CLAIMS

We claim:

1. A system for monitoring restraint of one or more containers ~~objects~~ that have been restrainedly secured to a container ship ~~vehicle~~ by one or more restraint members, the system comprising:

the one or more containers;

the one or more restraint members for restraining respective ones of the one or more containers, wherein the one or more restraint members each comprise a turnbuckle member configured for fastening to a fixed point on the container ship via a shackle or fork member;

a plurality of sensors each configured for monitoring one or more of a compressive or tensile stress or strain in one of the one or more restraint members, wherein each of the plurality of sensors is attached to the shackle or fork member of the turnbuckle member for monitoring stress or strain in one of the turnbuckle members, and wherein each of the plurality of sensors comprise a Fiber Bragg Grating (FBG) sensor configured for measuring the stress or the strain in one of the turnbuckle members; ~~and~~

a controller optically coupled to the plurality of sensors and ~~for~~ configured to periodically ~~interrogating~~ interrogate each of the plurality of sensors to ascertain a value of stress or strain detected by the respective sensor; and

a computing device electrically coupled to the controller and configured to monitor the stress or strain values ascertained by the controller and to determine whether each of the stress or strain values ascertained by the controller for the one or more restraint members satisfies a threshold condition in the FBG sensors for shipboard applications,

wherein the one or more restraint members monitored by the plurality of sensors are associated with only a subset of the one or more containers ~~objects~~ restrainedly secured to the container ship ~~vehicle~~ and are less than all restraint members restrainedly securing ~~an object~~ a container of the subset, the plurality of one or more containers ~~objects~~ in the subset selected in a selective manner based on ~~object~~ container location.

2. The system of claim 1, wherein the plurality of one or more containers in the subset selected in the selective manner based on container ~~object~~ location ~~selects an object~~ are selected for the subset based on the container ~~object~~ being at a location more vulnerable as compared to locations of other containers ~~objects~~ in an immediate vicinity.

3. The system of claim 2, wherein the container ~~object~~ being at a location more vulnerable as compared to locations of other ~~objects~~ containers in an immediate vicinity comprises the container ~~object~~ being at an outermost container ~~object~~ location in a row of ~~objects~~containers.

~~4. The system of claim 3, wherein the selective manner based on object location selects an object for the subset by selecting only one object for the subset in the row of objects.~~

4. The system of claim 3, wherein the containers on the container ship are stacked in longitudinally-oriented rows; and the outermost container location is a position on one of an outermost row with reference to a container ship longitudinal centerline.

5. The system of any of claims 2 to 4 wherein the container ~~object~~ being at a location more vulnerable as compared to locations of other containers ~~objects~~ in an immediate vicinity comprises the container ~~object~~ being part of a stack of containers ~~objects~~ having a highest stack weight as compared to stack weights of other stacks of containers ~~objects~~ in an immediate vicinity.

~~6. The system of any of the preceding claims, wherein the vehicle is a vessel.~~

~~7. The system of claim 6, wherein the vessel is a container ship.~~

6. The system of any of claims 1 to 5, further comprising the container ship.

~~8. The system of claim 7, wherein the one or more objects comprise one or more containers.~~

~~9. The system of claim 6, wherein the one or more restraint members each comprise a turnbuckle member configured for fastening to a fixed point on the vessel via a shackle or fork member, and wherein each of the plurality of sensors is attached to the shackle or fork member of the turnbuckle member for monitoring stress or strain in one of the turnbuckle members.~~

~~10. The system of claim 9, wherein each of the plurality of sensors comprises a Fiber Bragg Grating (FBG) sensor configured for measuring the stress or the strain in one of the turnbuckle members.~~

~~11~~7. The system of ~~claim 10~~any of claims 1 to 6, further comprising at least one temperature compensation sensor configured for adjusting stress or strain values detected by one or more of the FBG sensors.

~~12. The system of claim 1, wherein the vehicle is a container ship, and wherein each of the plurality of sensors comprises a Fiber Bragg Grating (FBG) sensor, the system further comprising a computing device coupled to the controller for determining whether the value of stress or strain satisfies a threshold condition in the FBG sensors for shipboard applications.~~

8. The system of any of claims 1 to 7, wherein the controller is configured to interrogate each of the plurality of sensors at an interval having a frequency of one Hertz.

9. The system of any of claims 1 to 8, wherein the threshold condition in the FBG sensors for shipboard applications comprises a tensile or compression strain value in excess of a predetermined baseline value, and wherein the computing device is configured to set an alert condition when the value of stress or strain ascertained by the controller satisfies the threshold condition in the FBG sensors for shipboard applications.

10. The system of claim 9, wherein the alert condition is only set when the threshold condition has been satisfied continuously over each of a predetermined number of time-successive interrogations of one of the plurality of sensors.

