrix	A						
		D	Special type takes dye to appear black.	Commonly	Fair	Special	Avoid repolishing or recutting.
PEARL Natural	E						
		B	Bleached to improve color and appearance.	Commonly	Excellent	Special	Avoid cosmetics and household chemicals.
		D	Dyed black.	Rarely	Good	Special	Same as above.
Cultured	E						
		B	Bleached to improve color and appearance.	Commonly	Good	Special	Same as above.
		D	Dyed to give rosy tint. Dyed blue and black.	Commonly Occasionally	Good Good	Special Special	Same as above. Same as above.
		R	Irradiated to produce blue and gray colors.	Occasionally	Good	Special	Same as above.
PERIDOT	A					Special	Avoid sudden temperature changes.

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	Frequency Used	Stability	CONSUMER CARE Care Required	Special Advice
RHODONITE	A						
RUBY	E						
		H	Heated to improve color and appearance.	Commonly	Excellent	Normal	
		D	Dyed with colored oil to improve appearance.	Rarely	Fair	Special	Avoid household chemicals and ultra-sonic.
		F	Surface cavities filled with a foreign material including glass.	Rarely	Fair to Good	Special	Foreign material is fragile and may fall out.
		U	Diffusion of color on surface or surface asterism.	Rarely	Good	Special	Avoid repolishing or recutting.
SAPPHIRE (All colors)	E						
		H	Heated to produce or intensify color; make color uniform, or to lighten stones.	Usually	Excellent	Normal	
		U	Diffusion of color on surface or surface asterism (blue only)	Rarely	Good	Special	Avoid repolishing or recutting.

GEMSTONE ENHANCEMENT INFORMATION GUIDE

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	Frequency Used	Stability	CONSUMER CARE Care Required	Special Advice
SAPPHIRE (Continued)							
		R	Irradiation of yellow stone to provide temporary intense yellow or orange color.	Rarely	Very Poor	Special	Fades quickly in light.
SERPENTINE	E						
		D	Dyed various colors.	Commonly	Good	Normal	
SODALITE	A						
SPINEL	A						
TANZANITE	E	H	Heated to produce violet-blue color.	Usually	Excellent	Special	Avoid sudden temperature changes.
TOPAZ-Blue	E	R	Irradiated and heated to produce color.	Usually	Excellent	Normal	
TOPAZ Yellow/Orange	E	R	Irradiated to intensify color.	Occasionally	Good	Special	Avoid heat and strong light.
Pink	E	H	Heated from certain brown stones.	Usually	Excellent	Normal	

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	Frequency Used	Stability	CONSUMER CARE Care Required	Special Advice
TOURMALINE							
Chrome/ vanadium	A						
Cats'-Eye	A						
Yellow/Orange	A						
		H	Heated to improve color.	Rarely	Excellent	Normal	
Green, Blue	E						
		H	Heated to improve color.	Commonly	Excellent	Normal	
		R	Irradiated to improve color.	Occasionally	Very Good	Normal	
Pink, Red, Purple	E						
		H	Heated to improve color.	Occasionally	Excellent	Normal	
		R	Irradiated to intensify color.	Occasionally	Very Good	Normal	
		P	Stabilized with colorless bonding agent to improve durability and appearance.	Occasionally	Very Good	Normal	
TURQUOISE	E						
		P	Stabilized with plastic to improve color and durability.	Commonly	Good	Normal	

GEMSTONE ENHANCEMENT INFORMATION GUIDE

GEMSTONE	Tag Code 1	Tag Code 2	ENHANCEMENT Method	Frequency Used	Stability	CONSUMER CARE Care Required	Special Advice
TURQUOISE (Continued)							
		I	Impregnated with oil or wax to enhance color.	Commonly	Fair to Good	Special	Avoid hot water and household chemicals.
		D	Dyed to improve color.	Rarely	Poor	Special	Same as above.
ZIRCON							
Yellow, Brown and Green	A						
Blue, Colorless and Red		H	Heated brown crystals turn these colors under certain conditions.	Always	Good	Normal	Avoid abrasives.

MAN-MADE PRODUCT GUIDE

Any synthetic, imitation, or assembled product must have on its tag the appropriate symbol indicated in the man-made product guide.

Note: Synthetic, imitation, or assembled product should be clearly identified as such on every stone paper, container, invoice and memorandum.

MAN-MADE PRODUCT GUIDE

TYPE	TAG	DEFINITION	COMMON EXAMPLES	CARE REQUIRED	SPECIAL ADVICE
Synthetic (laboratory grown)	SS	A laboratory grown material that exhibits essentially the same physical, optical and chemical properties as its naturally occuring counterpart.	Synthetic Alexandrite,	Normal	
			Amethyst, Emerald	Normal	
			Ruby, Sapphire, Spinel	Normal	
			Zirconia/Cubic (a diamond simulant)	Normal	
			Opal	Special	Avoid sudden shocks and temperature changes, household chemicals, cosmetics and abrasives.
Imitation	MM	Laboratory grown material, other than glass and plastic, that is used to simulate the appearance, but not necessarily duplicate the properties of a natural gemstone.	YAG	Normal	
			GGG	Normal	
			Strontium Titanate	Special	Same as above.
	YY	Manufactured product, fabricated in glass or plastic to imitate or resemble the appearance, but not the characteristic properties of a natural gemstone.	Glass	Special	Same as above.
			Plastic	Special	Same as above.

TYPE	TAG	DEFINITION	COMMON EXAMPLES	CARE REQUIRED	SPECIAL ADVICE
Assembled	ZZ	Multiple layers or combinations of manufactured and/or natural materials fused, bonded, or otherwise joined together to imitate the appearance of a natural gemstone, create a unique design or generate unusual color combinations.	Opal (various combinations) Garnet/Glass Sapphire/Synthetic Sapphire Colorless Beryl/Green bonding and/Colorless Beryl	Special Special Special Special	Avoid sudden shocks and temperature changes, household chemicals, cosmetics and abrasives with all assembled stones.

Note: Some synthetics imitate gemstones that do not have the same optical, physical and chemical composition.

(e.g. light blue synthetic spinel imitate aquamarine; light purplish synthetic sapphire imitate natural alexandrite; dark blue syntehtic spinel imitate natural blue sapphire; brownish-red synthetic ruby imitate red garnets, etc.)

Enclosure 3

Technical Issues Associated with Distribution of Radioactive Gems

For the radionuclides normally contained in irradiated topaz, the exempt concentration limit is about 0.4 nanocuries per gram. The University of Missouri and GA Technologies have proposed release limits above our exempt concentration limits. The University of Missouri requested a release limit of about 0.6 nanocuries per gram, and GA Technologies requested 2 nanocuries per gram. The staff does not recommend an exemption to allow distribution of gems to the public if they contain radioactivity above exempt concentration limits (i.e., licensable quantities). Section 32.11(c) prohibits radioactive material in products designed for "application to a human being," but exemptions could be granted pending review of the issue, in light of the assumed low hazard involved.

With respect to interim release limits for irradiated gems, the most straightforward choice would be the exempt concentration limits, because they are already specified in the regulations. There is a question as to whether these limits would provide adequate health protection, because the regulations are over 20 years old and were not developed to protect against products which are worn for long periods of time in direct contact with the body. However, the information currently available to the staff indicates that the current exempt concentration limits would provide adequate protection for gems. The staff would continue to gather data, and could impose a lower limit at a later date if necessary. The staff would also review the quality control procedures of applicants, to assure that screening methods were adequate to prevent release of gems with excess levels of radioactivity.