~~13. A device for monitoring a restraint member applied to restrainedly secure an object to a~~

~~vehicle by, the device comprising:~~

~~a sensor coupled to the restraint member and configured for monitoring one or more of a compressive or tensile stress or strain in the restraint member, wherein the restraint member comprises a turnbuckle member configured for fastening an object to a fixed point on the vehicle via a shackle or fork member, and wherein the sensor is attached to the shackle or fork member of the turnbuckle member.~~

~~14. The device of claim 13, wherein the sensors sensor is configured for monitoring stress or strain in the turnbuckle member.~~

~~15. The device of claim 14, wherein the sensor comprises a Fiber Bragg Grating (FBG) sensor.~~

~~16~~11. A method for monitoring restraint of one or more containers ~~objects that have been~~ each restrainedly secured ~~to~~ in a container field on a container ship ~~vehicle~~ by one or more restraint members, the method comprising the steps of:

providing a plurality of sensors, each of the plurality of sensors configured for attachment to a shackle or fork member of a turnbuckle member of a respective one of the one or more restraint members, wherein the turnbuckle member is configured to fasten the respective one of the one or more containers to a fixed point on the container ship, and each of the plurality of sensors comprising a Fiber Bragg Grating (FBG) sensor configured for ~~monitoring~~ measuring one or more of a compressive or tensile stress or strain in the turnbuckle member of one of the one or more restraint members, wherein the plurality of sensors are associated with only a subset of the one or more containers ~~objects~~ that have been restrainedly secured to the ~~vehicle~~container ship, the plurality of

containers ~~objects~~ in the subset selected in a selective manner based on container ~~object~~ location; ~~and~~

configuring a controller optically coupled to the plurality of sensors ~~for~~ to periodically ~~interrogating~~ interrogate each of the plurality of sensors to ascertain a value of stress or strain detected by the respective sensor; and

configuring a computing device electrically coupled to the controller to monitor the stress or strain values ascertained by the controller and determine whether each of the values of stress or strain ascertained by the controller for the one or more restraint members satisfies a threshold condition in the FBG sensors for shipboard applications.

~~17. The method of claim 16, wherein the vehicle is a vessel.~~

~~18. The method of claim 17, wherein the vessel is a container ship.~~

~~19. The method of claim 18, wherein the one or more objects comprise containers.~~

~~20. The method of claim 19, wherein the one or more adjustment restraint members each comprise a turnbuckle member configured for fastening to a fixed point on the container ship via a shackle or fork member, wherein each of the plurality of sensors is configured to be attached to the shackle or fork member of one of the turnbuckle members to monitor stress or strain in the one of the turnbuckle members.~~

~~21. The system method of claim 20, wherein each of the plurality of sensors comprises a Fiber Bragg Grating (FBG) sensor configured for measuring strain in one of the turnbuckle members on board the container ship.~~

~~22~~12. The method of claim ~~21~~11, further comprising the step of:

providing at least one temperature compensation sensor configured for adjusting stress or strain values detected by one or more of the FBG sensors.

~~23~~13. The method of claim ~~21~~11, further comprising the ~~steps~~ step of:

~~determining whether the value of stress or strain detected by each of the one or more of the FBG sensors satisfies a threshold condition for shipboard applications; and~~

~~setting~~ configuring the computing device to set an alert condition when the threshold condition has been satisfied for at least one of the ~~one or more of the FBG~~plurality of sensors.

~~24~~14. The method of claim ~~23~~13, wherein the computing device is further configured to set the alert condition ~~is~~ only ~~set~~ when the threshold condition has been satisfied continuously over each of a predetermined number of time-successive interrogations of the at least one respective sensor.

15. The method of claim 14 wherein configuring the controller further includes configuring the controller to interrogate each of the plurality of sensors at intervals having a frequency of one Hertz.

16. The method of claim 11, further comprising the steps of:

fastening each container of the subset of the one or more containers to a fixed point on the container ship by the turnbuckle member of one of the one or more restraint members; and

attaching each of the plurality of sensors to the shackle or fork member of the turnbuckle member of one of the one or more restraint members.

~~25~~17. The method of claim ~~19~~16, wherein attaching each of the plurality of sensors to the shackle or fork member of the turnbuckle member of one of the one or more restraint members comprises attaching ones of the plurality of sensors to restraint members securing the subset of the one or more containers ~~that are secured by restraint members having sensors for monitoring one or more of compressive or tensile stress or strain are a subset of containers on the container ship, the subset of containers on the container ship comprising the subset of the one or more objects that have been~~ restrainedly secured to the container ship.

~~26~~18. The method of claim ~~25~~16 or 17, wherein~~:~~ attaching each of the plurality of sensors to the shackle or fork member of the turnbuckle member of one of the one or more restraint members comprises attaching ones of the plurality of sensors to restraint members securing ~~the containers on the container ship are stacked in longitudinally-oriented rows; and~~ones of the one or more containers ~~that are secured by restraint members having sensors for monitoring one or more of compressive or tensile stress or strain are~~ positioned on one of an outermost row with reference to a container ship longitudinal centerline, the containers on the container ship being stacked in longitudinally-oriented rows, and/or positioned in a row having a highest stack weight among the ~~stacked~~ plurality of containers on the container ship.